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Cure rates for tuberculosis in the municipality of Rio de Janeiro, Brazil, in 2012 compared with coverage by, and time of establishment of, Family Health units, and socio-economic and demographic factors

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Abstract *Tuberculosis (TB) has high prevalence and is considered a world emergency by the World Health Organization (WHO), being the greatest cause of death from infectious diseases in adults. It is directly associated with access to health services and socio-economic factors. A reform of Primary Care in the municipality of Rio de Janeiro began in 2010, with coverage increasing from 7% in that year to 48.2% in 2014. This article compares the proportion of cures of TB, coverage by the Family Health Strategy (FHS), how long it has been in place, and socio-economic and demographic factors in the municipality of Rio, based on new cases notified in the year 2012. An association was found between cure of TB and the variable gender, being 40% greater in females – odds ratio 1.4 (CI95% 1.21–1.62); and with residence in favelas – OR 0.86 (CI95% 0.73–1.02), but there was no association with coverage of the FHS (OR 1.06; CI95% 0.92–1.22), nor with the time for which the teams had been in place. FHS coverage in the municipality of Rio was put in place as priority in areas of greater vulnerability; at the time of this study, more than 91% of the teams had been in place for less than five years before the date of diagnosis. These factors probably contributed to it not being possible to detect better results in the cure of tuberculosis in areas covered by the FHS in the year 2012.*

Key words *Primary healthcare, Tuberculosis, Family Health Strategy, Family health system*

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Introduction

Tuberculosis (TB) is an infectious disease that occurs at an important level of magnitude in the world. In 1993 the World Health Organization declared it to be a world emergency disease, as the largest cause of adult death from infectious diseases[1].

Brazil is one of the 22 priority countries in the control of tuberculosis by the WHO. These countries account for 80% of the world's cases. Brazil is 16th placed among these countries by absolute number of new cases in 2014. The prevalence of TB in that year was 33.5/100,000 population and the death rate was 2.3 per 100,000 population. In spite of this position, there has been a trend of reduction of 2.3% in annual average incidence, and 0.5 deaths/100,000 population, over the years 2005 to 2014[1].

In the same year of 2014, occurrence in the state of Rio de Janeiro was 60.9 per 100.000 population, almost twice the national average. The proportion of cure of bacilliferous pulmonary TB in the state was 68%, compared to a national average of 72.5%, lower than the 85% expected by the WHO[2].

The illness has a direct relationship with poverty and social exclusion, and thus the people who are most socially vulnerable have the highest chance of this illness developing and proliferating. A systematic review was published in 2013 correlating tuberculosis with socio-economic factors[3]. The studies used the census sectors as a level for aggregation of data, and found association with: a) households of more than five people; b) illiteracy; c) proportion of the population aged over 65; d) proportion of the population with low income; e) proportion of people over 15 with low schooling; f) proportion of immigrants, g) households with more than one resident per room; h) number of cases of re-treatment per census sector; and i) number of families with more than one case, per census sector.

Socio-economic factors also influence access to health services, resulting in more vulnerable people having more difficulty of access[4], which in turn contributes to delay of diagnosis and treatment of TB, increasing the possibilities of abandonment of treatment, one of the main obstacles for the control of this disease[4].

Primary Healthcare has a fundamental role in the cure of tuberculosis since it is the first level of access of a health system, presenting some of the basic principles of organization such as longitudinality, integrality of care and coordination of the care within the health system itself[5]. Thus, primary healthcare makes possible greater access and adhesion to treatment of the TB, as well as reaching the more vulnerable populations[2].

The countries that have adopted primary healthcare as an ordering factor of the health system have shown the effect with evidences of improvement in health indicators, as well as lower investments in health when compared with those that do not have a structured Primary Healthcare system[6,7].

The municipality of Rio had the worst Family Healthcare coverage of all Brazilian capitals, with approximately 7%.The reform of primary healthcare began in 2009, and increased this coverage to almost 40% in 2012 and 48.2% in 2015[8].

