

# Clinical and epidemiological aspects of tuberculosis in the Federal District (Brazil, 2006 to 2015)

## *Aspectos clínicos e epidemiológicos da tuberculose no Distrito Federal (2006 a 2015)*

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**ABSTRACT:** *Introduction:* Despite the low incidence rates of tuberculosis (TB) in the Federal District (FD), there are socioeconomic discrepancies allied to intense population growth in recent years, which demonstrates the need to study the trend of the disease in different regions of the FD. *Objective:* To describe the trend of morbidity and mortality due to TB in the FD from 2006 to 2015. *Methods:* Ecological study, with descriptive and analytical components, historical series type. *Results:* There was a decreasing trend in incidence rates (IR) (from 15.1 per 100,000 inhabitants to 11.7 per 100,000 inhabitants,  $r = -0.50$ ) and in the cure rate (from 86.0% to 74.7,  $r = -0.91$ ); people experiencing homelessness and incarceration have relative risks from 5 to 16 times higher than the general population; higher IR were found in Paranoá (27.5 per 100,000 inhabitants) and in Estrutural (17.3 per 100,000 inhabitants), areas with poor socioeconomic indicators and demographic explosion during the study period. A higher mean lethality rate was found in Águas Claras (8.5%) and in Lago Sul (7.0%), regions that have a high concentration of homeless and elderly people. *Conclusion:* TB persists as an important public health problem in the FD, especially in impoverished areas, with significant population growth or a high concentration of elderly or vulnerable populations.

**Keywords:** Tuberculosis. Health profile. Morbidity. Mortality. Lethality.

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**RESUMO:** *Introdução:* Apesar dos baixos coeficientes de incidência de tuberculose (TB) no Distrito Federal (DF), há discrepâncias socioeconômicas aliadas ao intenso crescimento populacional nos últimos anos que evidenciam a necessidade de estudar a tendência da doença nos diferentes cenários do DF. *Objetivo:* Descrever a tendência de morbimortalidade por TB no DF de 2006 a 2015. *Métodos:* Estudo ecológico com componentes descritivo e analítico, do tipo série histórica. *Resultados:* Houve tendência temporal de queda dos coeficientes de incidência (CI) (15,1/100 mil habitantes para 11,7/100 mil habitantes;  $r = -0,50$ ) e na proporção de cura (86,0 para 74,7%;  $r = -0,91$ ); populações em situação de rua e privados de liberdade têm riscos relativos de 5 a 16 vezes maior do que a população geral; maiores CI foram observados no Paranoá (27,5 / 100 mil habitantes) e na Estrutural (17,3 / 100 mil habitantes), áreas com indicadores socioeconômicos ruins e com explosão populacional no período; e maiores taxas médias de letalidade foram encontradas em Águas Claras (8,5%) e no Lago Sul (7,0%), regiões que concentram populações em situação de rua e idosos. *Conclusão:* A TB persiste como importante problema de saúde pública no DF, especialmente em áreas empobrecidas, com crescimento populacional expressivo ou com alta concentração de idosos ou de populações vulneráveis.

**Palavras-chave:** Tuberculose. Perfil de saúde. Morbidade. Mortalidade. Letalidade.

## INTRODUCTION

Tuberculosis (TB) is still a major public health problem in Brazil. Even in the Brazilian states that have the lowest incidence of TB and the highest cure rates for the disease, performing timely diagnoses and treatment are major challenges<sup>1</sup>. In Brazil in 2015, 63,189 new cases were reported, which represented an incidence rate of 30.9 per 100 thousand inhabitants<sup>2</sup>. In the same year, according to the Ministry of Health, this rate in the Federal District (FD) was 11.2 per 100 thousand inhabitants, the second lowest incidence of TB in the country<sup>2</sup>.

The FD does not have municipalities, but rather administrative regions (AR). There are currently 31 AR, which practically function as cities. They do not have mayors and councilors, but governor-nominated administrators instead<sup>3</sup>. Despite having one of the best human development indices (HDI) and the highest income *per capita* in the country, there is significant inequality in income distribution in the FD<sup>4,5</sup>.

In 2013, the second worst Gini index in the country (0.570) among federal units (FU) was the DF, which was worse only ahead of the state of Piauí<sup>5-7</sup>. This index measures the degree of income concentration, pointing to the difference between the income of the poorest and the richest<sup>8</sup>. In addition, the FD still lives an intense process of population growth. From 2006 to 2015, it is estimated that the population grew by 22.3% (from 2,383,784 inhabitants in 2006 to 2,914,830 inhabitants in 2015), and some ARs had real demographic explosions in the period, such as Paranoá, which grew by 176.9%<sup>9</sup>.

