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Social inequalities and tuberculosis: an analysis by race/color in Mato Grosso do Sul, Brazil

ABSTRACT

OBJECTIVE: To describe the sociodemographic and clinical-epidemiological characteristics of tuberculosis cases and identify associated factors with abandoning treatment and death whilst undergoing treatment.

METHODS: Epidemiological study based on cases of tuberculosis recorded in indigenous and non-indigenous individuals according to race/color in Mato Grosso do Sul, Midwestern Brazil, between 2001 and 2009. Descriptive analysis of the cases was carried out according to the variables of sex, age group, residence, type of test used in the diagnosis, clinical form, supervised treatment and final status, according to race/color. Univariate/multivariate logistic regression analyses were used to identify predictors of abandoning treatment and death, using odds ratio as a measure of association. A time series of incidence according to race/color was constructed.

RESULTS: In the period, 6,962 new cases of tuberculosis were registered, 15.6% being among indigenous. The illness was predominantly found in men and adults (20-44 years old) in all groups. Most of the indigenous patients lived in rural areas (79.8%) and 13.5% of the records in indigenous occurred in children aged < 10 years. The average incidence in the state was 34.5/100,000 inhabitants, being 209.0, 73.1, 52.7, 23.0 and 22.4 in indigenous, and those with yellow, black, white and brown skin, respectively. Patients aged 20 to 44 years (OR = 13.3, 95%CI 1.9;96.8), male (OR = 1.6, 95%CI 1.1;2.3) and of black race/color (OR = 2.5, 95%CI 1.0;6.3) were associated with abandoning treatment, while patients aged > 45 years (OR = 3.0, 95%CI 1.2;7.8) and with the mixed form (OR = 2.3, 95%CI 1.1;5.0) showed association with death. Although they only account for 3.0% of the population, the indigenous were responsible for 15.6% of cases recorded during the period.

CONCLUSIONS: Major inequalities in the tuberculosis illness process were found between the categories studied. Incidence in the indigenous population was consistently higher than recorded in any other group, reaching more than six times the national average. It was among those with black and brown skin that the worst treatment results were observed, as they were twice as likely to abandon treatment as the indigenous. Poor program performance was strongly associated with abandoning treatment and death. It is thought that as long as there is no reduction in poverty inequalities in health indicators will remain.

DESCRIPTORS: Tuberculosis, epidemiology. Indigenous Population. Ethnicity and Health. Socioeconomic Factors. Health Inequalities.

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INTRODUCTION

Although the incidence and mortality of tuberculosis (TB) has decreased by approximately 20.0% and 30.0% respectively in Brazil in the last few decades,[2,6] around 80,000 cases and 4,000 deaths are still recorded annually in the country.[24,a]

As they are preventable, deaths from TB can be considered sentinel events, identifying failures in the health care systems, as well as assessing the control strategies employed.[14,21,b] Mortality from TB is associated with irregular or inappropriate treatment, delays in diagnosis, drug resistance, HIV co-infection and the presence of other comorbidities, especially in older adults.[1,9,14,21]

The abandonment of treatment contributes to transmission, once TB sufferers who do not follow treatment or do not take medicines for the specified time and/or take them incorrectly remain as sources of contamination, increasing the rates of relapse and drug resistance. These factors impede achieving a cure, as they increase the duration and cost of treatment.[1,19,20] Such failures are usually associated with alcohol use and co-infection with HIV, more frequent in vulnerable populations.[18]

In Brazil, as in other countries, TB is linked to poor living conditions, with marked inequalities in the distribution of the disease. The highest rates of incidence are recorded among prison inmates, the homeless and ethnic minorities.[a] The situation among indigenous populations is worrying, as incidence up to ten times the national average, drug resistant cases, high prevalence of latent TB infection (LTBI) and a high proportion of falling ill in children and adolescents have been reported.[3-5,7,10,17]

Although there have been advances in knowledge, there are still gaps concerning follow up of cases undergoing treatment and in monitoring contacts. Moreover, little is known about the characteristics related to those cases that end in death, abandonment of treatment of multidrug-resistant tuberculosis (MRTB) among the indigenous, especially in comparison with other populations.

The aim of this study was to analyze sociodemographic and clinical-epidemiological characteristics of cases of TB reported in indigenous and non-indigenous according to race/color, and to identify factors associated with abandoning treatment and death while undergoing treatment.

METHODS

A retrospective descriptive and analytical epidemiology study was conducted. The population source was the inhabitants of the state of Mato Grosso do Sul (MS). Cases of TB reported in residents of the state were studied, which the data were obtained from the - *Sistema de Informação de Agravos de Notificação* (SINAN – Information System for Notifiable Diseases).