Currently there are two primary healthcare models in Rio de Janeiro: (1) Family Health, with a wider offer of health services, based on the principles of Family Healthcare (access, longitudinally, coordination of care, and integrality)[5] – with generalist doctors and nurses and health responsibility defined in territorial terms; and (2) traditional primary care, with the presence of focal specialists (pediatricians, gynecologists, clinical practitioners, and others).

Considering tuberculosis to be an illness strongly related with socio-economic factors and also with access to health services, it becomes necessary to evaluate the relationship between expansion of coverage of Primary Healthcare and the cure of TB in the municipality.

The purpose of this article is to compare the proportion of cure of tuberculosis according to both the coverage and the time of existence of implementation of family health, and socio-economic and demographic factors in the municipality of Rio de Janeiro, based on the new cases notified in the year 2012.

Methods

This is a cross-sectional study, carried out in the municipality of Rio de Janeiro, correlating cure of tuberculosis with coverage by the Family Health system and socio-economic and demographic variables, having as a unit of analysis individuals in new notified cases of TB. For some of the socio-economic explanatory variables, the census sectors were the level of aggregation. The municipality is in the southeastern region of Brazil, between latitudes 22°44'45.59" and 23°04'58.34" and longitudes 43°05'48.89" and 43°47'43.79". It has an area of 1,199.82 km^2, demographic den-

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sity of 5,265.82/km^2 and an exclusively urban population in 2015 estimated at 6,476,631[9]. It is divided into 161 districts, 34 administrative regions, and 10 health regions (planning areas). It has great economic and social contrasts, with approximately 22% of the population living in sub-normal agglomerations[9].

The population of the study comprises new cases of tuberculosis in residents in the municipality notified in 2012 – a total of 5,794 reports.

For identification of the Family Health coverage the technique of geo-referencing was used based on the address of the household, attributing a geographic position to each record (latitude and longitude). This made it possible to identify in which polygon of Family Health coverage each case was located, by spatial consultation. The coverage maps were prepared by the Rio de Janeiro municipal health department and correspond to the coverage existing in 2012. To achieve the georeferencing of the addresses, the cases of institutionalized people (356 cases), and homeless people living in the streets (67cases), were excluded from this phase of the study since these people cannot be classified as belonging to the responsibility of the team, nor as not having Family Health coverage. This was necessary in view of the impossibility of characterizing the primary healthcare coverage for these cases. This georeferencing of addresses used the "Geocode" tool available on Google Maps through a free Application Programming Interface (API). This process used the basis of addresses and localities provided by Google. Its exactness can be assessed based on a score from 0 to 10, (0 – not found; 1 – country level; 2 – state level; 3 – sub-region; 4 – city; 5 – postcode; 6 – address name; 7 – street intersection; 8 – address; 9 – name of building or firm; 10 – maximum precision). Those with result below '5' were considered lost. The records with result between '8' and '10' were considered to have acceptable precision. The other records were reviewed manually.

The software used for construction of the maps of coverage of the Family Health system and spatial consultation of data was ArcGIS, version 9.3 (Esri, Redlands, CA, USA) in projection Latlong/WGS84, made available in the *shapefile* extension. In 1,064of the 5,272 geo-referenced records (20.18%)it was not possible to determine the geographical coordinates with precision, characterizing losses to the geo-referenced sample.

The variable *time of implementation of Family Health teams* was obtained from the data of the Health Ministry's National Health Establishments Records System (SCNES –*Sistema de Cadastro Nacional de Estabelecimentos de Saúde*). For the purposes of classification of Family Health coverage all the records located in polygons of areas covered by the Family Health System in which the diagnosis took place as from three months from implementation of the team were considered as having coverage, and all the other cases as not having coverage. Three months was used as a cutoff point because it is the minimum reasonable time for a new Family Health team to carry out full registration of people resident in its territory of health responsibility and carry out an initial health diagnosis.