Since the incidence of TB is related to poverty and population agglomerations<sup>10,11</sup>, it is possible that the population growth of the FD has interfered with the behavior of the disease and that it is different among AR. Because of these reasons, the present study aimed

to describe the temporal trend of TB morbidity and mortality among residents of the FD, by AR, from 2006 to 2015.

## METHODS

This is an ecological epidemiological study, with descriptive and analytical components. It is a historical series, in which the cases included in the study were described and analyzed by year and period of study.

New cases of TB in residents of the FD, who were notified in the Notification Disease Information System (*Sistema de Informação de Agravos de Notificação - Sinan*) from January 1, 2006 to December 31, 2015 were included in the study. Cases that were entered as “unknown” and had information regarding the type of admission variable were kept in the analyzes.

Excluded from the study were cases of patients residing in other states or those that did not have information on their place of residence, those who came back after a relapse, those who came back after previously abandoning treatment, those who relapsed after abandoning treatment, those who were transferred, duplicate cases, cases that were terminated due to a change of diagnosis, and cases that had information errors regarding the diagnosis date - date of diagnosis was the same as the date of birth or prior to 2006.

For the calculations of incidence and mortality, the population bases of the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística - IBGE*) adapted by the Health Information and Analysis Situation Management of the Federal District (*Gerência de Informação e Análise de Situação de Saúde - GIASS / DIVEP / SVS / SES-DF*) of the Undersecretariat of the FD's Penitentiary System (*Subsecretaria do Sistema Penitenciário do DF - Sesipe / DF*) and the Specialized Social Approach Department of the Federal District (*Serviço Especializado de Abordagem Social - SEAS / DF*) were used.

To estimate TB lethality and mortality, using the Tab for Windows program (TabWin), we obtained the number of deaths from TB — a root cause in the International Classification of Diseases (ICD) A-15 to A-19 — recorded in the Information System of Mortality (*Sistema de Informação de Mortalidade - SIM*) that occurred in the study period, year by year, by AR. There was no linkage from the Sinan and SIM databases, as there was no way to access the nominal SIM database.

TB case definitions used were those recommended by the Ministry of Health<sup>12</sup>:

- laboratory criteria: any case which, regardless of clinical form, has at least one positive smear sample, either from a culture or a rapid molecular test for TB (TRM-TB);
- clinical-epidemiological criterion: any case that does not meet the laboratory confirmation criteria described above but has been diagnosed with active TB, taking into account clinical-epidemiological data.

The selected cases were described according to time (year and month of diagnosis), socioeconomic characteristics (age group, sex and education) and demographic

characteristics (AR of residence), clinical form of TB (pulmonary, extrapulmonary or mixed), associated clinical conditions, (HIV, diabetes, alcoholism, smoking and illicit drug use), the most socially vulnerable groups (incarcerated people, people experiencing homelessness, health professionals and indigenous people) and outcome variables (cure, abandonment, transfer and death).

The collected data were inserted, organized and analyzed in Excel spreadsheets (Windows 10). Absolute and relative frequencies were described year by year according to the selected variables, and incidence rates were analyzed in each of the ten years of the historical series (time trend). Relative risks (RR) were calculated from the ratios of the incidence rates.

To evaluate the temporal trend (year to year), Pearson's correlation coefficient ( $r$ ) was used, which measures the intensity and direction of the linear relationship between two quantitative variables, ranging from 0 to  $\pm 1$ , and the closer the number is to zero, the smaller the linear correlation<sup>13</sup>. The formula for calculating Pearson's correlation coefficient ( $r$ ) is given by Equation 1.

$$r_{xy} = \frac{\sum xy - (\sum x)(\sum y) / N}{\sqrt{[\sum x^2 - (\sum x)^2 / N][\sum y^2 - (\sum y)^2 / N]}} = \frac{SS(xy)}{\sqrt{(SS(x)SS(y))}} \quad (1)$$

In which:

$N$  = number of pairs of observations;

$\sum xy$  = sum of the products of the pairs of observations of the variables  $x$  and  $y$ ;

$\sum x$  = sum of observations of the  $x$  variable;

$\sum y$  = sum of observations of the  $y$  variable;

$\sum x^2$  = square sum of observations of the  $x$  variable;

$\sum y^2$  = square sum of observations of the  $y$  variable;

$SS(xy)$  = sample covariance for the variables  $x$  and  $y$ ;

$SS(x)$  = standard variation of the  $x$  variable; and

$SS(y)$  = standard deviation of the  $y$  variable.

Confidence intervals were not estimated, nor was any other technique of statistical inference used, since the analyzes were made from the scope of new reported cases.

