

# Between-group differences in dental caries in the Xavante Indians from Central Brazil

## Abstract

The aim of the study was to investigate caries experience levels in the Xavante Indians, in the state of Mato Grosso, Brazil, with a focus on between-group differences. Oral health data were collected in 2004, following WHO guidelines in four of the seven Xavante reserves (Pimentel Barbosa, Sangradouro, Areões and Marechal Rondon). Data were collected in the largest village in each of the reserves, using the DMFS index. Statistical analyses included sex-specific Poisson regressions to compare DMFS values among Xavante reserves. Prevalence ratios (PR) were used to measure the differences in caries experiences in the 6-to-34-year age group, whose losses varied between 26% and 30%. Xavante from the Pimentel Barbosa community were selected as reference group as they showed a lower prevalence of caries in all age groups. The major difference in DMFS was observed between Pimentel Barbosa and Sangradouro, both in males (PR 2.68, 95%CI 2.41-2.97) and in females (PR 2.03, 95%CI 1.85-2.23). The PRs of the filled component in Areões and Marechal Rondon (relative difference to Pimentel Barbosa) were lower, when compared to the total burden of disease observed in those reserves, indicating very low presence of restorative services. It was concluded that the oral health transition among Xavante has not been homogeneous and the differences found in caries experiences can be associated with the particularities of the interaction process between Indians and non-Indians. Local and regional determinants, including factors related to demography, specific economic and socio-cultural characteristics, health care access and type of oral health services received might have influenced the between-group differences in dental caries observed in the Xavante Indians.

**Key Words:** oral health, caries, DMFS index, epidemiology, cross-sectional study, South American Indians.

**Rui Arantes<sup>I</sup>**

**Ricardo Ventura Santos<sup>II,III</sup>**

**Paulo Frazão<sup>IV</sup>**

<sup>I</sup> Fundação Oswaldo Cruz, Unidade Cerrado Pantanal

<sup>II</sup> Departamento de Endemias, Escola Nacional de Saúde Pública, Fundação Oswaldo Cruz.

<sup>III</sup> Departamento de Antropologia, Museu Nacional, Universidade Federal do Rio de Janeiro.

<sup>IV</sup> Departamento de Prática de Saúde Pública da Faculdade de Saúde Pública da Universidade de São Paulo.

Correspondência: **Rui Arantes** FIOCRUZ – Unidade Cerrado Pantanal Av. Senador Filinto Muller, 1480 Vila Ipiranga - Campo Grande, MS CEP 79074-460 E-mail: arantesrui@hotmail.com

## INTRODUCTION

The epidemiological picture of oral health in Indigenous populations from Brazil is little known. Nonetheless, there is evidence of inequalities between Indians and non-Indians in terms of access to oral health care services and regular preventive methods, thus causing indigenous populations to be more vulnerable to caries and its complications,<sup>1,2,3,4</sup>. The risks of caries development in indigenous populations have increased due to their greater interaction with the surrounding Brazilian society<sup>1,2,5</sup>. Permanent contact with the non-indigenous society has imposed changes in the forms of subsistence, socio-cultural systems and lifestyles of these peoples, usually with negative impacts on their health<sup>4,6</sup>. Changes in eating habits and the introduction of manufactured foods, especially those rich in sugar, are particularly important to determine the current epidemiological picture of indigenous oral health<sup>5,7,8</sup>.

In 1999, health care of indigenous peoples became one of the responsibilities of Brazil's Health Ministry, after the implementation of the Indigenous Health Sub-System, and the creation of the – Special Indigenous Health Districts (DSEI) This process brought a greater amount of financial and human resources<sup>9</sup>. However, Ferreira (2005)<sup>10</sup> considers that oral health practices have not been implemented homogeneously in all Indigenous Health Districts. Whereas it is possible to perceive an increase in coverage in certain districts, there is a great difficulty in the implementation and organization of activities in others, often leaving a great part of the population without services.

While the presence of oral health inequalities between indigenous and non-indigenous peoples has been dealt with in the literature, one question that has been little investigated is the occurrence of intra-ethnic differences, i.e. among sub-groups of the same ethnic group. Donnelly et al. (1977)<sup>5</sup> analyzed the differences in caries experience of 210 Indians in three Yanomami villages with different levels of interaction

with the Brazilian society, situated on the border between Brazil and Venezuela. Less than one decayed tooth on average was observed in individuals aged between 20 and 43 years. In addition to lower caries experience than other indigenous populations (North American groups), the authors found that communities with the presence of a religious mission showed higher caries index than others, which was interpreted as indicative of the influence of Western eating habits on oral health<sup>5</sup>.