The epidemiological indicators and some socio-economic indicators such as age, gender, race/color and schooling were extracted from the records of the SINAN, representing each individual. The other socio-economic data were obtained from the polygons of the census sectors of the IBGE of the year 2010[9], represent the averages of the results of the residents in the same census sector. In this case the values were repeated for each individual in the same census sector.

The outcome variable considered in the present study was closing of the case by cure (yes/no), obtained from the SINANdatabase, and the exposure variables were COVERAGE – whether or not there was Family Health coverage (yes/no), and MONTHS_DIAG – time from implementation of the team up to the diagnosis of TB, controlling for the other variables, even if they were not significant, but were recognizably important.

The following demographic and socio-economic variables were added for control:

(a) AGE, (b) GENDER, (c) RACE/COLOR (white/non-white),(d) SCHOOLING (level), (e) FAVELA –home in favela (yes/no), (f) INCOME– proportion of heads of household with average monthly income of twice the minimum wage, or less[3], (g) BATHROOM–average number of bathrooms per domicile, (h) DENSITY–average residents per household, and (i) AGING–aging rate.

Descriptive analysis of the data was carried out with the SPSS 20.0 software (SPSS Inc., Chicago, United States)[10], through a bivariate logistic regression (gross analysis) and subsequently the multiple logistic regression model was applied, with one of the categorical exit variables being dichotomous (dependent variable) and multiple explanatory variables (independent), based on the theoretical reference of association of TB with socio-economic variables[11,12]. Termination by cure was adopted as the dependent variable (y) and the following were used as explanatory

variables: COVERAGE, MONTHS_DIAG, GENDER, RACE/COLOR, SCHOOLING, FAVELA, INCOME, BATHROOM, DENSITY, AGEING. The method of selection of variables used was theBackwardmethod, with verification of the significance of the likelihood ratio. For analysis of residuals the standardized form was selected with a confidence interval for the odds ratio. The significance of the variables was evaluated based on the Wald test and the effect measured by the Odds Ratio. Adjustment of the model was evaluated by the Hosmer-Lemeshow test.

To illustrate the spatial distribution of TB the point density analysis technique known as kernel density estimation was used. This consists of generating a point density surface, within a region of influence, the points being weighted by the distance of each one to the location of interest, for visual identification of the 'hot spots' on the map. A radius of 2,000mwas used with smoothing surface of 20 meters, through the ArcGIS program, version 9.3 (Esri, Redlands, CA, USA)[11], in Latlong/WGS84 projection. For this, the kernel ratio was used, which consisted of arbitrarily attributing all the geo-referenced points in the centroid of the corresponding census sector, dividing the number of cases notified by the population of each census sector.

The study was approved by the Ethics Committee of the Municipal Health Department of Rio de Janeiro and CAAE, in compliance with the recommendations of National Health Council Resolution 466/12.

Results

5,794 new cases of tuberculosis were identified in residents of the Municipality of Rio de Janeiro in 2012, resulting in an incidence rate of 90.67cases per 100,000 population. Of these, 5,436 new cases were closed (93.82%). The percentage of cure was70.42% (3,828 new cases) of the total of cases closed. In this period there were 369 cases of death from tuberculosis, resulting in an annual specific mortality coefficient of 5.77cases per 100,000 population, suggesting a death rate of 5.04% of the cases closed. If we consider only the cases closed notified by primary healthcare units (4,272 new cases), the percentage of cure rises to 74.58%.

Of the total of cases closed with cure, 83.23% were in primary healthcare notifying units.

Of all the new cases of residents in the municipality of Rio notified in 2012, 73.73% of notifications took place in primary healthcare units, and only 159 cases (2.74%) in prison units, and 49 cases (0.85%) in private units. Practically all the cases notified from primary healthcare units were closed (98.95%), but in 69.18% of the cases in prison units (110 cases) and in 13.41% of the cases in hospital units (172 cases) they were not closed (Table 1).

