

The impact of the Brazilian Family Health Strategy and the conditional cash transfer on tuberculosis treatment outcomes in Rio de Janeiro: an individual-level analysis of secondary data

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ABSTRACT

Background Unsuccessful tuberculosis outcomes are frequent; bold policies are needed to end the tuberculosis (TB) epidemic to attain the third Sustainable Development Goal (SDG) by 2030. We examined the effect of the Family Health Strategy (FHS) and its interactions with the conditional cash transfer programme (CTP) on TB outcomes in Rio de Janeiro, Brazil.

Methods We performed individual-based analyses of a database resulting from deterministic and probabilistic linkages of the TB information system, FHS registries and CTP payrolls. Patients ≥ 15 years old treated with the standard RHZE regimen were included. The rates of successful outcomes were analysed according to coverage by FHS. Effects from the CTP and its interactions with the FHS were examined among the poorest.

Results FHS coverage increased the likelihood for successful outcomes by 14% (12–17%) among 13 482 new cases, and by 35% (25–47%) among 1880 retreatment cases. The CTP had an independent effect but no interaction with the FHS among the poorest.

Conclusions This is the first individual-based study to show a relevant protection of poor urban communities regarding patient-important health outcomes by the Brazilian FHS and CTP. These findings support strategies of universal health coverage, primary care strengthening and social protection to achieve a major SDG.

Keywords conditional cash transfer, neglected diseases, primary healthcare, secondary data, tuberculosis

Introduction

The United Nations' post-2015 third Sustainable Development Goals (SDG)¹ include achieving universal health coverage, financial risk protection and the end of the tuberculosis (TB) epidemic by 2030. As the directly observed treatment (DOT) strategy was not sufficient to achieve the 85% successful treatment rates recommended by the World Health Organization (WHO) and to achieve the 2015 Millennium

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Development Goals, new approaches and evidence of their impact are needed. Strengthening of the health system and no catastrophic costs for patients' families are clear recommendations of the post-2015 End TB Strategy.²

In Brazil, healthcare is a constitutional right since the 80s.³ Free-of-charge (tax-paid) universal and equitable healthcare is the goal of the Brazilian 'Sistema Único de Saúde' (SUS), the largest public health system in the world. Over 140 million people's health depend exclusively on SUS.⁴ The Family Health Strategy (FHS, see Supplementary material) was launched in Brazil in the 90s to ensure capillarity of primary healthcare, and is currently still expanding throughout the country, mainly in poor neighbourhoods during the implementation period.⁵ Family Health teams consist of one physician, one nurse, one nurse aid and 6–10 community healthcare agents, responsible for 1000 families (3000–4500 persons) living in a specific catchment area.⁶ Community healthcare agents do regular home visits and offer home-delivered or clinic-based directly observed TB treatment.

Ecological studies have consistently shown that increasing coverage by the FHS reduces post-natal and child mortality.^{7–13} Other health improvements have also been suggested in isolated studies.^{14–16} However, the provision of quality health services implies in more than effective health access and programmes. Indeed, studies on the impact of the FHS that controlled for the effect of the 'Bolsa Família' programme, the largest conditional cash transfer programme (CTP) in the world, showed that the latter enhances the beneficial effect of the former.^{7,10,16} Although CTP is not expected to have direct effects on health outcomes, it does improve service utilization. Indeed, conditionality of the Bolsa Família programme includes not only educational but also health obligations,⁶ which stimulates health service usage. Health impacts from the Bolsa Família programme were shown for TB treatment outcomes,¹⁷ leprosy detection¹⁶ and infant mortality.¹⁰

To date, to the best of our knowledge, no individual-based study has evaluated the effects of the FHS and its synergy with the CTP on health outcomes. Evidence for the abovementioned health impacts derives mainly from ecological studies, with the exception of two.^{15,17} Ecological studies can result in the so-called 'ecological fallacy', i.e. the overall observed effect in the community is not necessarily observed in the exposed population.