The state of Mato Grosso do Sul is located in the Midwest egion of Brazil and has borders to the North with Mato Grosso; to the South and Southwest with Paraguay; to the Northeast with Goiás and Minas Gerais; to the East with Sao Paulo; to the Southeast with Paraná; and with Bolívia to the West. It has an area of 357,145.836 km^2, 78 municipalities and a population of 2,449.024 inhabitants. According to the most recent census, 73,295 individuals in the state reported themselves to be indigenous (3.0% of the population).[c]

Indigenous health care is organized in the form of *Distritos Sanitários Especiais Indígenas* (DSEI – Special Indigenous Health Districts), 34 of which are spread throughout the national territory, and which are considered operational units the territorial definition of which does not include simply technical-operational or geographical criteria, but also seeks to respect culture, political relationships and the ancestral population distribution of the indigenous peoples. It is the responsibility of the DSEI/MS, which has an area covering 29 municipalities to care for the indigenous population, and it is responsible for the health care of 69,830 indigenous individuals living in villages, from the following ethnicities: Guarani, Kaoiwá, Terena, Kadiwéu, Kinikinawa, Guató, Atikun and Ofaié-Xavanté.[d]

Any notification in which the variable "type of case" is recorded as "new case" or "unknown" was deemed to be a new case. All cases recorded between January 1, 2001 and December 31, 2009 were included. Duplicated records, cases of relapse, readmission post-abandonment of treatment or transfer from other facilities and those cases that were closed as "change of diagnosis" or "transfer". were excluded.

In order to identify indigenous cases, the race/color variable, which should be completed according to self-classification, was consulted, the categories being white,

[a] Ministério da Saúde, Secretaria de Vigilância em Saúde, Departamento de Vigilância Epidemiológica, Coordenação Geral do Programa Nacional de Controle da Tuberculose. Manual de recomendações para o controle da tuberculose no Brasil. Brasília (DF); 2011.
[b] Ministério da Saúde, Secretaria de Vigilância em Saúde, Departamento de Vigilância Epidemiológica, Coordenação Geral de Doenças Endêmicas, Área Técnica de Pneumologia Sanitária. Guia para cálculo de indicadores básicos e de avaliação da base de dados de tuberculose
[c] Instituto Brasileiro de Geografia e Estatística, Sistema IBGE de Recuperação Automática – SIDRA. Censo demográfico e contagem da população, Brasil 2010. [cited 2013 Oct 2]. Available from: http://www.sidra.ibge.gov.br/bda/tabela/protabl.asp?c=3175&z=cd&o=7&i=P
[d] Ministério da Saúde, Fundação Nacional de Saúde, Departamento de Saúde Indígena, Rede Nacional de Estudos e Pesquisas em Saúde dos Povos Indígenas. Distrito sanitário: Mato Grosso do Sul: Município sede: Campo Grande. [cited 2013 Apr 26]. Available from: http://sis.funasa.gov.br/portal/detalhe_dsei.asp?strcddsei=20

black, brown, yellow[e] and indigenous. The distribution of new cases was analyzed according to race/color and to the following variables: sex, age group and zone of residence, supervised treatment, case follow up, how case was closed, clinical form, bacilloscopy and culture sputum, x-ray of thorax, tuberculin test (TT) and HIV serology.

An indicator of the follow up of the cases was used based on an empirical classification system, which includes national guidelines for TB control,[11] to wit: performing bacilloscopies in the 2nd, 4th and 6th months of treatment; recording examinations of contacts; and carrying out supervised treatment. Follow up was considered poor when cases met, or not, only one of the recommendations. The cases that met two recommendations were classified as regular and those that met three as good. Those that met at least four recommendations were classed as excellent.

The clinical and epidemiological characteristics of the reported cases were aggregated and analyzed for the entire period in order to see the scale of TB in the state. An historical time series of the mean annual coefficients of incidence in the state between 2001 and 2009 was created based on race/color.

New reported cases in the period were used, according to race/color in the numerator and population data from the censuses (2000 to 2010) in the denominator, and thus data on the population contingent by race/color was obtained to that the coefficients of incidence could be calculated.[c] For the inter-census population estimates, the geometric progression method was used, with a mean rate of growth of 0.2%; 5.4%; 6.3%; 3.1% and 3.1% per year for whites, black, brown, yellow and indigenous, respectively.

The database contained 9,323 records of TB for the period. Of these, 13 (0.1%) were excluded as duplicate records, 1,279 (13.7%) were not classified as new cases, 489 (5.2%) were cases in which the diagnosis changes and 580 (6.2%) were transfers to other facilities, leaving 6,962 new cases to be analyzed (annual mean = 774 reports).

Due to the low number of deaths (n = 15), and the high percentage of records in which the race/color (20.3%) and supervised treatment (95.7%) variables were not reported between 2001 and 2006, descriptive analysis was only carried out for clinical and sociodemographic characteristics for the period 2001 to 2009. This was assuming that not completing the data for the above-mentioned variables occurred randomly among the different categories.

In order to identify possible associations between the independent variables (sex, age group, zone of residence, race/color and follow up) and the outcomes under study (abandoning treatment and death while undergoing treatment), data from 2007 to 2009 were used. There were 146 reported deaths and the percentage of not recording the race/color and supervised treatment variables was 2.8% and 3.7%, respectively, in this period.

