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Tuberculosis among Yanomami communities from Alto Rio Negro, State of Amazonas, Brazil, 1990 to 2002

Resumen

Fundamentos: Las poblaciones indígenas brasileñas muestran altas tasas de tuberculosis, las cuales pueden ser atribuidas no sólo a las condiciones socio-económicas y a la dificultad de acceso a los servicios de salud, sino también a una posible susceptibilidad intrínseca de estas poblaciones. Buscamos describir los casos y explorar el posible cluster de tuberculosis en familias Yanomami.
Método: Estudio descriptivo de casos de tuberculosis en las comunidades Yanomami de Ariabú y Maturacá (São Gabriel da Cachoeira, AM, Brasil) entre 1990 y 2002, basado en informes médicos facilitados por los profesionales de salud trabajando en el área. Las comunidades estudiadas están situadas cerca una de la otra, separadas por un río, pero compartiendo los mismos recursos ambientales, sin diferencias en las condiciones sociales, económicas o de la vivienda.
Resultados: En este periodo, fueron registrados 101 casos de tuberculosis, correspondiendo a una incidencia estimada anual de 1.082/100.000 en Ariabú y 2.452/100.000 en Maturacá. Múltiples casos familiares fueron significativamente más frecuentes en la comunidad de Maturacá, independientemente del tamaño familiar, sugiriendo agregación familiar ($p<0.001$).
Conclusiones: La tuberculosis es un serio problema entre los Yanomami. Para mejorar su control en estas comunidades, requerirá de una mejora en las condiciones de las casas, una búsqueda activa y estudio de contactos y mejoras en los medios diagnósticos. Los múltiples casos familiares en los Yanomami deberían ser investigados como un potencial grupo con híper-susceptibilidad para la tuberculosis.
Palabras clave: Tuberculosis. Clustering en el espacio-tempo. Susceptibilidad. Busca activa. Amazonia. Ianomâmi.

Summary

Background: Brazilian indigenous populations show high tuberculosis rates, which can be attributable not only to socio-economic conditions and poor access to health care services, but also to an intrinsic susceptibility of these individuals. We describe the distribution of tuberculosis cases in two Yanomami communities, and focus on the occurrence of familial clustering of TB cases.
Methods: We have performed a descriptive study of TB cases in the Yanomami communities of Ariabú and Maturacá (São Gabriel da Cachoeira, AM, Brazil) between 1990 and 2002, based on medical records provided by health care professionals working in the area. The communities studied are located close to each other, separated by a river, but sharing the same environmental resources, with no differences in social, economic or housing conditions.
Results: In this period, 101 cases of TB were registered, corresponding to an estimated annual incidence after active surveillance of 1,082/100,000 at Ariabú and 2,452/100,000 at Maturacá. Multicase families were significantly more frequent in Maturacá community, independent of family size, suggesting familial aggregation ($p<0.001$).
Conclusions: Tuberculosis is a serious problem among the Yanomami. TB control in Yanomami communities will require improvement in housing conditions, active surveillance, contact tracing and diagnosis. Yanomami multicase families should be investigated as a potential group with hyper-susceptibility to tuberculosis.
Key words: Tuberculosis. Space-time clustering. Disease susceptibility. Health care surveys. Amazon. Yanomâmi.

Introduction

Tuberculosis is a major health problem among Brazilian indigenous populations[1-3]. In spite of the efforts directed to control the disease, continuous surveillance, contact tracing and follow-up for treatment adherence is still mostly lacking. TB incidence rate among indigenous groups was estimated to be 108.6 cases per 100,000 inhabitants in 2002[2].

Rapid socio-cultural, economic and environmental changes, which have lead to profound effects in subsistence activities, housing, and risk exposure, have been suggested to favor this scenario[1,3-7]. It is known that in most indigenous communities the socio-economic conditions and health care access are marginal, and there are reports of nutritional deficit, severe anemia and high rates of infectious diseases other than TB[2,3,8]. These populations have also been historically associated with enhanced susceptibility to TB[9].