TB is a primary care-sensitive poverty-related disease that incurs in heavy social and economic burden.¹⁸ Thus, we conducted an individual-based evaluation of the effects of the FHS on TB treatment outcomes in Rio de Janeiro, a city with a 66.8/100 000 TB incidence rate and a 69.2% successful TB treatment rate.¹⁹ We also analysed the independent

and imbricated effects of both programmes (FHS and Bolsa Família) among those with <4 years of schooling, as a proxy for lower socioeconomic status.

Methods

Setting

Rio de Janeiro is a large metropolis where 6 498 837 inhabitants live under extreme income inequity (GINI coefficient = 0.6391 in 2013). The FHS coverage in the city has expanded from 3.5% of the population in 2009 to 70% in 2016.²⁰ Most clinics were opened in the poorest neighbourhoods of the city, including slums. Bolsa Família currently covers 57% of entitled families (see Supplementary material).

Study design and population

Eligible patients to this retrospective cohort study were adult (≥ 15 years) residents of Rio de Janeiro city notified to the TB information system (SINAN-TB) by any health facility, with a known treatment outcome. According to the Brazilian National TB Program Guidelines,²¹ the current recommended regimen for susceptible TB treatment in Brazil is 2 months of Rifampicin, Isoniazid, Pyrazinamide and Ethambutol (2RHZE) followed by 4 months of RH (4RH), extendable to a total of 9 months in specific situations. All patients needing a change of the RHZE regimen due to drug intolerance or drug-resistance are followed by secondary and tertiary facilities, no longer at the primary care level. Thus, only susceptible TB patients using RHZE were included in the present study.

Data sources

The following databases referring to the study period were cross-linked:

- (i) *TB information system (SINAN-TB)*: TB notification is compulsory in Brazil. Cases notified between 1 January 2011 and 31 December 2014 were included. 2014 was defined as the limit period to exclude patients still on treatment, because in 2015 the list of possible outcomes was changed in Brazil (failure was added). Thus, we used registries until 2014 to ensure uniformity and completeness of outcomes.
- (ii) *Cadastro Único*: All candidates to any social programme (including Bolsa Família) in the country must register to this database, and reported information about their income is checked by a social worker. We also used the payroll of the benefit to make sure subjects were receiving it by the time of their TB diagnosis.

(iii) *Family Health Strategy Electronic medical records*: Individuals registered to a Family Health clinic from 1 January 2009 to 31 December 2014 were included.

Exposure variables

The main exposure variable was registration to a FHS clinic. We also explored the benefit from the Bolsa Família programme among the poorest (see definition below) and its interactions with the FHS.

Outcome definitions

The following outcomes were registered in the TB information system during the study period: cure (which, in Brazil, includes treatment completion without bacteriological confirmation), loss to follow-up, death from TB, death from other causes, drug-resistance suspicion, transfer out, change of diagnosis and change of treatment regimen. We further classified outcomes as successful (cure) or unsuccessful (loss to follow-up, transfer out—considered as losses to follow up in this study—and death from any cause). Other outcomes were excluded from the analyses, since they are not TB cases or are not followed in the primary care level (Supplementary material).

Adjustment variables

We used SINAN-available socio-demographic and comorbidity variables to adjust the model: sex, age, race, years of schooling, site of TB (pulmonary versus extrapulmonary or both), HIV status, diabetes and alcohol addiction.

Procedures

Individuals in the TB notification database were searched for in the other databases. Because there is no unique identifier common to all databases, a strategy combining deterministic and probabilistic record linkage based on users' and mother's name, sex and date of birth, through the softwares R-project (R Core Team, 2016) and OpenRecLink (<http://reclink.sourceforge.net/>),²² respectively (Supplementary material), was used. A study subject was considered exposed to the FHS during TB treatment if he/she was registered to the FHS unit prior to or up to 30 days after TB diagnosis.