Uni-variate and multivariate analyses were carried out using logistical regression. The variables that showed association at the 20% level of significance were included in order of decreasing p values and of odds ratio. Those values with significance of 5% remained in the final model.

The data were analyzed using the Statistical Package for the Social Sciences, version 9.0 (SPSS Inc, Chicago, IL, EUA) program.

This study is part of a wider investigation entitled "Social inequality and tuberculosis: spatial distribution, risk factors and pharmacogenetics from the perspective of ethnicity", approved by the Research Ethics Committee of the *Escola Nacional de Saúde Pública* (CEP/ENSP) and by the National Research Ethics Committee of *Conselho Nacional de Saúde* (CONEP/CNS) (Reports 96/2010 and 400/2010).

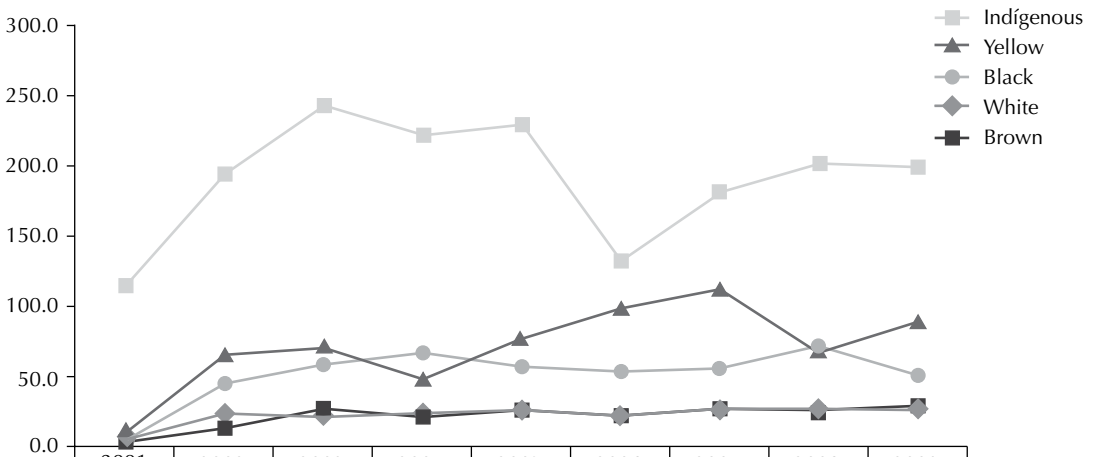
RESULTS

Of the recorded cases, 84.4% were among non-indigenous, with an annual mean of 653 records. Among the indigenous, 1,085 new cases were recorded (15.6% of the total), with an annual mean of 121 records.

In all of the populations, it was predominantly males who fell ill (2/1 ratio men to women) (p = 0.04) and the most commonly affected age group was the 20 to 44 year old group. This distribution was not homogenous across categories, because among the indigenous, children aged zero to nine made up 13.5% of the total cases, whereas in other categories the proportion of children with tuberculosis did not exceed 5.0%. There was a greater concentration of TB cases in the urban zone (approximately 80.0%), although among the indigenous the majority came from the rural zone (79.8%) (Table 1).

The greatest number of sputum bacilloscopies was carried out among the indigenous (80.3%), and the lowest among yellows (65.8%). On the other hand, in 65.0% of records for all race/color categories, sputum culture was not performed. Among the indigenous, more than 50.0% of diagnoses used sputum culture. The records of thorax x-rays showed high proportions of exams suggesting TB

[e] In Brazil, there is a system of ethnic/racial classification, adopted by the Brazilian Institute of Geography and Statistic in all demographic and health systems, which is based on the color of skin of the people. In general, people classified as brown belong to groups whose ethnicity is result of a mix of black and white people, these people are also known as Pardos. People classified as yellow, usually, are people whose ethnic heritage is from Asiatic groups.



	2001	2002	2003	2004	2005	2006	2007	2008	2009
White	5.8	23.3	22.2	25.2	26.4	24.5	25.6	29.0	25.8
Black	2.7	45.6	60.1	67.3	57.3	53.4	55.5	72.1	50.0
Yellow	11.6	65.3	71.7	48.2	77.0	98.0	112.3	67.9	88.7
Brown	3.6	14.2	27.0	21.3	26.3	22.4	27.7	25.3	29.7
Indigenous	115.1	193.7	241.9	221.5	229.1	132.7	181.0	201.7	199.8

Figura. Incidence rate for tuberculosis (per 100,000 inhabitants), according to race/color. Mato Grosso do Sul, Midwestern Brazil, 2001-2009.

(> 75.0%), with no marked difference between categories. The TT was not used in approximately 80.0% of TB cases records; among the indigenous this percentage was lower (closer to 60.0%). The pulmonary clinical form predominated in more than 80.0% of records and was more frequent among the indigenous (92.3%). The highest percentage of extra-pulmonary and mixed forms was found among yellows (28.9% and 3.4% respectively). HIV serology was not performed in approximately 40.0% of the cases and the highest percentages of this not being done were among browns and indigenous. There were 11 positive results among the indigenous (Table 2).