The present report documents the TB cases found in two Yanomami communities of Sao Gabriel da Cachoeira, Amazonas, Brazil. These Yanomami communities are comparable in terms of geographic location, socio-economic condition and housing. We describe the cases and suggest a possible role for familial susceptibility to TB in the increased incidence of tuberculous disease in this population, in addition to known risk factors associated with poor living conditions.

Materials and Methods

Study population and study area

We have performed a retrospective description of all TB cases in two Yanomami communities of the Alto Rio Negro, Amazonas, Brazil, from 1990 to January 2003. The communities are Ariabú and Maturacá, located in the National Park of Pico da Neblina, lying at each side of the Cauaburis River, united by a bridge, and assisted by the same health care facility. A population census was performed in 2000 by the Instituto Brasileiro de Geografia e Estatistica (Brazilian Ministry of Planning, Budget and Management). For both communities, agriculture is the main and most frequent of the subsistence activities[6]. Both communities interchange with the city. Houses in both communities are very similar, with a mean area of 34.1 m^2, distributed in circle around a central area that is used for rituals (Figure 1). Usually, the floor and the walls are made of clay, and the ceiling is made of a palm tree (carana: *Mauritia sp.*).

Data collection and ethical considerations

All data for the present study was obtained from medical registries and reports of field work provided by the Instituto Brasileiro pelo Desenvolvimento Sanitário (IBDS), which is responsible for medical assistance to the communities studied. The data are being published with their permission and collaboration. All collection of biological samples, interviews or questionnaires was performed by IBDS in the context of medical care. This study complies with the ethical principles contained in the Helsinki Declaration, as well as with Brazilian National Health Council Resolution 196/96 Guidelines.

Disease diagnosis

TB diagnosis in the area has been routinely performed by medical staff from IBDS, based on sputum smear and patient history. For individuals with suggestive symptoms and in close contact with diagnosed TB patient, in the absence of sputum smear or with negative sputum smear result, diagnosis was based on chest radiography and one or more of the following: Mantoux positivity, culture or biopsy, and clinical improvement upon standard therapy.

Disease relapse was documented if another case registry was found for a same individual more than six months later, with a report of disease cure in the first registry, and/or without reported resistance to treatment or treatment failure/discontinuity in the following registry. Cases were matched to their family units (composed of one father, one mother and their children), using the census population, and data were confirmed with local health care staff. Families with more than one case of TB in different family members were considered multicase families. Eight registries from each community

Figure 1. Partial view of Ariabú community, Alto Rio Negro, São Gabriel da Cachoeira – Amazonas, Brazil. The arrow points to a common area used for flour production. The other constructions are houses occupied by families

noted as "without information" were excluded from analyses (16 excluded cases).

Statistical analyses

The quantitative variables were described using mean and standard deviation (SD), and median and interquartile range (IR) if the data did not follow a normal distribution. The chi-square test was used to compare qualitative variables, except for those with absolute frequencies below 10, for which the Fisher's exact test was used instead. ANOVA and its corresponding non-parametric tests were used to compare the quantitative variables. The rates of incidence were calculated using the population census performed in the year 2000, that reports 462 Indians living in Ariabú and 367 Indians living in Maturacá. The data obtained was graphically represented and analyzed by Microsoft Excel 2002 (Microsoft Corporation, Redmond, WA) and GraphPad Prism, v 3.00 (GraphPad Inc., San Diego, CA) software.

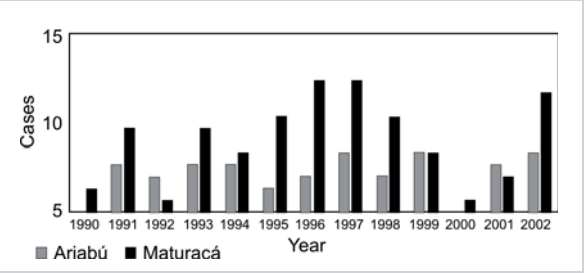

Figure 2. Tuberculosis cases among Yanomami Indians of Alto Rio Negro, Ariabú and Maturacá communities (São Gabriel da Cachoeira – Amazonas), from 1990 to 2002. White bars, Ariabú; black bars, Maturacá