For the Bolsa Família CTP, biannual payrolls for each year were available. Subjects were considered exposed to cash transfer benefits if they were in at least one payroll during the year of TB diagnosis. We assumed that if a subject was in the payroll for one of those months, he/she has received the benefit for the following 6 months (duration of treatment). Indeed, it takes at least 6 months before one is

excluded from the payroll because of non-adherence to the programme's conditionality.

Analyses

The analyses were stratified by the TB information system entry status: new and retreatment cases. Bivariate and multivariate analyses were performed with the dependent (treatment outcome) and the main independent covariates (exposure and adjustment variables). To estimate the relative risk for successful outcome and the 95% confidence intervals (CI), we opted for a modified Poisson regression approach (i.e. Poisson regression with a robust error variance),^{23,24} due to the higher precision of the estimates of this technique.²⁵

To properly evaluate the effects of the CTP, a choice was made to evaluate this effect among those more likely to be eligible to receive the benefit. Thus, a separate analysis was performed in the subgroup of TB patients with <4 years of schooling, with low education levels being used as a proxy for poverty and eligibility to the CTP.

The analysis consisted on repeating the previously used Poisson regression with a robust error variance model in this subgroup of individuals and measuring a possible interaction between the FHS and the CTP regarding their effect on TB treatment success, both in the multiplicative and the additive scales. For the analysis, programme exposure was classified into four categories: no exposure to any of the programmes, exposure to CTP only, exposure to FHS only and exposure to both programmes.

In the multiplicative scale, the relative risks and the 95% CI were estimated by the modified Poisson regression approach, by including an interaction term to the model. The estimated measures of interaction on the additive scale in this analysis were: the relative excess risk due to interaction, which expresses part of the total effect due to the interaction,²⁶ the attributable proportion due to interaction, which expresses the proportion of the combined effect due to the interaction²⁷ and the Synergy Index, defined as the ratio between the combined effects and the individual effects.²⁸

To evaluate the effect of cases with missing adjustment variables, a sensitivity analysis including all cases was performed. Analyses were carried out using the R-project software.

Ethics

The study was approved by the Health Municipal Secretariat of Rio de Janeiro City, protocol 50 385 515.2.0000.5279 on 27 November 2015.

Results

There were 26 931 TB cases reported to SINAN among residents of Rio de Janeiro between 2011 and 2014. Overall successful treatment rates were 73%: 75% for new and 55% for retreatment cases. Excluded from this database were 2286 cases: a reported outcome was missing for 1436; 513 had the diagnosis changed, 324 had drug-resistance suspicion and 13 changed their therapy due to regimen intolerance. Therefore, a total of 21 463 new and 3182 retreatment TB cases treated with RHZE remained for database linkage (Fig. 1). Additional 7675 new cases and 1293 retreatment cases were excluded because of missing data on adjustment variables, as well as 306 children among new cases and 9 among retreatment cases.

Out of the 13 482 new TB cases, 2552 (18.9%) were exposed to FHS at the time of their TB diagnosis. New TB cases exposed to FHS were less likely to be white, diagnosed with HIV, and to have extrapulmonary disease. They were more likely to have a successful outcome (83.1 versus 73.3%, Table 1).

Out of the 1880 retreatment TB cases, 338 (18.0%) were exposed to FHS at the time of their TB diagnosis (Fig. 1). Retreatment TB cases exposed to FHS were less likely to be diagnosed with HIV, and more likely to have successful outcomes (71.6 versus 51.3%, Table 1).

In the multivariate analysis of new TB cases, the FHS increased the risk for successful outcomes by 14% (12–17%). Of notice, among the adjustment variables, markers of poverty such as non-white ethnicity, less schooling, HIV-infection and alcohol abuse decreased the likelihood for successful outcomes (Table 2).

Among TB retreatment cases, the multivariate analysis showed that the FHS increased the risk for successful outcomes by 35% (25–47%). Again, the same markers of poverty decreased the likelihood for successful outcomes (Table 2).