The mean incidence of TB in the state was 34.5/100,000 inhabitants between 2001 and 2009, being higher among the indigenous (209.0/100,000). The incidence among white and browns was similar (23.0 and 22.4 respectively).

Table 1. Distribution of cases of tuberculosis according to race/color and sociodemographic variables. Mato Grosso do Sul, Midwestern Brazil, 2001-2009.

Variable	White		Black		Yellow		Brown		Indigenous		Unknown		Total	
	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%
Sex														
Male	1,606	67.3	300	67.6	102	68.5	1,255	67.6	675	62.2	680	65.3	4,618	66.3
Female	781	32.7	144	32.4	47	31.5	601	32.4	410	37.8	361	34.7	2,344	33.7
Total	2,387	100.0	444	100.0	149	100.0	1,856	100.0	1,085	100.0	1,041	100.0	6,962	100.0
Age group (years)														
45 and +	1,013	42.4	180	40.5	63	42.3	694	37.4	264	24.3	345	33.1	2,559	36.8
20 to 44	1,120	46.9	233	52.5	69	46.3	954	51.4	555	51.2	540	51.9	3,471	49.9
10 to 19	158	6.6	20	4.5	11	7.4	148	8.0	119	11.0	88	8.5	544	7.8
0 to 9	96	4.0	11	2.5	6	4.0	60	3.2	147	13.5	68	6.5	388	5.6
Total	2,387	100.0	444	100.0	149	100.0	1,856	100.0	1,085	100.0	1,041	100.0	6,962	100.0
Zone														
Urban	2,105	88.2	387	87.2	136	91.3	1664	89.7	156	14.4	744	71.5	5,192	74.6
Rural	190	8.0	49	11.0	7	4.7	126	6.8	866	79.8	148	14.2	1,386	19.9
Urbana/rural	14	0.6	2	0.5	1	0.7	5	0.3	29	2.7	2	0.2	53	0.8
Unknown	78	3.3	6	1.4	5	3.4	61	3.3	34	3.1	147	14.1	331	4.8
Total	2,387	100.0	444	100.0	149	100.0	1,856	100.0	1,085	100.0	1,041	100.0	6,962	100.0

Table 2. Distribution of cases of tuberculosis according to race/color and clinical variables. Mato Grosso do Sul, Midwestern Brazil, 2001-2009.

Variable	White		Black		Yellow		Brown		Indigenous		Unknown		Total	
	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%
Bacilloscopy[a]														
Positive	1,141	47.8	225	50.7	56	37.6	993	53.5	552	50.9	514	49.4	3,481	50.0
Negative	664	27.8	113	25.5	42	28.2	418	22.5	308	28.4	248	23.8	1,793	25.8
Not done	582	24.4	106	23.9	51	34.2	445	24.0	225	20.7	279	26.8	1,688	24.2
Total	2,387	100.0	444	100.0	149	100.0	1856	100.0	1085	100.0	1041	100.0	6,962	100.0
Culture[a]														
Positive	433	18.1	81	18.2	16	10.7	397	21.4	348	32.1	134	12.9	1,409	20.2
Negative	225	9.4	47	10.6	12	8.1	137	7.4	105	9.7	61	5.9	587	8.4
In process	147	6.2	36	8.1	5	3.4	100	5.4	103	9.5	87	8.4	478	6.9
Not done	1,582	66.3	280	63.1	116	77.9	1222	65.8	529	48.8	759	72.9	4,488	64.5
Total	2,387	100.0	444	100.0	149	100.0	1856	100	1085	100.0	1,041	100.0	6,962	100.0
X-Ray[b]														
Suspected	1,864	78.1	340	76.6	113	75.8	1,428	76.9	856	78.9	781	75.0	5,382	77.3
Normal	144	6.0	25	5.6	15	10.1	75	4.0	32	2.9	45	4.3	336	4.8
Another pathology	41	1.7	6	1.4	2	1.3	18	1.0	7	0.6	27	2.6	101	1.5
Not done	324	13.6	69	15.5	19	12.8	325	17.5	184	17.0	175	16.8	1096	15.7
Unknown	14	0.6	4	0.9	0	0.0	10	0.5	6	0.6	13	1.2	47	0.7
Total	2,387	100.0	444	100.0	149	100.0	1,856	100.0	1,085	100.0	1,041	100.0	6,962	100.0
TT[c]														
0 to 4 mm	155	6.5	29	6.5	11	7.4	97	5.2	111	10.2	52	5.0	455	6.5
5 to 9 mm	131	5.5	20	4.5	3	2.0	64	3.4	59	5.4	36	3.5	313	4.5
≥ 10 mm	280	11.7	48	10.8	20	13.4	148	8.0	225	20.7	63	6.1	784	11.3
Not done	1,779	74.5	340	76.6	115	77.2	1,527	82.3	667	61.5	856	82.2	5,284	75.9
Unknown	42	1.8	7	1.6	0	0.0	20	1.1	23	2.1	34	3.3	126	1.8
Total	2,387	100.0	444	100.0	149	100.0	1,856	100.0	1,085	100.0	1,041	100.0	6,962	100.0
Forma clínica														
Pulmonary	1,962	82.2	379	85.4	101	67.8	1,598	86.1	1,001	92.3	897	86.2	5,938	85.3
Extra-pulmonar	372	15.6	56	12.6	43	28.9	222	12.0	62	5.7	130	12.5	885	12.7
Mixed[d]	53	2.2	9	2.0	5	3.4	36	1.9	22	2.0	14	1.3	139	2.0
Total	2,387	100.0	444	100.0	149	100.0	1,856	100.0	1,085	100.0	1,041	100.0	6,962	100.0
Anti-HIV														
Positive	199	8.3	43	9.7	19	12.8	142	7.7	11	1.0	66	6.3	480	6.9
Negative	1,124	47.1	219	49.3	90	60.4	776	41.8	493.0	45.4	305	29.3	3,007	43.2
In process	168	7.0	49	11.0	5	3.4	120	6.5	125.0	11.5	69	6.6	536	7.7
Not done	896	37.5	133	30.0	35	23.5	818	44.1	456.0	42.0	601	57.7	2,939	42.2
Total	2.,87	100.0	444	100.0	149	100.0	1,856	100.0	1085.0	100.0	1,041	100.0	6,962	100.0