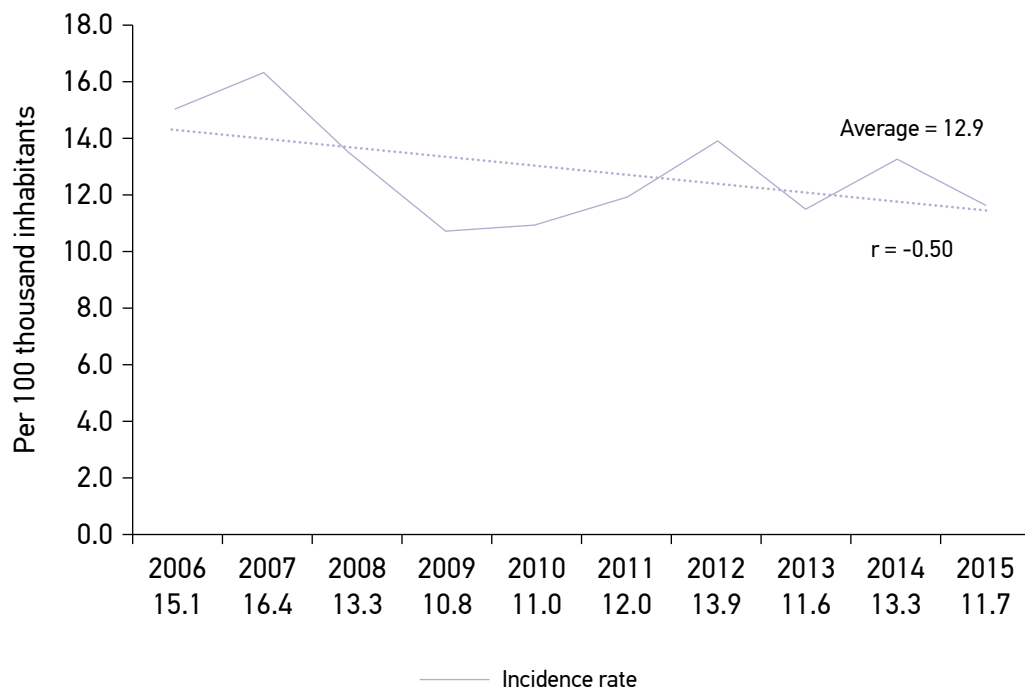
The master's dissertation from the Graduate Program of the Tropical Medicine Center of the School of Medicine of the University of Brasilia, which was defended and approved on March 8, 2017, was the start of the present manuscript. The research project of this study was submitted to the Research Ethics Committees of the University of Brasília (UnB) and the Federal District Teaching and Research Foundation (*Fundação de Ensino e Pesquisa do Distrito Federal* – FEPECS): CAAE 55235616.5.3001.5553; and CAAE 55235616.5.0000.5558; both approved in 2016. All of the data were analyzed in groups, maintaining the privacy and confidentiality of the information collected, therefore informed consent was not required.

## RESULTS

Of the 5,398 TB cases reported in Sinan in the FD from 2006 to 2015, 3,385 were selected for the study because they met the selection criteria. Among the excluded cases were 1,340 residents from other states (or those that did not have information on their FU of residency).

Regarding the temporal distribution of cases, an average of 338.5 new cases of TB were reported each year (standard deviation = 37.4), ranging from 282 in 2009 and 2010 to 399 in 2007. On average, 28.2 new cases of TB were diagnosed monthly (standard deviation = 2.8), and the monthly average distribution ranged from 23.1 cases in December to 33.4 in August, and were not characterized by seasonality.

The annual incidence rate of overall TB tended to decline during the study period, with an average of 12.9 per 100,000 inhabitants, from 15.1 per 100,000 inhabitants in 2006 to 11.7 per 100,000 inhabitants in 2015, with moderate correlation ( $r = -0.50$ ). However, in a five-year cut-off period, it was observed that in the first 5 years of the series (2006-2010), the downward trend in incidence rate was quite evident, with a strong linear temporal correlation ( $r = -0.89$ ). In the last 5 years (2011-2015), the downward trend was very slight and the correlation was very weak/negligible ( $r = -0.18$ ) (Figure 1).



Source: Brazilian Institute of Geography and Statistics and the Reporting Disease Information System.

Figure 1. Temporal trend of the annual tuberculosis incidence rates (Federal District, 2006 to 2015).

Most cases were of males (64.2%), dark or light-skinned black people (58.9%), and those that had up to 8 years of schooling (74.9%). The average incidence rates of TB were 10.4 per 100,000 inhabitants for women and 20.5 per 100,000 inhabitants for men, and the risk in men was 1.9 times higher than in women. The average age of the cases was 42 years and the median was 40 years (the youngest was 1 month and the oldest was 97 years), and 57.5% of the cases occurred in people aged 30 to 59 years old. The highest annual incidence rates of TB were found in people 60 years of age and older (28.2 per 100,000 inhabitants). However, over the years, it was observed that the annual incidence rates of TB in people aged 30 to 59 years old are close to those found in the elderly (Table 1).