Among individuals with <4 years of schooling, 1841 new cases and 385 retreatment cases were diagnosed. Among these new cases, the adjusted relative risk of success in CTP-exposed individuals was 1.19 (1.09–1.31), the adjusted relative risk of success in FHS-exposed was 1.20 (1.12–1.28) and the adjusted relative risk for both was 1.25 (1.12–1.40), all reaching statistical significance. The relative risk ratio of the CTP–FHS interaction on a multiplicative scale was 0.88 (0.76–1.01). The relative excess risk due to interaction, the attributable proportion due to interaction and the synergy index did not yield any additive effect. For the retreatment cases, the adjusted relative risk for CTP was 1.53 (1.14–2.06), for FHS 1.46 (1.18–1.81) and for both 1.41 (0.93–2.15), with no interaction found on either of the scales (Table 3).

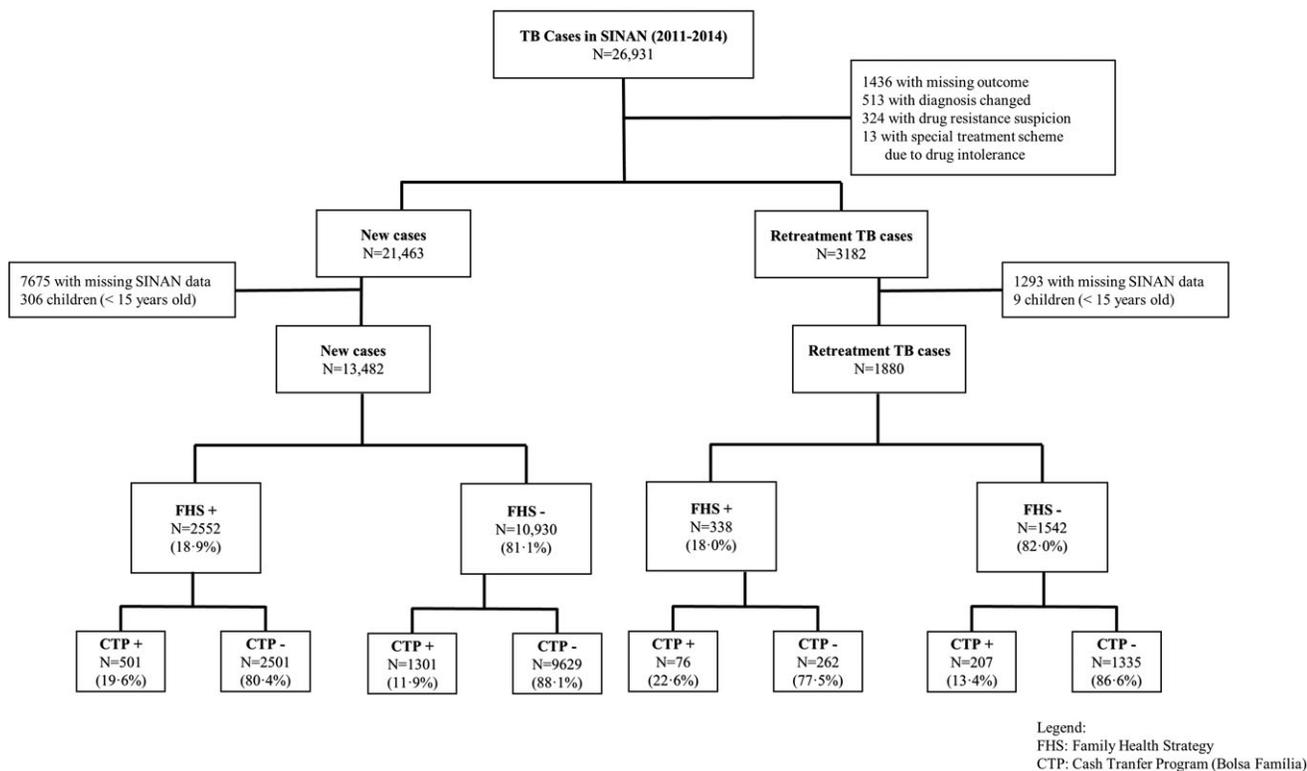


Fig. 1 Study population. FHS: Family Health Strategy; CTP: cash transfer programme (Bolsa Família).