[a] Sputum culture
[b] Thorax x-ray
[c] Tuberculin test
[d] Pulmonary + extra-pulmonary

Yellows had the second highest rate of incidence (73.1/100,000), followed by blacks (52.7/100,000). In all the years studied, the highest incidence of TB was reported among the indigenous (Figure).

There was no information on the treatment regime (98.2% and 92.8% of fields remaining blank, respectively) in more than 90.0% of the records in the first and second three-year periods (2001 to 2003 and 2004 to 2006). There was significant improvement in the final three year period (2007 to 2009) with the coverage of supervised treatment reaching approximately 75.0% of cases. The highest proportions were recorded amongst the indigenous (88.1%) and the lowest in whites (68.9%) (Table 3).

In the first and second three-year periods, almost half of the cases were classified as having poor follow up, although the cases classified as excellent increased from 4.0% to 17.8%. In the final three-year period, there was a decrease in poor (28.7%) and a significant increase in excellent follow up (32.8%). The classification of follow up had a heterogeneous distribution between the categories.

Table 3. Distribution of cases of tuberculosis according to race/color and variables: supervised treatment, follow up and closure of the case according to period 2001-2003; 2004-2006; 2007-2009. Mato Grosso do Sul, Midwestern Brazil.

Supervised treatment	White		Black		Yellow		Brown		Indigenous		Unknown		Total	
	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%
2001-2003														
Not done	20	3.4	0	0.0	0	0.0	10	2.6	3	0.9	1	0.1	34	1.5
Done	2	0.3	0	0.0	0	0.0	0	0.0	2	0.6	2	0.3	6	0.3
Unknown	564	96.2	88	100.0	28	100.0	371	97.4	313	98.4	795	99.6	2,159	98.2
Total	586	100.0	88	100.0	28	100.0	381	100.0	318	100.0	798	100.0	2,199	100.0
Follow up														
Poor	340	58.0	58	65.9	23	82.1	239	62.7	129	40.6	325	40.7	1,114	50.7
Regular	53	9.0	8	9.1	2	7.1	40	10.5	42	13.2	84	10.5	229	10.4
Good	147	25.1	17	19.3	1	3.6	79	20.7	143	45.0	381	47.7	768	34.9
Excellent	46	7.8	5	5.7	2	7.1	23	6.0	4	1.3	8	1.0	88	4.0
Total	586	100.0	88	100.0	28	100.0	381	100.0	318	100.0	798	100.0	2,199	100.0
Case closure														
Cured	508	86.7	68	77.3	19	67.9	304	79.8	285	89.6	635	79.6	1,819	82.7
Abandoned treatment	51	8.7	15	17.0	5	17.9	58	15.2	26	8.2	111	13.9	266	12.1
Death	24	4.1	5	5.7	4	14.3	16	4.2	6	1.9	51	6.4	106	4.8
MRTB	3	0.5	0	0.0	0	0.0	3	0.8	1	0.3	1	0.1	8	0.4
Total	586	100.0	88	100.0	28	100.0	381	100.0	318	100.0	798	100.0	2,199	100.0
2004 -2006														
Not done	32	3.7	3	1.8	0	0.0	17	2.6	0	0.0	4	3.1	56	2.5
Done	46	5.3	13	7.9	3	6.0	32	5.0	12	3.3	2	1.5	108	4.8
Unknown	796	91.1	148	90.2	47	94.0	594	92.4	353	96.7	124	95.4	2,109	92.8
Total	874	100.0	164	100.0	50	100.0	643	100.0	365	100.0	130	100.0	2,273	100.0
Follow up														
Poor	371	42.4	70	42.7	28	56.0	287	44.6	119	32.6	95	53.7	970	42.7
Regular	134	15.3	25	15.2	7	14.0	103	16.0	57	15.6	26	14.7	352	15.5
Good	189	21.6	35	21.3	6	12.0	159	24.7	120	32.9	38	21.5	547	24.1
Excellent	180	20.6	34	20.7	9	18.0	94	14.6	69	18.9	18	10.2	404	17.8
Total	874	100.0	164	100.0	50	100.0	643	100.0	365	100.0	177	100.0	2,273	100.0
Case closure														
Cured	739	84.6	134	81.7	46	92.0	540	84.0	342	93.7	143	80.8	1,944	85.5
Abandoned treatment	74	8.5	21	12.8	1	2.0	61	9.5	8	2.2	15	8.5	180	7.9