Units other than primary healthcare units had 87.53% (316 cases) of all the 361 cases that were not in a situation of closure.

Of the total of 4,208 cases geo-referenced, 2,639 (62.7%) were covered by the Family Health System. The distribution of these cases, however, was not uniform over the municipality: there was a greater concentration in the regions with worse social development indicators.

To evidence the heterogeneous nature of the distribution the density ratio of the cases per population of each census sector was calculated using kernel estimation (Figure 1). It can be seen that the 'hot spots' are concentrated in the central regions of the municipality of Rio and the North Zone (the *Alemão* Complex, Acari), followed by the South Zone (the *Rocinha* favela) and the Eastern Zone of the map (Santa Maria Community).

Of the geo-referenced cases (N = 4,208), the median age was 36, the lowest age less than one year, and the highest age 102. The majority of the cases were in males (n = 2,651; 63.0%), people with race/color identified as white (n = 1,708; 43.4%) and with primary schooling (n = 1,628; 57.1%).

An association was found in the bivariate analysis between coverage by the Family Health System and the variables *age*, *gender, race/color, schooling*, and *living in favela*. People living in a favela had 3.65 (CI95%, 3.04-4.39) times more chance of having Family Health coverage than those not living in a favela ($p < 0.001$). Those considered to be illiterate had 2.23 (CI95%, 1.61-3.07) times more chance of being covered by a Family Health system than those with higher education ($p < 0.001$). People of white race/skin color had 0.57 (0.50-0.65) times the chance of having Family Health coverage ($p < 0.001$) compared to non-white people.

Family Health coverage was associated, also, with supervised treatment – OR 2.28 (CI95%: 1.96-2.54) and with search for contact parties– OR 1.38 (CI95%: 1.21-1.57).

Further in the bivariate analysis, an association was found between cure of tuberculosis and the variables *gender, race/color, schooling, residents in favela, low income, average number of bath-*

Table 1. New cases of tuberculosis notified, by closing situation, and type of notifying unit. Rio de Janeiro (RJ), Brazil, 2012.

Closing situation	Type of notifying health unit											
	Primary HC	%	Hospital	%	Prison	%	Private	%	Not known	%	total	%
Not closed	**45**	**1.05**	**172**	**13.42**	**110**	**69.18**	**11**	**22.45**	**23**	**71.88**	**361**	**6.23**
Closed	**4,227**	**98.95**	**1,110**	**86.58**	**49**	**30.82**	**38**	**77.55**	**9**	**28.13**	**5,433**	**93.77**
Cure	3,186	75.37	589	53.06	33	67.35	17	44.74	3	33.33	3,828	70.46
Abandoned	538	12.73	98	8.83	5	10.20	1	2.63	2	22.22	644	11.85
Death from TB	92	2.18	134	12.07	4	8.16	3	7.89	1	11.11	234	4.31
Death from other causes	66	1.56	52	4.68	0	0.00	2	5.26	0	0.00	120	2.21
Transfer	225	5.32	204	18.38	6	12.24	12	31.58	2	22.22	449	8.26
Change of diagnosis	71	1.68	29	2.61	1	2.04	3	7.89	1	11.11	105	1.93
Multi-resistant TB	49	1.16	4	0.36	0	0.00	0	0.00	0	0.00	53	0.98
Wrong classification	3	0.07	0	0.00	0	0.00	0	0.00	0	0.00	3	0.06
Total	**4,272**	**100.00**	**1,282**	**100.00**	**159**	**100.00**	**49**	**100.00**	**32**	**100.00**	**5,794**	**100.00**

Source: SINAN municipal database (DATASUS/Health Ministry). Updated January 10, 2016.