Table 1 Distribution of new and retreatment TB cases by exposure to Family Health Strategy, Rio de Janeiro City, 2011–14

| Characteristics | New TB cases | | | Retreatment TB cases | | |
|-------------------------|-------------------------------|-------------------------------------|---------|------------------------------|-----------------------------------|---------|
| | FHS exposed (%) (n = 2552) | FHS not exposed (%) (n = 10 930) | P-value | FHS exposed (%) (n = 338) | FHS not exposed (%) (n = 1542) | P-value |
| Male gender | 61.7 | 63.2 | 0.146 | 68.8 | 70.1 | 0.912 |
| Age | | | | | | |
| 15–24 | 23.4 | 21.1 | 0.988 | 9.2 | 15.1 | 0.461 |
| 25–34 | 21.8 | 25.1 | | 27.5 | 28.0 | |
| 35–44 | 17.4 | 18.2 | | 20.7 | 22.4 | |
| 45–54 | 18.6 | 16.7 | | 20.1 | 18.7 | |
| 55–64 | 12.3 | 11.4 | | 16.9 | 9.3 | |
| ≥65 | 6.4 | 7.5 | | 5.6 | 9.3 | |
| White race | 35.0 | 44.1 | <0.001 | 29.9 | 30.0 | 0.958 |
| Schooling (year) | | | | | | |
| <4 | 15.6 | 13.2 | 0.289 | 22.8 | 20.0 | 0.754 |
| 4–12 | 78.2 | 74.2 | | 74.3 | 75.3 | |
| >12 | 6.2 | 12.6 | | 3.0 | 4.7 | |
| Pulmonary TB (yes) | 89.9 | 86.0 | <0.000 | 95.6 | 93.3 | 0.124 |
| HIV-positive (yes) | 7.7 | 10.4 | <0.001 | 12.0 | 15.9 | <0.001 |
| Diabetes (yes) | 8.0 | 6.9 | 0.078 | 7.4 | 5.0 | 0.077 |
| Alcohol addiction (yes) | 9.0 | 9.4 | 0.382 | 18.9 | 16.5 | 0.288 |
| Success (yes) | 83.1 | 73.3 | <0.001 | 71.6 | 51.3 | <0.001 |

Source: SINAN-TB and Family Health Strategy (FHS) electronic medical records, Rio de Janeiro City Health Secretariat.

FHS = Family Health Strategy; RR = relative risk; TB = tuberculosis.

Discussion

The WHO has established a target of at least 85% successful outcomes for TB treatment to achieve the SDG specific TB aims. Brazil, one of WHO's TB priority countries because of its high TB burden, has been struggling to improve TB outcomes, but rates of successful treatment have remained around 74.2% for new cases and 51.6% for retreatment cases in recent years.¹⁹ Rio de Janeiro is among the capitals with the worst TB outcomes in the country (69.2 and 42.5% of cure, respectively).¹⁹

Main findings of this study

In the current study, we confirmed very low overall rates of successful treatment outcomes but found that coverage by the FHS substantially increased these rates. This effect was observed both for new (14% increase) and—to a much higher extent—for retreatment cases (35% increase), and was independent of—and despite—clinical and socio-economic variables known to have an adverse impact on TB outcomes.^{29–31} Moreover, among the least educated (a proxy for the poorest), besides the protective effect of the FHS,

there was a clear independent benefit from the CTP, although no synergistic effect could be demonstrated with the current design and sample size.