During the study period, new cases of TB were reported in residents of all 31 AR of the FD. Ceilândia was the AR with the highest number of new TB cases (16.2% of the total), but the highest average incidence rates were found in Paranoá (27.5 per 100 thousand inhabitants), in Estrutural (17.3%), in Sobradinho I (17.3 per 100 thousand inhabitants), in São Sebastião (16.5 per 100 thousand inhabitants), in Samambaia (16.4 per 100 thousand inhabitants) and in Planaltina (16.2 per 100 thousand inhabitants) (Figure 2).

Few cases were reported as belonging to social groups that are most vulnerable to TB: 11 health professionals, 13 people experiencing homelessness (PEH), 15 indigenous people and 38 incarcerated people (IP). For PEH, in 2015 the incidence rate was 175.0 per 100 thousand inhabitants, with a RR of 14.9 in relation to the general population of the FD. For IP, the incidence rates were 75.8 per 100 thousand inhabitants in 2014 and 195.9 per 100 thousand inhabitants in 2015, which represents an RR of 5.7 in 2014 and 16.7 in 2015, respectively, in relation to the general population of the FD.

Although there was no specific field for IP and PEH in the report forms until 2012, some reports from previous years of the historical series contained “Papuda Prison” and similar terms in the residence address variables. According to this information, from 2006 to 2013, another 32 new cases of TB affected IP, which increased the total number of cases in this population to 70.

With regard to clinical presentation, 70.3% of the cases were pulmonary, 26.9% were extrapulmonary and 2.8% were mixed. By age group, among those older than 15 years old, 70.3% had pulmonary TB and 29.8% had extrapulmonary or mixed TB. In children under 15 years old, 69.8% had pulmonary TB and 30.2% had extrapulmonary or mixed TB.

The proportion of cases tested for HIV during the study period was 71.6%, and there was a considerable increase of testing for HIV in the decade studied, going from 54.2% in 2006 to 90.3% in 2015 ( $r = 0.94$ ). The average positivity of the test was 15.9% (ranging from 19.4% in 2008 to 12.6% in 2010), with a temporal trend of reduction, although the linear correlation is very weak/negligible ( $r = -0.21$ ).

For other associated health problems, completeness for the variables specified in the report form increased considerably over the period. Of those who had information for the variables in the study period, 8.4% had diabetes, 12.9% were smokers, 14.1% were alcoholics, and 6.7% used illicit drugs (Table 2). We also found 394 cases associated with other diseases not specified in the report form, among which included several neoplasms ( $n = 25$ ),

Table 1. Absolute frequencies of new cases and incidence rates of tuberculosis in the Federal District, by sex, age group and year, from 2006 to 2015.

		Age Group										
		0 to 14 years		15 to 29 years		30 to 59 years		≥ 60 years		Ignored	Total	
		n (%)	IR	n (%)	IR	n (%)	IR	n (%)	IR	n (%)	n (%)	MIR
2006	Female	5 (41.7)	1.5	32 (37.2)	7.9	87 (39.7)	20.1	19 (44.2)	26.8	0 (0.0)	143 (39.7)	14.1
	Male	7 (58.3)	2.0	54 (62.8)	36.1	132 (60.3)	35.0	24 (55.8)	42.4	0 (0.0)	217 (60.3)	28.9
		12 (100.0)	1.9	86 (100.0)	11.8	219 (100.0)	26.6	43 (100.0)	32.2	0 (0.0)	360 (100.0)	15.1
2007	Female	8 (66.7)	2.5	31 (34.8)	8.6	80 (35.4)	16.1	25 (35.7)	26.6	1 (50.0)	145 (36.3)	13.4
	Male	4 (33.3)	1.2	58 (65.2)	17.1	146 (64.6)	34.2	45 (64.3)	65.6	1 (50.0)	254 (63.7)	29.6
		12 (100.0)	1.9	89 (100.0)	11.5	226 (100.0)	27.3	70 (100.0)	52.3	2 (100.0)	399 (100.0)	16.4
2008	Female	9 (81.8)	2.7	32 (39.0)	8.5	60 (30.8)	11.3	26 (51.0)	25.4	0 (0.0)	127 (37.5)	12.0
	Male	2 (18.2)	0.6	50 (61.0)	14.2	135 (69.2)	29.7	25 (49.0)	33.6	0 (0.0)	212 (62.5)	19.4
		11 (100.0)	1.6	82 (100.0)	11.6	195 (100.0)	19.7	51 (100.0)	28.3	0 (0.0)	339 (100.0)	13.3
2009	Female	7 (58.3)	2.1	21 (42.0)	5.6	58 (35.8)	10.6	24 (42.1)	22.2	0 (0.0)	110 (39.0)	10.1
	Male	5 (41.7)	1.5	29 (58.0)	8.2	104 (64.2)	22.2	33 (57.9)	42.1	1 (100.0)	172 (61.0)	18.5
		12 (100.0)	1.8	50 (100.0)	7.0	162 (100.0)	16.0	57 (100.0)	30.0	1 (100.0)	282 (100.0)	10.8
2010	Female	5 (45.5)	1.7	19 (30.6)	5.0	45 (28.7)	8.2	25 (51.0)	22.2	0 (0.0)	94 (33.3)	9.3
	Male	6 (54.5)	1.9	43 (69.4)	12.1	112 (71.3)	23.4	24 (49.0)	28.2	3 (100.0)	188 (66.7)	16.4
		11 (100.0)	1.8	62 (100.0)	9.3	157 (100.0)	14.7	49 (100.0)	24.8	3 (100.0)	282 (100.0)	11.0
2011	Female	5 (33.3)	1.6	28 (39.4)	7.3	56 (31.8)	10.0	25 (52.1)	21.9	1 (50.0)	115 (36.9)	10.2
	Male	10 (66.7)	3.2	43 (60.6)	11.9	120 (68.2)	24.7	23 (47.9)	26.7	1 (50.0)	197 (63.1)	16.6
		15 (100.0)	2.4	71 (100.0)	10.0	176 (100.0)	16.7	48 (100.0)	22.9	2 (100.0)	312 (100.0)	12.0