The Xavante Indians, whose lands are situated in the state of Mato Grosso, comprise one of the most studied indigenous peoples in Brazil from the health perspective. Investigations have evidenced how changes resulting from the interaction with the Brazilian society have interfered with their way of life and morbidity and mortality profile<sup>11,12</sup>. The Xavante is a good example of oral health transition. Very low levels of disease, observed in the first decades of permanent contact with non-indigenous society, contrast with the current situation, characterized by a high number of decayed teeth, several missing teeth, and infectious and pain episodes<sup>3,7,13</sup>.

The present study aimed to assess levels of dental caries experience in Xavante communities, situated in different Indigenous Reserves (IR), to investigate the presence of inequalities among sub-groups of one indigenous ethnic group. In addition, caries attack components (decayed, missing and filled surfaces – DMFS) were analyzed as an indication of the type of service received.

## POPULATION AND METHODS

### Study population

Although comprising one ethnic group that shares the same language (categorized into the Jê Family, Macro-Jê linguistic root) and socio-cultural organization, the Xavante do not constitute one socio-political unit. They are currently distributed into seven Indigenous Reserves (IR), situated in Eastern Mato Grosso<sup>14</sup> (Figure 1). Through-

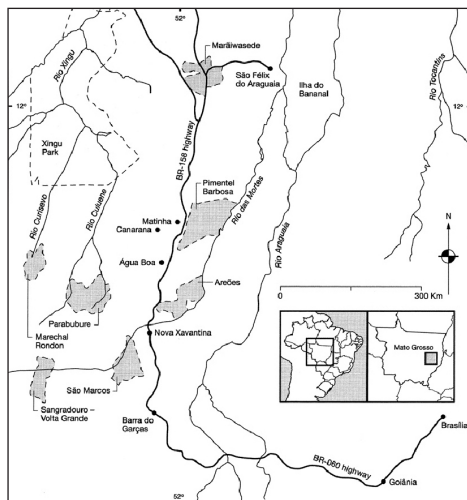
out time, the Xavante of several IRs have followed distinct trajectories of interaction with the surrounding society, thus affecting disease-health profiles differently<sup>6,7,12,15,16</sup>.

In addition to the high mortality due to post-contact epidemics in the 1950s and 1960s, throughout time, the Xavante have experienced a reduction in their characteristic pattern of high mobility associated with the use of the environment. This led to a decrease in hunting and gathering activities and an increase in the importance of farming, associated with sedentarism and changes in eating habits, including the growing dependence on manufactured products<sup>6,7,12,15,16</sup>. The Xavante diet, which used to be based on the gathering of fruits and wild roots, hunting and horticulture, especially corn, began to have rice as staple food<sup>6,17,18,19</sup>. Data available from the 1960s have shown an increase in health problems associated with a diet that has become increasingly monotonous and poor in nutrients, with a high prevalence of anemia in children, and obesity, diabetes and arterial hypertension in adults<sup>6,12,15,20</sup>. The new dietary pattern also had consequences on the oral health profile of the Xavantes, with a trend of increase in caries levels throughout time<sup>2,7,13</sup>.

In 2003, the DSEI Xavante included 144 villages, with a population of 11,227 individuals in seven Indigenous Reserves (Pimentel Barbosa, Marechal Rondon, Areões, Sangradouro, Parabubure, São Marcos and Marãwasede). The largest Xavante area in extension is the Pimentel Barbosa IR (328 thousand hectares), which also has the lowest population density. The largest population is found in the Parabubure, with almost half of the total population of this ethnic group, the largest number of villages and the highest population density. The majority of Xavante villages (about 80%) have a population below 100 individuals, 16% between 100 and 300 individuals, and only 4% (six villages) between 300 and 500 individuals. The Xavante population is predominantly young, including more than 50% of individuals aged less than 15 years<sup>21</sup>.