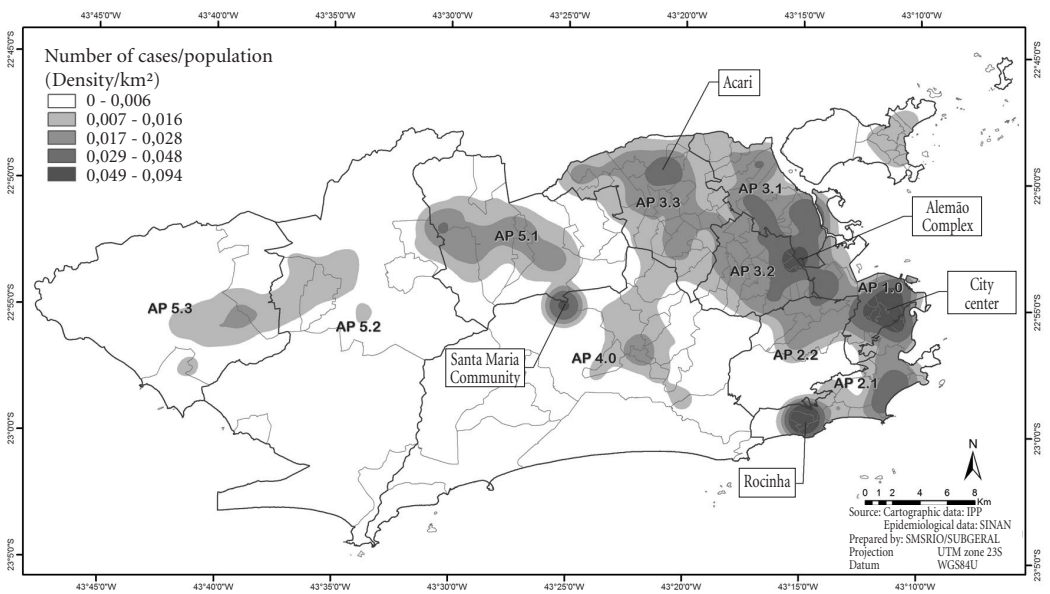

Figure 1. Kernel ratio of new tuberculosis cases. Municipality of Rio de Janeiro (RJ), Brazil, 2012.

rooms, density and aging rate (Table 1). Females had 1.40 (CI95%:1.21-1.62) times more chance of cure of tuberculosis than males ($p < 0.001$). People of white race/color had0.75 (CI95%:0.65-0.87) times the chance of cure compared to non-white people ($p < 0.001$), and people with higher education had 2.10 (CI95%:1.43-3.08) times more chance of cure than people who were illiterate ($p < 0.001$).

The socio-economic variables which in the gross analysis had association with cure of tuberculosis, and the variables *Family Health coverage* and *time of existence of Family Health teams* were used for the binary and logistic regression model,

Table 2. Gross analysis of new casesclosed (N = 4,208), vs.cure of tuberculosis and socio-economic and assistential variables. Municipality of Rio de Janeiro (RJ), Brazil, 2012.