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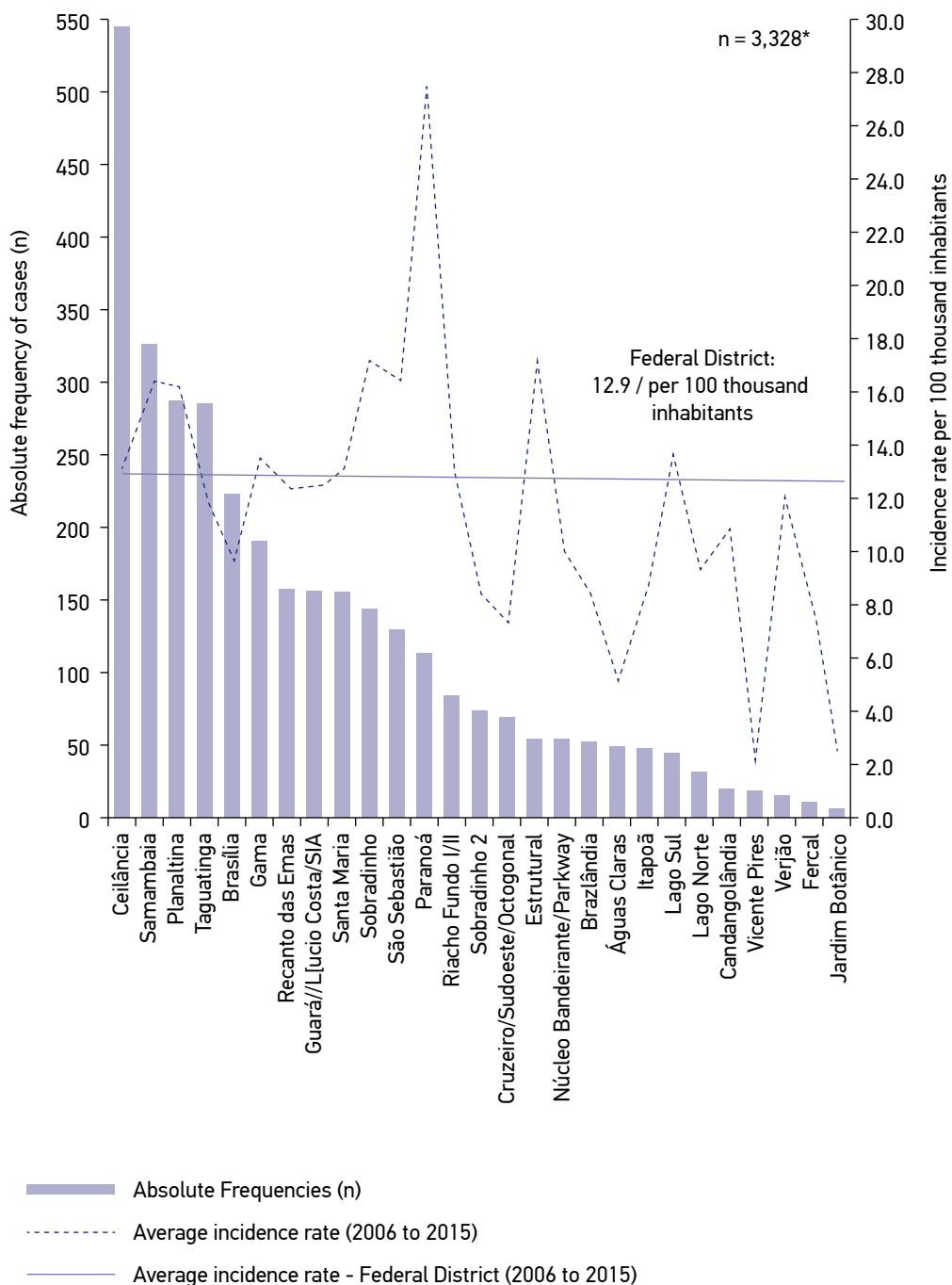
Table 1. Continuation.