Aiming to achieve the main objective of this study, to investigate the occurrence of differences in caries experience among Xavante sub-groups, the strategy of selecting the largest village of each Indigenous Reserve investigated was adopted. In the case of Pimentel Barbosa, the investigation was conducted in the *Etenheritipá* village, with 511 individuals; in Sangradouro, in the Sangradouro village, with 379 individuals; in Marechal Rondon, in the Batovi village, with 135 individuals; in Areões, in the Dois Galhos and Mutum villages, which totaled 193 individuals. It was not possible to research Parabubu, once there were conflicts between the local population and the governmental organization responsible for health care at the time of this study. São Marcos was not investigated either, as a result of limitations related to resources and personnel for conducting field work. In the case of Areões, the population is less dense than in the remaining IRs, so that data were collected in the two largest existing villages (Dois Galhos and Mutum).

In the villages investigated, all households were visited and individuals aged more than two years who were present were evaluated, aiming to include the universe of the population in the studied communities.



Source: Coimbra Jr. et al., 2002.

**Figure 1** - Geographic location of Xavante Indigenous Reserves, Mato Grosso, Brazil

The Xavante show high mobility associated not only with subsistence activities (going to gardens and hunting, fishing and gathering activities), but also with visits to family members living in other communities. For this reason, population-based studies performed in this ethnic group frequently encounter difficulties due to losses, common in the case of indigenous peoples, even in the case of prolonged stay of research teams in the communities. There were no refusals to participate in the study among the Xavante and losses corresponded to individuals who were absent at the time of the field work. In the 6 to 34-year age group, from which the regression analysis was performed and prevalence ratio calculated, losses in the communities investigated varied between 26% and 30%.

### Data collection procedures

Oral health evaluation was performed according to the criteria recommended by the World Health Organization<sup>22</sup>. Data were gathered by only one examiner (Arantes), helped by an indigenous resident of the respective village, who took notes. Clinical examinations were conducted in the homes and, in the case of school-age children, in the schools situated in the village, when these existed.

The survey, performed in 2004, included caries, periodontal conditions, occlusion and dentofacial anomalies (dental aesthetic index - DAI)<sup>3</sup>. For the purposes of this study, data on caries experience were analyzed. To achieve this, the DMFS index was used, which is comprised of the sum of three indicators related to different dimensions of caries experience in permanent teeth. Whereas the D-component refers to untreated decayed surfaces and its value can be interpreted as the current need for treatment, the M- and F-components refer to missing and filled surfaces, respectively, whose values can be interpreted as the past need for treatment. By admitting that the missing teeth had been extracted mostly due to caries and that the filled teeth showed a condition of

unequivocal caries lesion, the analysis of the component related to the number of missing surfaces and the number of filled surfaces can indicate the type of oral health service received. This service, in its turn, can depend on several aspects, among which are variations in treatment technology available for health care, dentists' treatment philosophy, patients' choices and the durability of restorative materials<sup>23</sup>. High dental loss and a low number of filled surfaces can indicate experience with irregular services, predominantly urgent and leading to dental mutilation. In the case of deciduous teeth, the dmfs index was calculated.

Kappa coefficient was used to assess the intra-examiner agreement during data collection. A total of 21 individuals were analyzed and subsequently re-analyzed, totaling 2,256 doubly examined dental surfaces. Kappa coefficient showed a value of 0.94, thus indicating excellent agreement between exams.

### Ethical aspects

The present study met the directives and norms established by Resolution 196/196 of the Brazilian Health Council<sup>24</sup>, which regulates the performance of research in human beings. It was approved by the National School of Public Health Research Ethics Committee and the National Research Ethics Committee (Process 25000.083934/2003-51).

### Data analysis

The database was developed using the EPI-Info software, version 6.04b, and the analysis was performed using Stata software, version 10.1. Caries index was calculated by age group, according to type of dentition. The following groups were used: 2 to 5 years (deciduous), 6 to 11 years (mixed) and 12 to 19 years, 20 to 34 years and 35 years and more (permanent).

The utilization of dental surface as unit of analysis causes the missing component to have a greater contribution to the DMFS

composition, when compared to the D- and F-components. For each missing tooth, the DMFS increases four or five units (once anterior teeth have four surfaces and the posterior ones, five), although the caries that led to dental loss had not reached all surfaces. To reduce this effect, some correction factors have been suggested in the literature. Wagg (1974)<sup>25</sup> proposed an increase of 2.2 in the DMFS for each missing tooth, whereas the proposal by Abreu et al. (1998)<sup>26</sup> was 3.5. An intermediate value corresponding to 3.0 was used in the present study. The reason for this was the need for the DMFS to be an integer number, so that the outcome was maintained as a discrete variable, a prerequisite for the Poisson regression analysis used in this study.