Table 1. Number and incidence of tuberculosis cases by sex and age in Ariabú and Maturacá communities, Alto Rio Negro, São Gabriel da Cachoeira, Amazonas, Brazil

		Tuberculosis cases absolute frequency (incidence[1])		p value*
		Ariabú	Maturacá	
Sex[2]				
	Male	16 (1310)	33 (3448.3)	0.68
	Female	20 (896.9)	32 (1554.4)	
Age (years)[3]				
	0-10	15 (1010.1)	21 (3597.1)	0.14
	11-45	16 (900.9)	23 (2105.3)	
	>45	5 (4761.9)	1 (2439)	

*[1]In 2002, expressed as rate per 100,000 inhabitants of the category; [2]Differences in TB incidence between male and female were not significant in Ariabú (p=0.68) or Maturacá (p=0.32); [3]Differences in TB incidence between age groups were not significant in Ariabú (p=0.68) or Maturacá (p=0.88); *Difference between communities.*

Results

Tuberculosis incidence

In the period of 1990 to 2002, 64 cases of TB were registered in the Maturacá community and 36 cases of the disease were registered in the Ariabú community. Raw incidence rates of TB were estimated as 1,082 cases/100,000 inhabitants in Ariabú (5 cases/462 inhabitants) and 2,452 cases/100,000 inhabitants in Maturacá (9 cases/367 inhabitants) in 2002 (p=0.17). Figure 2 shows the annual distribution of new TB cases for the studied period.

No significant differences were found between Ariabú and Maturacá in total number of TB cases or disease incidence by sex or age (Table 1). The main form of TB found in both communities was pulmonary TB, accounting for 82% of the cases registered in Ariabú and for 68% of the cases registered in Maturacá (for one TB case in Maturacá disease form was not recorded). Extrapulmonary TB forms included: lymph node or mixed lymph node and pulmonary TB, intestinal TB, miliary TB, pleural TB and tuberculous meningitis. Disease relapse occurred in 9 individuals. There was no significant difference between Ariabú and Maturacá in the proportion of extrapulmonary forms observed (p=0.60).

Housing conditions and familial aggregation

Houses were generally small, dark, and low-ventilated. The average dimensions were 3 m height, 7m length and 5m width. The mean number of rooms/house was 1.69, and there were in average 0.89 windows/house and 1.49 doors/house (JGP, unpublished data). One to twelve people lived in the same house ((median, 6 (IR 3-7) in Ariabú, and 5 (IR 4-7) in Maturacá, p=0.81)).

We have found significant discrepancies in the frequency of families with more than one case of TB among the two communities studied (Tables 2 and 3). In Ariabú, 34% of all families registered in the census had at least one TB case in the study period, while in Maturacá this proportion attained 48%. The proportion of families with more than one TB case registered was significantly higher in the Maturacá community (p<0.001).

Table 3 lists the TB cases in multicase families from both areas. Of note, three cases of TB non-responsive to treatment were documented in Maturacá (including two cases in the same family, a mother with pleural TB diagnosed in March 1997 and previous pulmonary disease in February 1992, and her daughter with ganglio-pulmonary TB diagnosed in January 2003, and previous ganglio-pulmonary disease in May 2002). Drug resistant strains of *Mycobacterium tuberculosis* have never been demonstrated in any of the studied communities (AB, unpublished data).

The number of household contacts in multicase families in Ariabú was significantly higher than in families with only one case of TB (p=0.027). In Maturacá, however, there was no significant difference in the number of household contacts between multi- and single case families (p=0.74). There was also no difference in the number of individuals per house among families bearing

Table 2. Number of tuberculosis cases per family in Ariabú and Maturacá communities, Alto Rio Negro, São Gabriel da Cachoeira, Amazonas, Brazil

TB cases in the family	Number of families	Individuals per house median (IR)
Ariabú		
0	57	6 (3-7)
1	23	5 (4-6.5)
2	5[1]	9 (6-9)[2]
3 or more	1[1]	6[2]
total	86	6 (3-7)
Maturacá		
0	36	5 (3-7.2)
1	12	5 (4.5-6.2)
2	15[1]	5 (4.5-6)[2]
3 or more	6[1]	6.5 (6-7)[2]
total	69	5 (4-7)