		Age Group										
		0 to 14 years		15 to 29 years		30 to 59 years		≥ 60 years		Ignored	Total	
		n (%)	IR	n (%)	IR	n (%)	IR	n (%)	IR	n (%)	n (%)	MIR
2012	Female	6 (42.9)	1.9	32 (39.5)	8.2	70 (30.8)	12.4	22 (48.9)	19.0	0 (0.0)	130 (35.2)	10.4
	Male	8 (57.1)	2.5	49 (60.5)	13.3	157 (69.2)	31.9	23 (51.1)	26.3	2 (100.0)	239 (64.8)	18.5
		14 (100.0)	2.2	81 (100.0)	11.5	227 (100.0)	21.0	45 (100.0)	21.6	2 (100.0)	369 (100.0)	13.9
2013	Female	5 (50.0)	1.6	28 (37.8)	6.9	44 (24.9)	7.1	19 (37.1)	13.7	2 (100.0)	98 (30.3)	7.4
	Male	5 (50.0)	1.6	46 (62.2)	12.0	133 (75.1)	25.3	41 (68.3)	40.4	0 (0.0)	225 (69.7)	19.8
		10 (100.0)	1.6	74 (100.0)	9.8	177 (100.0)	15.3	60 (100.0)	24.6	2 (100.0)	323 (100.0)	11.6
2014	Female	10 (66.7)	3.3	28 (34.6)	6.9	70 (34.1)	11.0	32 (41.6)	21.5	1 (100.0)	141 (37.2)	10.7
	Male	5 (33.3)	1.6	53 (65.4)	13.7	135 (65.9)	24.9	45 (58.4)	41.6	0 (0.0)	238 (62.8)	20.4
		15 (100.0)	2.6	81 (100.0)	10.7	205 (100.0)	17.2	77 (100.0)	28.8	1 (100.0)	379 (100.0)	13.3
2015	Female	4 (36.4)	1.3	27 (35.1)	6.6	63 (31.0)	9.6	14 (29.8)	8.8	1 (50.0)	109 (32.1)	6.6
	Male	7 (63.6)	2.2	50 (64.9)	12.7	140 (69.0)	25.1	33 (70.2)	28.7	1 (50.0)	231 (67.9)	17.2
		11 (100.0)	2.1	77 (100.0)	9.8	203 (100.0)	16.5	47 (100.0)	16.4	2 (100.0)	340 (100.0)	11.7
Total	Female	64 (52.0)	2.0	278 (36.9)	7.2	633 (32.5)	11.6	231 (42.2)	20.8	6 (40.0)	1212 (35.8)	10.4
	Male	59 (48.0)	1.8	475 (63.1)	15.1	1314 (67.5)	27.6	316 (57.8)	37.6	9 (60.0)	2173 (64.2)	20.5
		123 (100.0)	2.0	753 (100.0)	10.3	1947 (100.0)	19.1	547 (100.0)	28.2	15 (100.0)	3385 (100.0)	12.9

IR: incidence rate; MIR: mean incidence rate.

Source: Brazilian Institute of Geography and Statistics and the Reporting Disease Information System.





\*New cases from the Papuda Prison Complex (n = 34) and cases with no information (n = 23) are not in the graph. GIS: graphic industry sector.

Source: Brazilian Institute of Geography and Statistics and the Reporting Disease Information System.

Figure 2. Distribution of absolute frequencies and mean incidence rates of tuberculosis by administrative region (Federal District, 2006 to 2015).

chronic renal failure (n = 12), hepatitis (n = 8), systemic lupus erythematosus (n = 6) and unspecified leishmaniasis (n = 5).