Death	2	0.2	2	1.2	0	0.0	11	1.7	0	0.0	0	0.0	15	0.7
MRTB	53	6.1	6	3.7	2	4.0	27	4.2	12	3.3	11	6.2	111	4.9
Unknown	6	0.7	1	0.6	1	2.0	4	0.6	3	0.8	8	4.5	23	1.0
Total	874	100.0	164	100.0	50	100.0	643	100.0	365	100.0	177	100.0	2,273	100.0
2007-2009														
Not done	249	26.9	49	25.5	15	21.1	197	23.7	32	8.0	16	24.2	558	22.4
Done	639	68.9	135	70.3	54	76.1	618	74.3	354	88.1	43	65.2	1,843	74.0
Unknown	39	4.2	8	4.2	2	2.8	17	2.0	16	4.0	7	10.6	89	3.6
Total	927	100.0	192	100.0	71	100.0	832	100.0	402	100.0	66	100.0	2,490	100.0
Follow up														
Poor	289	31.2	60	31.3	27	38.0	256	30.8	63	15.7	20	30.3	715	28.7
Regular	219	23.6	39	20.3	29	40.8	194	23.3	85	21.1	10	15.2	576	23.1
Good	136	14.7	30	15.6	5	7.0	139	16.7	60	14.9	13	19.7	383	15.4
Excellent	283	30.5	63	32.8	10	14.1	243	29.2	194	48.3	23	34.8	816	32.8
Total	927	100.0	192	100.0	71	100.0	832	100.0	402	100.0	66	100.0	2,490	100.0

Continue

Continuation

	2007-2009													
Case closure														
Cured	660	71.2	139	72.4	44	62.0	594	71.4	336	83.6	52	78.8	1,825	73.3
Abandoned treatment	67	7.2	17	8.9	8	11.3	80	9.6	11	2.7	7	10.6	190	7.6
Death	51	5.5	13	6.8	8	11.3	58	7.0	13	3.2	3	4.5	146	5.9
MRTB	82	8.8	15	7.8	8	11.3	43	5.2	16	4.0	2	3.0	166	6.7
Unknown	67	7.2	8	4.2	3	4.2	57	6.9	26	6.5	2	3.0	163	6.5
Total	927	100.0	192	100.0	71	100.0	832	100.0	402	100.0	66	100.0	2,490	100.0

MRTB: Multidrug-resistant tuberculosis

The best results were observed in the indigenous, where good and excellent follow up reached 14.9% and 48.3%, respectively between 2007 and 2009 (Table 3).

Between the first and second three-year period, improvements were observed in all the populations in the percentages of those who were cured and those who abandoned treatment; however, there was an increase in the proportion of deaths, MRTB and records with information missing in the final period, compared with the first two. There was a lower percentage of MRTB among the indigenous.

In the first three-year period, no deaths while undergoing treatment were reported, and 15 (0.7%) were recorded in the second. Between 2007 and 2009, 146 deaths were recorded, with a lower percentage among the indigenous (3.2%) (Table 3).

Age group, race/color, sex and follow up proved to be associated with abandoning treatment. The chance of abandoning treatment was 13.3 times higher in people in the 20 to 44 year old age group when compared with that of children aged zero to nine. The chance of abandoning treatment was 12.4 times higher in cases with poor follow up than in cases with excellent follow up. The chance of abandoning treatment was two times higher for blacks and browns compared with the indigenous. Males suffering from TB had a 1.6 times greater chance of abandoning treatment (Table 4).

The variables poor follow up, age group ≥ 45 years and having the mixed clinical form proved to be predictors of death while undergoing treatment (Table 4).

DISCUSSION

This study shows the epidemiological situation for TB in MS and reveals significant inequalities in the characteristics related to falling ill according to race/color. Incidence in the indigenous were consistently higher than that recorded in any other group, sometimes more than six times the national average for the period. Although the indigenous make up less than 3.0% of the population of the state, they made up 15.6% of records of TB between 2001 and 2009.