TB: tuberculosis, IR: interquartile range; [1]The proportion of families with more than one case of TB is significantly different between the two communities (p<0.001); [2]The number of individuals per house is significantly different between families with one TB case and families with more than one TB case in Ariabú (p=0.027) but not in Maturacá (p=0.74)

at least one case of the disease when comparing both communities ((median, 6 (IR 4-7) individuals/house in Ariabú and 5 (IR 5-7) in Maturacá, p=0.15)).

Discussion

Tuberculosis severely affects Brazilian indigenous groups, which taken together exhibit an incidence rate of the disease more than double the incidence calculated for the whole Brazilian population[2]. Several factors influence TB epidemiology, including biological behavior of circulating strains[10], co-infections[11-13], socio-economic and environmental conditions[14,15] and the efficacy of disease control programs[16]. Brazilian indigenous communities affected correspond to over

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Table 3. Distribution of TB cases among families with more than one case of the disease, at Ariabú and Maturacá communities, Alto Rio Negro, São Gabriel da Cachoeira, Amazonas, Brazil

		1st TB case		2nd TB case		3rd TB case		4th TB case		5th TB case	
Community	Sputum smear	Age[1]	Month/year	Age[1]	month/year	Age[1]	month/year	Age[1]	month/year	Age[1]	month/year
Ariabú	not done	2	aug/1997	3	dec/1999[2]						
	negative	4	apr/1998	1	may/1998						
		20	jul/1993[3]	60	aug/1996						
	positive	22	mar/1992	15	apr/1999	46	mar/2002				
		6	oct/1991	12	feb/1993						
		50	oct/1996	50	may/2002[2]						
Maturacá	not done	2	mar/1997	23	nov/1997						
		16	dec/1999[4]	45	oct/2001						
	negative	16	apr/1995	60	dec/1996						
		38	oct/1992	43	may/1996[2]	2	may/1997				
		11 months	oct/2001	10	may/2002						
		6	sep/1996	60	aug/1998	3	sep/1998	10	jul/2002		
		24	aug/1994	19	jan/1997						
		22	feb/1992	25	mar/1997[2,4]	10	may/2002	10	jan/2003[2,4]		
		3	sep/2001[4]	4	may/2002[2]						
	positive	16	aug/1995	75	may/2002						
		30	aug/1990	4	dec/1995	35	mar/1996[2]				
		26	nov/1999	3	nov/1999	11 months	dec/1999	25	may/2002		
		45	oct/1995	4	jul/1996						
		20	jun/1991	7	nov/1996						
		30	nov/1991	3	may/1995	23	jun/1995	10	sep/1996	9	mar/2000[2]
		20	mar/1993	17	oct/1993						
		20	jun/1994	15	mar/1995						
		40	oct/1990	46	mar/1998[2]						
		27	mar/1997	10	sep/1997						
		23	mar/1996	2	feb/2002						
		25	jun/1991	20	jun/1994						

[1]Age in years (except otherwise indicated); [2]Relapse from previous case; [3]Ganglio-pulmonary tuberculosis. All other cases in this column are pulmonary TB; [4]Tuberculosis resistant to treatment.

200 different ethnic groups scattered in the whole country, what underlines the importance of poor life conditions and access to health care services in TB endemicity among these populations.

During the study period, most Yanomami communities in the Alto Rio Negro benefited from diagnosis by trained personnel (recruited mostly from other Brazilian states) only for short periods. Important changes in health care teams which are in charge of the health assistance to these populations are frequent (AB, unpublished results). This picture favors considerable variability in the technical competence of health care teams involved throughout the years, a matter of concern when taking into account that unsuccessful TB treatment has been documented. On the other hand, the discontinuity of the health care staff, allied to social and cultural gaps and low empowerment already implicit in the health care assistance relationship, contributes for a huge disequilibrium in doctor-patient communication, and poor compliance to treatment.