For each age group, a chi-square test was performed to verify the existence of differences between sexes, according to the village. Means of DMFS and respective 95% confidence intervals were calculated for each age group and sex of each village. Although a universal sampling was conducted, the use of confidence intervals was adopted to minimize possible sources of uncertainty associated with non-response rate. Kruskal-Wallis test was used to test differences in age composition among villages.

The association between outcomes (DMFS and components) and independent variables (age and village) for each sex was estimated by the prevalence ratio (PR), calculated from the caries experience measured by the DMFS index, using Poisson regression. Poisson regression assumes that observations are independent and the logarithmic function of outcome changes linearly according to exposure variables<sup>27</sup>. This regression model was adopted because distributions were asymmetrical, with the majority of individuals having few decayed surfaces, contraindicating the use of linear regression methods. Differences in sex composition among IRs were observed in individuals aged 35 years and older and, for this reason, only data on permanent dentition of individuals aged between 6 and 34 years were analyzed. As the Pimentel Barbosa IR

showed the lowest level of caries, it became the reference category. Prevalence ratios between each Xavante village and reference category were calculated.

## RESULTS

Data from 691 individuals were collected, of which 281 were from Pimentel Barbosa (59.2% of the *Etenheritipá* village population), 209 from Sangradouro (57.7% of the village population), 115 from Areões (62.8% of the two villages analyzed) and 86 from Marechal Rondon (66.2% of the Batovi village population). For the 6-to-34-year age group, used in the calculation of caries prevalence ratio among villages, similar percentages were obtained as regards the proportion of individuals analyzed. In Pimentel Barbosa, 74% of the individuals in this age group were included, in addition to 73% in Sangradouro, 70% in Areões and 74% in Marechal Rondon. The distribution of the population studied per age group and sex and according to is shown in Table 1. Significant differences among IRs in the composition per sex were only observed for the age group above 35 years ( $p < 0.05$ ).

In the 2-to-5-year age group, Pimentel Barbosa showed the lowest value (4.6 surfaces of decayed, missing or filled deciduous dental surfaces), while Areões showed the highest value (10.5) (Table 2). There is an overlapping between confidence intervals, when Pimentel Barbosa is compared to the remaining IR, an indication that the differences were not statistically significant.

For the 6-to-11-year age group, Pimentel Barbosa also showed the lowest mean value, i.e. 0.7 (Table 2). The highest value was found in Sangradouro (3.4), with a statistically significant difference, when compared to Pimentel Barbosa and Areões.

For the remaining age groups, 12 to 19 years, 20 to 34 years and 35 years or older, the same pattern is observed, i.e. Pimentel Barbosa showed the lowest mean DMFS values. The highest values were found in Marechal Rondon (12-to-19-year and 35-year-or-older age groups) and Areões

**Table 1** - Age and sex composition of the study population, Xavante Indigenous Reserves, Mato Grosso, Brazil, 2004.

Age group (years)	Xavante Indigenous Reserves								p-value*
	Pimentel Barbosa		Sangradouro		Areões		Marechal Rondon		
	M (%)	F (%)	M (%)	F (%)	M (%)	F (%)	M (%)	F (%)	
2-5	21 (61,8)	13 (38,2)	16 (61,5)	10 (38,5)	13 (59,1)	09 (40,9)	08 (72,7)	03 (27,3)	0,893
6-11	41 (44,6)	51 (55,4)	29 (48,3)	31 (51,7)	18 (56,3)	14 (43,8)	10 (43,5)	13 (56,5)	0,690
12-19	38 (58,5)	27 (41,5)	42 (55,7)	34 (44,7)	10 (50,0)	10 (50,0)	12 (60,0)	08 (40,0)	0,899
20-34	32 (47,8)	35 (52,2)	22 (61,1)	14 (38,9)	11 (42,3)	15 (57,7)	06 (30,0)	14 (70,0)	0,144
35 e +	14 (60,9)	09 (39,1)	08 (72,7)	03 (27,2)	06 (40,0)	09 (60,0)	02 (16,7)	10 (83,3)	0,026
Total	146 (52,0)	135 (48,0)	117 (56,0)	92 (44,0)	58 (50,4)	57 (49,6)	38 (44,2)	48 (55,8)	

\* Teste de qui-quadrado / \* Chi-square test

**Table 2** - Mean values and confidence intervals (95% CI) of DMFS (decayed, missing and filled dental surface index), according to age groups and Xavante Indigenous Reserves, Mato Grosso, Brazil, 2004.