Variables (N = 4.208)	Cura						OR	CI 95%	p-value
	Yes		No		Total				
	n	%	n	%	n	%			
Family Health Coverage									
Yes	1,824	62.3	718	63.7	2,542	62.7	1.00[a]		0.414
No	1,103	37.7	409	36.3	1,512	373	1.06	0.92-1.22	
Time – team in place									
4 to 11 months	150	25.1	367	24.0	517	24.3	1.00[a]		0.285
12 to 17 months	132	22.1	376	24.6	508	23.9	0.86	0.65-1.13	0.874
18 to 25 months	171	28.6	409	26.8	580	27.3	1.02	0.79-1.33	0.717
>25 months	145	24.2	374	24.5	519	24.4	0.95	0.72-1.24	
Age									
≤ 36	1,396	47.7	542	48.1	1,938	47.8	1.00[a]		0.830
>36	1,531	52.3	585	51.9	2,116	52.2	1.02	0.89-1.17	
Gender									
Male	1,785	61.0	774	68.7	2,559	63.1	1.00[a]		< 0.001[b]
Female	1,142	39.0	353	31.3	1.495	36.9	1.40	1.21-1.62	
Race/color									
White	1,258	45.4	396	38.5	1.654	43.5	1.00[a]		< 0.001[b]
Non-white	1,512	54.6	632	61.5	2.144	56.5	0.75	0.65-0.87	
Schooling									
Illiterate	198	9.7	84	11.6	282	10.2	1.00[a]		0.955
Primary	1,113	54.4	468	64.8	1.581	57.1	1.01	0.76-1.33	0.001[b]
Secondary	453	22.1	113	15.7	566	20.4	1.70	1.23-2.36	< 0.001[b]
Higher	282	13.8	57	7.9	339	12.2	2.10	1.43-3.08	
Favela									
Yes	672	23.0	230	20.4	902	22.2	1.00[a]		0.078
No	2,255	77.0	897	79.6	3,152	77.8	0.86	0.73-1.02	0.002[b]
Low income	2.927	100.0	1127	100.0	4,054	100.0	0.60	0.43-0.83	0.002[b]
Bathroom	2,927	100.0	1127	100.0	4,054	100.0	1.29	1.01-1.52	0.001[b]
Density	2,927	100.0	1127	100.0	4,054	100.0	0.77	0.65-0.91	0.025[b]
Ageing	2,927	100.0	1127	100.0	4,054	100.0	3.89	1.19-12.68	

Source: SINAN municipal database (DATASUS/Health Ministry). Updated January 10, 2016.
Abbreviations: n = sample size; OR = unadjusted odds ratio; CI = confidence interval; p-valor = level of significance. [a] Reference category. [b] Statistical significance $p < 0.05$.

with the variable *cure of tuberculosis* as the dichotomous (Yes/no) dependent variable (y) and the other variables as predictor variables (x) introduced in the same block. The chi-squared statistic of the residuals was 55.02, with p = < 0.001.

In the multivariate analysis (Table 3), the cure of tuberculosis was associated with the variables *gender* and *residents in favela*. Females had 1.33 (CI95%:1.04-1.69) times the chance of cure compared to males. People living in favelas had 1.82 (CI95%: 1.36-2.43) times the chance of cure than people not living in favelas. There was no statistically significant association with time of implantation of Family Health teams, nor with Family Health coverage.

The VIF did not show evidence of multicollinearity for the adjusted model.

Discussion

Notifications in primary health units were 73.73% (4,272 cases) of the total of notified cases, evidencing primary care as an important point of entry to care in the municipality, even though it had an estimated coverage of 39.84% of the population in December 2012 in the municipality[8]. Of these cases, 98.95% have been closed, while 69.18% of all the new cases notified in the prison system did not have closure, representing

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Table 3. Result of the explanatory model: logistical regression (Backward/Likelihood Ratio) (N = 4,208). Municipality of Rio de Janeiro (RJ), Brazil, 2012.

Variable	Wald	*Odds Ratio*	CI 95%	DF	p-value
Female	5.14	1.33	1.04-1.69	1	0,023
White	3.05	1.25	0.97-1.59	1	0,081
Schooling – primary	2.24	0.74	0.51-1.09	1	0,134
Schooling – secondary	2.73	1.49	0.93-2.37	1	0,098
Schooling – highereducation	0.31	1.18	0.65-2.12	1	0,580
Favela (yes)	16.61	1.82	1.36-2.43	1	0,000
Proportion of heads of household with average monthly income of 2 x minimum wage, or less	9.32	0.35	0.17-0.68	1	0,002

Sources: Municipal database of SINAN (DATASUS/MS); IBGE, 2010. Updated January 10, 2016.
Abbreviations: Wald = Wald statistic; DF = degrees of freedom; p-value = significance level. a statistical significance $p < 0.05$.

a very high percentage, in view of the fact that it is a vulnerable population. Also, the very low number of notified cases in the prison system (159 cases) and in the private system (49 cases) attracts attention – representing respectively 2.74% and 0.85% of all the cases.