Regarding the outcomes of the studied cases, 99.2% had information, 81.5% were closed because they had been cured, 4.0% were closed because they had abandoned treatment, 8.9% had been closed because they had been transferred, 1.5% were closed due to death from TB, 4.0% were closed due to death from other causes, and 0.1% were closed due to drug-resistant TB or treatment failure. The time trend for cure was down, and the proportion went from 86.0% in 2006 to 74.7% in 2015 ( $r = -0.91$ ). The linear temporal correlation was weak ( $r = -0.37$ ) in the first five years (2006 to 2010) and strong ( $r = -0.88$ ) in the second (2011 to 2015). For abandonment and transfers, there was an upward temporal trend with strong temporal linear correlations ( $r = 0.73$  and  $r = 0.71$ , respectively). It was also observed that 47.9% of the cases that were closed because of transfer, did not leave the FD (45.3% went to “the same municipality” and 2.6% went to “another municipality in the same FU”).

According to SIM data, during the study period, 133 people died from TB in the Federal District. The temporal trend for the absolute frequency of deaths increased ( $r = 0.46$ ) and ranged from 4 deaths in 2009 to 19 deaths in 2013. The average mortality rate for TB at 10 years was 0.5 deaths per 100,000 inhabitants and ranged from 0.2 per 100,000 inhabitants in 2009 to 0.7 per 100,000 inhabitants in 2013. An upward temporal trend was observed,

Table 2. Frequencies of diabetes, smoking, alcoholism and illicit drug use in new tuberculosis cases reported in the Federal District from 2006 to 2015.

Year	Diabetes		Smoking*		Alcoholism		Drug addiction*	
	n (%)	Completeness n (%)	n (%)	Completeness n (%)	n (%)	Completeness n (%)	n (%)	Completeness n (%)
2006	15 (31.9)	47 (13.1)	-	-	24 (45.3)	53 (14.7)	-	-
2007	25 (10.4)	241 (60.4)	-	-	25 (10.5)	238 (59.6)	-	-
2008	21 (8.1)	258 (76.1)	-	-	22 (8.6)	257 (75.8)	-	-
2009	15 (6.9)	216 (76.6)	-	-	33 (15.3)	216 (76.6)	-	-
2010	15 (6.8)	220 (78.0)	-	-	25 (11.2)	224 (79.4)	-	-
2011	26 (10.9)	239 (76.6)	-	-	33 (13.5)	245 (78.5)	-	-
2012	17 (6.1)	279 (75.6)	1 (33.3)	3 (0.8)	48 (16.7)	288 (78.0)	-	-
2013	20 (7.8)	256 (79.3)	3 (42.9)	7 (2.2)	46 (18.0)	256 (79.3)	2 (25.0)	8 (2.2)
2014	21 (6.6)	320 (84.4)	15 (8.9)	168 (44.3)	52 (16.3)	319 (84.2)	7 (4.0)	173 (48.1)
2015	23 (8.0)	289 (85.0)	40 (14.3)	279 (82.1)	29 (10.1)	287 (84.4)	22 (7.9)	278 (77.2)
Total	198 (8.4)	2.365 (69.9)	59 (12.9)	457 (13.5)	457 (14.1)	2.383 (70.4)	31 (6.7)	461 (13.6)

\*Variables included in the 2012 Reporting Disease Information System.

Source: Reporting Disease Information System (new tuberculosis cases, 2006-2015).

but with a very weak linear correlation ( $r = 0.28$ ). The average case lethality rate from TB was 3.9% and it ranged from 1.4% in 2009 to 5.9% in 2013. For lethality, the temporal trend rose, with a weak linear correlation ( $r = 0.47$ ).

Most deaths in the FD occurred in Ceilândia ( $n = 24$ ), Planaltina ( $n = 14$ ) and Samambaia ( $n = 14$ ). The highest average mortality rates were in residents of Lago Sul (1.0 per 100 thousand inhabitants), Recanto das Emas (0.9 per 100 thousand inhabitants), Planaltina (0.8 per 100 thousand inhabitants) and São Sebastião (0.8 per 100 thousand inhabitants). The highest average lethality rates were found in residents of Águas Claras (8.2%), Lago Sul (7.0%), Sobradinho II (6.8%) and Recanto das Emas (6.4%).

## DISCUSSION

The main findings of this study were: a high proportion of TB cases in people residing outside the FD (24.8% of the initial data collected); a downward trend in annual incidence rates; higher incidence rates in the elderly; higher incidence rates in Paranoá and Estrutural (AR with poor socioeconomic indicators that had expressive population growth); a higher risk of illness between PEH and IP; a different clinical distribution than expected; increased HIV testing over the years; a decrease in the proportion of cases closed because of a cure; an increase in cases closed because of transfer and abandonment; a trend of an increasing number of deaths; higher lethality in ARs that have a high concentration of elderly (Lago Sul) and PEH (Águas Claras).

In the selection of cases for the study, it was observed that 24.8% of TB reports in the FD are related to people residing in other FUs, especially in Goiás. This can be justified by the lack of health services in cities bordering the FD and by the significant fluctuating population in the FD (workers of the FD, who use the health equipment of the FD, but who reside outside the FD). According to the District Household Sample Survey (*Pesquisa Distrital de Amostras de Domicílios – PDAD*), in 2012, the floating population in the DF was about 700,000 people per day<sup>14</sup>.