In Brazil, non-complicated susceptible TB is treated in the primary care level, preferably in FHS clinics. Populations uncovered by the FHS are treated in traditional primary care clinics by general practitioners or eventually, by pulmonologists or infectious disease specialists. Our results thus suggest that the FHS model itself—and not availability of any model of primary care—improves the outcomes. We believe that the comprehensive package of care interventions of the FHS—a patient-centred healthcare system sensitive and responsive to patients' educational, emotional and material needs—is the basis for the clear effect we see in this model. Home visits by community health agents for DOT and for reminders among those who skip a consultation, capillarity of the clinics in the territory facilitating access, as well as strengthened bond between health teams, the communities and users may be the underlying mechanisms for our finding. Regardless of the mechanisms by which the FHS package works, the effect of this model over TB outcomes is clear and was robust in the sensitive analysis including missing values cases.

Table 2 Relative risk and 95% confident intervals for successful tuberculosis treatment adjusted for potential confounding variables in a multivariate model, according to Family Health Strategy exposure in Rio de Janeiro City, 2011–14

| Covariates | New TB cases RR [CI 95%] | Retreatment TB cases RR [CI 95%] |
|-------------------|-----------------------------|-------------------------------------|
| FHS covered | | |
| No | Reference | Reference |
| Yes | 1.14 [1.12; 1.17] | 1.35 [1.25; 1.47] |
| Sex | | |
| Female | Reference | Reference |
| Male | 0.93 [0.92; 0.95] | 0.95 [0.87; 1.03] |
| Age (year) | | |
| 15–24 | Reference | Reference |
| 25–34 | 1.01 [0.98; 1.04] | 1.13 [0.97; 1.32] |
| 35–44 | 1.05 [1.02; 1.08] | 1.17 [1.00; 1.38] |
| 45–54 | 1.10 [1.07; 1.14] | 1.40 [1.20; 1.63] |
| 55–64 | 1.07 [1.04; 1.11] | 1.58 [1.35; 1.86] |
| ≥65 | 1.00 [0.96; 1.04] | 1.30 [1.07; 1.58] |
| Ethnicity/colour | | |
| Non-white | Reference | Reference |
| White | 1.08 [1.06; 1.10] | 1.09 [1.00; 1.18] |
| Schooling (year) | | |
| <4 | Reference | Reference |
| 4–12 | 1.07 [1.03; 1.10] | 1.12 [1.00; 1.25] |
| >12 | 1.19 [1.15; 1.24] | 1.41 [1.20; 1.66] |
| Pulmonary TB | | |
| No | Reference | Reference |
| Yes | 0.94 [0.92; 0.96] | 0.87 [0.75; 1.02] |
| HIV-infection | | |
| No | Reference | Reference |
| Yes | 0.71 [0.68; 0.75] | 0.77 [0.66; 0.89] |
| Diabetes | | |
| No | Reference | Reference |
| Yes | 1.03 [0.99; 1.07] | 0.94 [0.79; 1.11] |
| Alcohol addiction | | |
| No | Reference | Reference |
| Yes | 0.81 [0.77; 0.85] | 0.74 [0.64; 0.84] |

Source: SINAN-TB and Family Health Strategy (FHS) electronic medical records, Rio de Janeiro City Health Secretariat.

FHS = Family Health Strategy; RR = relative risk; TB = tuberculosis.

What is already known on this topic and what this study adds

Social protection is now part of the recommendations of WHO's End TB strategy² because it can impact many steps of TB control—including treatment adherence—but needs a multidisciplinary and integrated approach. Although a systematic review found no clear benefit of incentives and

enablers regarding TB treatment adherence,³² other studies in Brazil¹⁷ and elsewhere^{33,34} have shown an increase in cure rates, besides other benefits for TB control. In our analyses, we found an independent effect of social protection and the FHS in the outcomes of the poorest patients, underscoring the need for comprehensive and intersectorial approaches to end the TB epidemic.