Souza et al.[4] reported that in the city of Salvador 41%of the cases were notified by the Primary Healthcare System, and in Recife, 45%. This high index (73.73%) in the municipality of Rio is in line with the policy of decentralization of actions on tuberculosis for primary healthcare promoted by the WHO and by the Brazilian Health Ministry[2]. Even so, the ideal is that every patient should be first diagnosed and accompanied by primary healthcare.

The incidence rate of 90.67 and the mortality coefficient of 5.77/100,000 population are considered to be high, compared to the Brazilian prevalence of 33.5 and death rate of 2.3/100,000, respectively.

The percentage of cure, 70.42%, is lower than the value found in other studies in other cities of the country, such as Silva et al.[13] which found 90.9% of the cases closed with cure in Maranhão. However, it is better than in Ceará, where Pinto et al.[14] found a cure percentage of 47.2%.

Many authors have studied the correlation between tuberculosis and socio-economic indicators. Queiroga[12] found a higher differentiation of rates between the strata of *regular* and *worst* conditions of life, in the municipality of Campina Grande (in the State of Paraíba), in which the rate in districts with the lowest QLI (Quality of Life Index) was 86% higher than the rate in the *regular* QLI stratum, but the district with the best QLI had high incidence, possibly due to sub-notification of cases of tuberculosis in the other QLI strata.

In view of the results presented in this study, it is possible to see a higher concentration of cases of tuberculosis in the areas covered by a Family Health team (62.7% of the cases). Considering that tuberculosis is directly related with more vulnerable areas, with worse socio-economic indicators, supposedly the coverage of the Family Health strategy took place unevenly in the territory of the municipality, giving priority to coverage of areas with lower social development. This hypothesis is strengthened when we analyze the distribution of the families that are beneficiaries of the *Bolsa-Família*and the Rio de Janeiro *Cartao-Família* benefits, in which there is a larger concentration in the areas covered by the Family Health Strategy and a spatial superimposition with the distribution of tuberculosis. Analyzing statistically, it is possible to compare this association between Family Health coverage and worse socio-economic situation in the notified cases of tuberculosis in the year 2012. Considering that tuberculosis is also directly associated with socio-economic factors, these factors probably operate as confounding factors in the association between Family Health coverage and cure of tuberculosis.

Of the total of new cases in areas with Family Health coverage (2,639cases), in 271 cases (10.26%) the Family Health teams had been implemented for up to and including three months, and 91% were implemented up to five years, from the date of diagnosis of tuberculosis, evidencing that they are very recent teams in the municipal-

ity of Rio. The time for which the Family Health team has been implemented probably influences care to patients with tuberculosis, especially in identification of new cases, early start of treatment, identification of contacts, and treatment compliance in the case of supervised treatment.

Conclusion

There has been a strong expansion in primary healthcare in the municipality of Rio de Janeirosince 2010, but based on the results found for new cases of TB notified in 2012, it has not yet been possible to evidence better results for cure and abandonment than in areas not covered by the Family Health system, in spite of these areas with coverage having better results of closing of cases and supervised treatment of tuberculosis. Family Health coverage took place preferentially in more vulnerable areas of the municipality of Rio; and also, the short time of implementation of the Family Health team probably contributed to it not yet being possible to detect a significant improvement in the cure of tuberculosis.

Collaborations

JC Prado Júnior took part in the conception, delineation, georeferencing, analysis and interpretation of the data, and writing of the paper; T Virgilio carried out the preparation of the maps and techniques of geoprocessing and revision; R Medronho participated in the conception, writing and critical revision of the article.

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