Indigenous Reserves		DMFS				
		Age groups (years)				
		2 a 5(a)	6 a 11	12 a 19	20 a 34	35 ou mais
P. Barbosa	N	34	92	65	67	23
	Means	4,6	0,7	5,5	19,0	34,1
	95% CI	1,7 a 7,5	0,3 a 1,1	4,1 a 6,6	14,5 a 23,5	21,7 a 38,5
Sangradouro	N	26	60	76	36	11
	Means	9,6	3,4	10,5	26,8	60,9
	95% CI	6,4 a 12,9	2,4 a 4,4(*)	8,3 a 12,6(*)	19,5 a 34,1	46,7 a 75,1(*)
Areões	N	22	32	20	26	15
	Means	10,5	1,6	8,3	40,1	56,9
	95% CI	3,5 a 17,5	1,0 a 2,3	3,1 a 13,5	28,0 a 52,2(*)	45,0 a 68,8(*)
Marechal Rondon	N	11	23	20	20	12
	Means	6,6	2,1	12,5	34,6	71,5
	95% CI	0,4 a 13,7	0,5 a 3,7	7,0 a 18,0(*)	26,0 a 43,1(*)	57,9 a 85,1(*)

(a) The "dmfs" index was used in this age group.

(\*) statistically significant differences in relation to Pimentel Barbosa.

(20-to-34-year age group) (Table 2). In these three age groups, there were statistically significant differences when the IRs are compared to Pimentel Barbosa, particularly in the case of Marechal Rondon and in the 35-year-or-older age group.

Table 3 shows the descriptive statistics of DMFS components for the 6-to-34-year age group, according to IR and sex. First, the average values for age among IRs were compared, without statistically significant

differences ( $p=0.752$ ). As regards the comparison among IRs, for each of the sexes and for both, statistically significant differences were found in the mean values. Pimentel Barbosa showed the lowest values for missing and decayed surfaces. In contrast, Areões showed the highest values for decayed surfaces and Marechal Rondon, the highest values for missing surfaces. In terms of filled surfaces, Areões showed the lowest means and Sangradouro, the highest ones.



When sexes were compared, the accumulated caries experience, mostly due to decayed and missing surfaces, was found to be more relevant in women (Table 3).

Considering the 6-to-34-year age group, table 4 shows the values of prevalence ratios (PR) between each IR and Pimentel Barbosa as reference for the several outcomes, using Poisson regression adjusted for age. Results were statistically significant for the majority of outcomes, both for women and men. Prevalence ratios of DMFS values indicate the magnitude of differences in burden of

disease accumulated in the 6-to-34-year age group between each village and the reference group.

In the comparison with Pimentel Barbosa, which showed the lowest DMFS values, the burden of disease in men was greater in other villages. In males, the worst condition of caries experience was identified in Sangradouro and the best one in Marechal Rondon. Untreated decayed teeth follow the pattern of global caries experience. As regards missing teeth, while Sangradouro showed the worst condition, Marechal Rondon and

**Tabela 3** - Média, mediana e desvios-padrão das superfícies cariadas, perdidas e obturadas dos dentes permanentes na faixa etária entre 6 e 34 anos de idade, de acordo com as Terras Indígenas Xavante e sexos.

**Table 3** - Mean, median and standard deviation of DMFS (decayed, missing and filled dental surface index) on permanent teeth in individuals aged from 6 to 34 years, according to sex and Xavante Indigenous Reserves, Mato Grosso, Brazil, 2004.