Our estimates of TB incidence among the studied communities of Yanomami Indians from the Alto Rio Negro are comparable with estimates from studies comprising all indigenous communities of the São Gabriel da Cachoeira district[17,18]. The estimated incidence of TB cases among the Yanomami of the whole rural area of São Gabriel da Cachoeira in 2002 was 2,133.3/100,000[17]. In our study, however, no significant differences in TB incidence were found between sexes, in contrast with findings for the urban and rural region of Sao Gabriel da Cachoeira in the same period[17] and the general Brazilian population[19]. In our study, children under 10 years of age corresponded to a great proportion of TB cases, as also found in other indigenous populations[1,4,20,21]. This can be attributable to the structure of these populations, as no significant differences were found when comparing incidence among age groups.

We observed significant differences in TB occurrence between the two Yanomami communities studied, in spite of similar socio-economic conditions, and shared environmental resources and access to health care service. A significant aggregation of disease cases was found in the Maturacá community, where, in spite of not being able to verify significantly higher disease incidence rates, we observed a higher number of multicase families. These differences are not likely associated with housing conditions, as house dimensions and ventilation apertures did not differ among the communities studied. Exposure to pulmonary TB cases with positive bacilloscopy is an important risk factor for TB infection[22]. Hence, a higher number of TB cases would be expected in larger families. The number of disease cases was significantly correlated with the number of house dwellers in Ariabú but not in Maturacá, suggesting a role for other family-related factors in the distribution of the disease.

Brazilian Yanomami indians present specially high rates of tuberculous disease[3]. Tuberculosis incidence among the Yanomami indians of São Gabriel da Cachoeira is up to ten-fold higher than among neighbouring non-Yanomami indigenous groups[17]. Previous studies in the Yanomami population also demonstrated low rates of tuberculin responsiveness after BCG vaccination, and low percentages of skin test positivity among individuals with active TB, leading to the suggestion of possible genetic susceptibility to TB[9]. However, no immunogenetical studies to explore this issue have so far been performed in this population or selectively in any other indigenous group in Brazil. The study of TB multicase families would be an interesting approach to confirm genetic susceptibility among the Yanomami and help identify genetic factors associated with tuberculous disease.

Strengths and limitations of this study: To our knowledge, this is the first report describing the distribution of TB cases among Yanomami families living in indigenous communities. The elevated TB rates in this population underline the need for a better understanding of the risk factors associated with the spread and development of the disease in Yanomami communities.

Increased number of cases in specific years is most probably a reflection of fluctuations in the surveillance for the disease, following the variability of medical staff in the area, and periodic systematic surveys of disease cases performed in the context of epidemiological research or by health assistance teams. Particularly, in 1997 and 2002, active searches for TB cases were performed by the IBDS in the Yanomami communities of Alto Rio Negro.

This study was based on data drawn from medical records of the IBDS, institution responsible for locally providing assistance to these indigenous communities. Registries have missing entries, especially regarding the community of origin of each individual (which was assessed by consulting the population census), the results of sputum smear test, culture or biopsy results. Cure results were often reported in the absence of registry of negative sputum smear after initiation of the treatment, for sputum smear positive pulmonary cases. Most individuals for which bacilloscopy was not performed or was negative were extrapulmonary TB cases or children under 5 years of age, but some individuals with indication for bacilloscopy were not tested.

There are no systematic birth registries before the year 1999; therefore, for most Indians, self-reported age was considered, with significant variability, especially in the elderly.

Conclusions

We have found significant differences between Maturacá and Ariabu families, suggesting familial aggregation of the disease independent of family size in the Maturacá community. Genetic susceptibility to TB has been extensively described worldwide, but is still poorly explored in indigenous populations. Our data suggest that genetically hyper-susceptible families may exist among the Yanomami.

The factors associated to the lack of TB control in indigenous populations need to be clarified, through careful investigation of biological and socio-economic variables associated with disease susceptibility. Health care assistance should also include actions to evaluate the efficacy of TB control among these populations, as well as offer more training opportunities to local, more permanent health care staff.

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