It was predominantly males who fell sick, with a higher concentration of cases among young adults in all categories of race/color, which does not differ from what is reported in the literature.[11,18,24]

However, indigenous children aged zero to nine years old made up a significant part of treatments started in MS. In cases reported in individuals aged younger than ten, almost 40.0% were in indigenous children (147 cases, of a total of 388 records). This indicates that there is active transmission within the villages (for probable recent infection) and suggests that activities controlling contacts were not enough to control the spread of the disease.[5,15-17] Other factors associated with the high frequency of TB in children, such as: the effect of intestinal parasites, anemia and malnutrition on immune response and the contribution of social determinants, should be better studied, preferably using primary data.[16]

In contrast to what has been reported among other indigenous groups,[3,4,7] for whom it has been described that they were disfavored in being offered examinations compared to other sectors of the population, the health service (provided by the DSEI/MS) appears to be better structured for meeting the needs of the indigenous in MS. Higher proportions of bacilloscopies and sputum cultures being carried out were observed in this group, as were TT and thorax x-rays. The analysis of variables of supervised treatment and follow up in three-year periods showed that there was admirable evolution in control actions over the period, as well as improvements in collecting data. This situation is confirmed by the higher proportions of supervised treatment and follow up classified as excellent among the indigenous.

Although rates of abandoning treatment still fall short of the World Health Organization goal (maximum 5.0%),[24] there was a decrease in the proportion of abandoning treatment in all race/color categories and improvements in the rate of those cured over the period. In the indigenous population, there was a significant decrease in abandonment of treatment and an increase in cures. However, the cases of multidrug-resistant tuberculosis did not follow the same trend in this group and went from 1.9% in the first three-year period to 4.0% in the final three-year period.

Table 4. Predictors of abandoning treatment and death while undergoing treatment for tuberculosis. Mato Grosso do Sul, Midwestern Brazil, 2007-2009.

Variable	Reference group/ Comparison	N	Raw OR	80%CI	Adjusted OR	95%CI
	Abandoning TB treatment					
Follow up	Excellent	772				
	Poor	665	11.9	7.9;18.0	12.4	6.1;24.9
	Regular	546	7.7	5.0;11.9	8.9	4.4;18.4
	Good	356	4.9	3.0;7.9	5.3	2.4;11.8
Age group (years)	0 to 9	112				
	45 and over	913	6.6	1.8;24.2	6.5	0.9;48.2
	20 to 44	1,157	12.9	3.6;47.1	13.3	1.8;96.8
	10 to 19	157	4.8	1.2;19.2	6.2	0.7;51.3
Race/color	Indigenous	392				
	White	888	2.8	1.8;4.2	1.9	0.9;4.3
	Black	189	3.5	2.1;5.7	2.5	1.0;6.3
	Yellow	69	4.5	2.4;8.4	2.6	0.9;7.6
	Brown	801	3.8	2.5;5.8	2.3	1.0;5.2
Sex	Female	732				
	Male	1,607	1.8	1.4;2.3	1.6	1.1;2.3
Zone	Rural	468				
	Urban	1,871	1.9	1.4;2.6	Not Sig.	Not Sig.
	Death while undergoing TB treatment					
Follow up	Excellent	772				
	Poor	665	34.9	18.1;67.4	35.7	13.0;98.0
	Regular	546	11.5	5.8;22.9	11.5	4.0;32.9
	Good	356	3.2	1.4;7.4	3.1	0.9;11.1
Race/color	Indigenous	392				
	White	888	1.7	1.2;2.6	Not Sig.	Not Sig.
	Black	189	2.2	1.3;3.5		
	Yellow	69	3.8	2.1;6.9		
	Brown	801	2.2	1.5;3.3		
Form	Pulmonary	1,978				
	Extra-pulmonary	299	2.1	1.6;2.7	1.2	0.7;1.8
	Pulmonary + Extra-pulmonary	62	2.9	1.8;4.7	2.3	1.1;5.0
Sex	Female	732				
	Male	1,607	1.5	1.2;2.0	1.4	0.9;2.1
Age group (years)	0 to 9	112				
	45 and over	913	2.2	1.2;4.1	3.0	1.2;7.8
	20 to 44	1,157	0.9	0.5;1.6	1.0	0.4;2.7
	10 to 19	157	0.4	0.2;1.0	0.5	0.1;2.1
Zone	Rural	468				
	Urban	1,871	1.5	1.1;2.1	Not Sig.	Not Sig.

TB: tuberculosis

Success in supervised treatment among the indigenous is probably associated with the adequate infrastructure of services provided by the DSEI/MS, with the availability or human resources (qualified, in sufficient numbers and with low turnover) and with community involvement in activities to control the disease. Although there were fewer cases of multidrug-resistant tuberculosis among the indigenous, the increase in the number detected recently may be related to the greater provision of sputum cultures and test the sensitivity of the drugs, provided in partnership with the *Laboratório Central de Saúde Pública*.