From 2006 to 2015, there was a general downward trend in annual TB incidence rates in the FD. However, in the first 5 years of the series (2006 to 2010), the downward trend was quite evident, with a strong linear correlation ( $r = -0.89$ ), while in the last 5 years (2011 to 2015) the decreasing trend was very slight, with a very weak/negligible temporal linear correlation ( $r = -0.18$ ).

The profile of new TB cases in the FD is similar to the national profile: mostly males, light and dark-skinned black people, and those with low levels of education. It is worth noting that, at the beginning of the historical series, the TB incidence rates in people aged 60 and over were the highest. This could be an indication that the disease was in fact heading towards elimination as a public health problem<sup>15</sup>. However, as of 2010, the risk of illness among adults aged 30 to 59 has approached and even matched (in 2012 and 2015) those of people aged 60 and over.

Two of the three ARs that had the highest average incidence rates in the period showed true demographic explosions from 2007 to 2015: the population of Paranoá grew by 176.9%

and that of Structural grew by 99.0%<sup>9</sup>. Both Paranoá and Estruturao have poor socioeconomic indicators compared to other ARs in the FD. While the average monthly household income of the DF is 6.6 minimum wages (MW), that of Paranoá is 3.5 MW and that of the Estrutural is 2.5 MW. Paranoá (4.0%) and Estrutural (2.5%) have illiteracy rates that are also higher than the DF (2.0%) average<sup>16</sup>.

Regarding the social groups that are most vulnerable to TB, it is possible that this study only portrayed the tip of the iceberg, because even with the low completeness of the variables, it was observed that the disease affects the PEH (RR = 14.9 in 2015) and the IP (RR = 16.7 in 2015) much more than the general population.

Also worth noting were the differences between the clinical distribution of cases and the TB case matrix recommended by the Ministry of Health. While the matrix estimates that 80.0% of cases that affect children older than 15 years are pulmonary<sup>17</sup>, in the FD only 70.0% were of this nature. In addition, 85.0% of cases of children under 15 years of age should have been pulmonary<sup>17</sup>, but in this study, there were only 69.8%. A possible hypothesis for the data found in the FD is the underdiagnosis of pulmonary cases. There is evidence that the proportion of respiratory symptoms in the FD is not different from the national average. A survey conducted in three AR of the FD, in 2009, found a prevalence of 4.8 to 5.7% of respiratory symptoms, which is similar to other Brazilian states (4.0 to 10.3%)<sup>18</sup>. In the same study, 70% of participants reported not having sought out medical services<sup>18</sup>.

The significant increase in HIV testing among new TB cases may be related to the increased availability of rapid HIV testing in primary health care. Even though in 2015 there is an apparent tendency towards the reduction of a TB-HIV co-infection in Brazil, 9.7% of the cases were co-infection<sup>2</sup>, and in the DF, the co-infection rate was 13.0%.

It is worth noting the drop in the proportion of cases closed because they were cured and a very strong linear correlation rate. It is important to evaluate possible causes of worsening in this indicator, since untreated cases tend to worsen outcomes (complications and death), additionally they are potential sources of disease transmission in the community. Similarly, it is essential to investigate cases that were closed because of transfer within the DF itself, which account for 47.9% of total transfers. Transfers within the DF, which is a single municipality, should be transitional closures. It is expected that the cases would have reinvented into Sinan in a short period of time, linked and then later closed due to the patient being cured, abandoning treatment, or dying.

The highest average TB mortality rate and the second highest estimated case fatality rate were in Lago Sul, an AR where the population has very high purchasing power and excellent social indicators. This finding may be related to the high concentration of elderly people in this AR (30.1% in 2011)<sup>19</sup>. The other ARs that had the highest mortality rates have very poor social indicators compared to Lago Sul. Finally, the AR with the highest average TB mortality rate (8.2%), Águas Claras, has the highest PEH concentration (it has a shelter located in Areal, which is called Albercon – *Albergue Conviver*)<sup>20</sup>.

It is worth noting that the lethality rates by AR were estimated from the deaths found in the SIM, by AR, and that no linkage was performed from the databases of Sinan with the

SIM. In addition, as this is an ecological study using secondary data, all limitations of this type of study should be considered.

## CONCLUSION

TB persists as an important public health problem in the DF, especially in impoverished areas, with expressive population growth or with a high concentration of elderly or vulnerable populations. Despite the apparent downward trend in incidence, other findings, such as the significant decrease in cure rate and the unequal distribution of new cases among AR, suggest that greater efforts are still needed in both surveillance and health care to properly diagnose and treat TB cases in the FD.

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