Limitations of this study

Our study has a few limitations. Firstly, we cannot generalize our findings to patients intolerant to the RHZE regimen or presenting with resistant TB, who were outside the scope of our analysis. In addition, as in any study based on secondary data, the reliability of our results depends on the quality of the databases, and many patients had to be excluded because of missing variables. However, the sensitivity analysis including all cases confirmed our results. Finally, unlike the previous analysis,¹⁷ we did not restrict our analyses to users registered to the Cadastro Único. However, TB is a poverty-related disease and Rio de Janeiro is no exception to this rule.

Conversely, the study has many strengths. It consists of an individual-based analysis. We used multiple techniques to link the databases and complemented them with a clerical review, which improves the quality of the final linked database. Previous studies have shown that the databases we used are reliable despite incompleteness.³⁵ Moreover, our findings were robust when patients with missing values were included in the analyses. Finally, we believe the risk of bias is low in this study. Selection bias is unlikely: in Brazil, all patients with TB must be notified and TB drugs are only provided by the public health system, which will also report the final outcome. It is also unlikely that reporting of outcome was biased. Both FHS and traditional primary care doctors or nurses are required to feed the notification system at most 1 year after treatment initiation.

Conclusions

In summary, this is the first individual-based study to show a clear and relevant protection of poor urban communities regarding patient-important health outcomes by the Brazilian FHS taking into account the effect of other relevant programmes and socioeconomic variables. A significant and independent increase in successful TB outcomes was observed for those registered in the FHS services. Universal health coverage through effective primary care programmes may help countries achieve other health targets of the SDG, such as TB control. The effect from the CTP

Table 3 Relative risk and 95% confident intervals for successful tuberculosis treatment in individuals with <4 years of study, adjusted for potential confounding variables* and assessment of the interaction terms between Family Health Strategy and Cash Transfer Programme, Rio de Janeiro city, 2011–14

| | New TB cases | | Retreatment TB cases | |
|--|----------------|---------------------|----------------------|---------------------|
| | Freq. [% cure] | RR [CI 95%] | Freq. [% cure] | RR [CI 95%] |
| Programmes | | | | |
| None | 1248 [63.9%] | Reference | 269 [42.8%] | Reference |
| CTP exposed | 195 [73.8%] | 1.19 [1.09; 1.31] | 39 [56.4%] | 1.53 [1.14; 2.06] |
| FHS covered | 319 [79.9%] | 1.20 [1.12; 1.28] | 64 [70.3%] | 1.46 [1.18; 1.81] |
| Both | 79 [82.3%] | 1.25 [1.12; 1.40] | 13 [69.2%] | 1.41 [0.93; 2.15] |
| Measure of interaction on a multiplicative scale | | RR [CI 95%] | | RR [CI 95%] |
| Ratio of RRs | – | 0.88 [0.76; 1.01] | – | 0.63 [0.38; 1.05] |
| Measure of interaction on an additive scale | | Measures [CI 95%] | | Measures [CI 95%] |
| Relative excess risk due to interaction | – | –0.14 [–0.53; 0.26] | – | –0.58 [–1.85; 0.69] |
| Attributable proportion due to interaction | – | –0.11 [–0.44; 0.23] | – | –0.41 [–1.52; 0.69] |
| Synergy Index | – | 0.65 [0.17; 2.56] | – | 0.41 [0.04; 4.66] |

Source: SINAN-TB and Family Health Strategy (FHS) electronic medical records, Rio de Janeiro City Health Secretariat. Cadastro Único and Bolsa Família payment databases, Rio de Janeiro City Social Development Secretariat.

*Adjusted for sex, age, ethnicity/colour, form of TB, HIV status, diabetes and alcohol addiction.

CTP = cash transfer programme; FHS = Family Health Strategy; RR = relative risk; TB = tuberculosis.

among the poorest underlines the need of a multisectorial and integrated approach to reach the SDG goal for TB and other health issues. Additional research could bring more insights to this discussion.

Supplementary data

Supplementary data are available at the *Journal of Public Health* online.

Conflicts of interest

Betina Durovni was under-secretary of Rio de Janeiro Municipal Health Department (2014–16). All authors had access to data and approved the final version of the article.

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