Analysis of the coefficients of incidence shows that the indigenous were in a disadvantaged situation compared with other race/color categories throughout the period. As seen in other investigations,[3,4,5,7,12] the present findings reinforce the hypothesis that the indigenous in Brazil are more vulnerable to falling ill from tuberculosis compared

to other segments of the population. Ferreira et al,[15] analyzing demographic aspects and patterns of mortality in MS between 2004 and 2006, highlighted that the risk of dying from TB was nine times higher for indigenous males than for the general population.

Abandoning treatment proved to be associated with being male and with being in the 20 to 44 year old age group, as in other contexts.[1,19,20,23] This phenomenon may be related to factors that make it difficult to adhere to treatment, including smoking, drug and alcohol use, low levels of schooling, the adverse effects of the medication, co-infection with HIV and previous abandonment, in addition to other socioeconomic disadvantages.[13] Abandoning treatment compromises one of the pillars of the program for controlling tuberculosis (PCT), treatment, which can be decisive in the path of the disease and lead to complications, including multidrug-resistant TB and death.[1,19,20,23]

The indigenous population had the highest rates of cure during the period, as described by Croda et al[12] in Dourados, MS, Midwestern Brazil. Cases reported in blacks and browns had a higher chance of abandoning treatment compared with the indigenous. The lower frequency of being HIV positive in the indigenous may contribute to explaining the better treatment results in this group.

The ≥ 45 age group and the mixed clinical form of the disease proved to be associated with death while undergoing treatment. With the ageing population, individuals who had been infected in childhood/adolescence may become susceptible again on reaching old age. Often, diagnosis and starting treatment is delayed in older adults due to atypical clinical manifestations. The presence of other comorbidities is also frequent in those over 60, with HIV co-infection and diabetes being the most significant predictors of death from TB.[1,9,13]

Poor PCT performance contributes to unfavorable outcomes, as the cases classified as having poor follow up proved to be strongly associated with abandoning treatment and death. Despite being empirical and not validated, the system for classifying follow up operates within the logic of the PCT, indicating that successful treatment is also related to the structure and training of monitoring by health care services. Patients who undergo supervised treatment and are properly followed up throughout the treatment are more frequently cured, are less likely to abandon treatment and less likely to develop complications or die.[11,21,24]

A review of the Mortality Information System (SIM) data available for MS by one of the authors (MM), showed that 183, 191 and 170 TB deaths were recorded in the periods 2001-2003, 2004-2006 and 2007-2009 respectively. This exposes the problem of underreporting deaths in SINAN and compromises the evaluation of the effectiveness of control strategies. However, there was a significant improvement in records in the final three-year period, suggesting that underreporting of this event in the SINAN decreased by at least 15.0% (146 deaths reported in SINAN, compared with 170 in the SIM).

Analysis of the records indicated that the majority of indigenous with active TB came from rural areas and lived in municipalities located near the county's international borders. The presence of indigenous peoples in Latin America has ancestral ties going beyond geopolitical limits set by national governments. The indigenous in this area are marked by their mobility and groups frequently move to visit their families on both sides of the border. This habit may contribute to the spread of a lot of contagious diseases, including TB.

Controlling TB on the borders constitutes a difficult task due to the problems the TB cases often have accessing health care services.[8,22] These obstacles may cause delays in diagnosis and in starting treatment, with the subsequent effect of maintaining the chain of transmission. Moreover, the responsibility for treating cases of TB in the border area does not fall solely to one country, which calls for international agreements for effective control of the disease.[8,22]

Despite the limitations inherent in studies based on secondary data (underreporting of cases, errors in classification and/or diagnosis, low representativeness of the indigenous in the health care information systems and the way in which the variables are collected by these systems), our findings revealed the epidemiological situation for TB in Mato Grosso do Sul.

Structuring the health care services, training the teams, increasing supervised treatment and increases in laboratory examinations (especially sputum cultures) seem to have had positive and notable impacts on controlling TB in MS, particularly in the indigenous population.

Due to the extreme poverty experienced by the indigenous in the state (hunger, malnutrition, unemployment, low and/or no income, precarious housing, discrimination, high infant mortality rates, among others), associated with territorial restriction and the confinement of the population to small reserves marked out by the federal government,[f] the coefficients of incidence remained high and at levels above those recorded for the non-indigenous population, throughout the period.

In conclusion, we believe that effort in structuring health care services to improve detection of cases, increase coverage of supervised treatment and examinations of contacts are not enough to face the tuberculosis. While there is no political interest and guarantees of investment and concrete actions to reduce poverty and inequalities, the incidence and persistence of TB transmission in the Brazilian indigenous population will remain at alarming levels.

[f] Ministra de Direitos Humanos afirma que vai a Mato Grosso do Sul verificar o que está ocorrendo com os Guarani Kaiowá. Manchetes Ambientais [Internet]. 2012 out 24. [cited 2012 Oct 28]. Available from: http://site-antigo.socioambiental.org/nsa/detalhe?id=3689

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