Indigenous reserves	Number of surfaces								
	Decayed			Missing			Filled		
	M	F	Both	M	F	Both	M	F	Both
<b>Pimentel Barbosa</b>									
Mean	2,69	5,19	3,96	1,89	3,42	2,67	0,86	1,04	0,95
SD	5,93	10,27	8,48	4,82	6,36	5,69	2,75	2,83	2,78
Median	0,0	1,00	1,0	0,0	0,0	0,0	0,0	0,0	0,0
N	111	113	224	111	113	224	111	113	224
<b>Sangradouro</b>									
Mean	6,09	6,56	6,30	3,68	4,06	3,85	1,17	1,38	1,27
SD	8,03	12,00	10,02	6,30	9,63	7,98	2,58	2,27	2,44
Median	4,00	4,00	4,00	0,0	0,0	0,0	0,0	0,0	0,0
N	93	79	172	93	79	172	93	79	172
<b>Areões</b>									
Mean	7,26	13,49	10,37	2,85	8,46	5,65	0,33	0,0	0,17
SD	15,30	19,27	17,56	4,81	14,81	11,29	1,51	0,0	1,07
Median	2,00	5,00	3,00	0,0	0,0	0,0	0,0	0,0	0,0
N	39	39	78	39	39	78	39	39	78
<b>Marechal Rondon</b>									
Mean	4,57	6,43	5,60	5,89	12,77	9,71	0,64	0,20	0,40
SD	4,95	9,83	8,03	9,40	18,54	15,45	2,87	1,02	2,05
Median	3,00	3,00	3,00	3,00	3,00	3,00	0,0	0,0	0,0
N	28	35	63	28	35	63	28	35	63
p-value (*)	<0,00	<0,00	<0,00	0,02	0,03	<0,00	<0,00	<0,00	<0,00

\* Teste de Kruskal Wallis entre as Terras Indígenas. / \* Kruskal Wallis test among Indigenous Reserves.

Areões showed equivalent PRs. In the case of the filled component, differences were less evident. If the highest number of filled surfaces was found in Sangradouro, Areões and Marechal Rondon showed values without statistically significant association, when compared to Pimentel Barbosa. In other words, there were fewer restorative services received where they would be expected, given the greater burden of disease in relation to the reference group.

Among women, burden of disease was greater in Sangradouro, Areões and Marechal Rondon, when compared to Pimentel Barbosa (Table 4). The worst condition in terms of caries experience was identified in Sangradouro, while the best one was in Marechal Rondon. Missing teeth follow this pattern of inequality. However, it was

observed that Marechal Rondon does not differ from Pimentel Barbosa in terms of the number of untreated decayed teeth. In Marechal Rondon and Areões, there were either no filled teeth in women or a significantly smaller number than in Pimentel Barbosa, whose burden of disease is lower, thus expressing low availability of restorative services.

## DISCUSSION

Since the 1990s, there has been a growing increase in the number of studies on health of indigenous peoples in Brazil<sup>11,13,28,29</sup>. One of the most significant difficulties in these studies is how to obtain representative samples from the point of view of the population. Indigenous com-

**Tabela 4** - Razão de prevalência (RP) para o CPOS e componentes na população de estudo entre 6 e 34 anos entre as Terras Indígenas e a referência (Pimentel Barbosa). Intervalos de confiança (95%) e valores estimados obtidos através de regressão de Poisson ajustados pela idade e de acordo com o sexo.

**Table 4** - Prevalence ratio (PR) of the DMFS index and its components in men and women aged between 6 and 34 years living in Xavante Indigenous Reserves (Pimentel Barbosa as reference). 95% confidence intervals and estimated values were obtained through Poisson regression, adjusting for age. Mato Grosso, Brazil, 2004.

Outcome	Men				Women			
	PR	Estimated parameters			PR	Estimated parameters		
		95% CI	SD	p-value		95% CI	SD	p-value
DMFS								
Sangradouro/Ref	2,68	2,41 a 2,97	0,14	0,00	2,03	1,85 a 2,23	0,10	<0,00
Areões/Ref	1,62	1,52 a 1,73	0,05	0,00	1,46	1,39 a 1,53	0,03	<0,00
M. Rondon/Ref	1,33	1,27 a 1,39	0,03	0,00	1,17	1,13 a 1,21	0,02	<0,00
Cariado								
Sangradouro/Ref	2,68	2,32 a 3,09	0,02	0,00	1,86	1,64 a 2,11	0,12	<0,00
Areões/Ref	1,88	1,73 a 2,04	0,08	0,00	1,56	1,47 a 1,65	0,05	<0,00
M. Rondon/Ref	1,23	1,15 a 1,31	0,04	0,00	1,01	0,96 a 1,06	0,03	0,66
Perdido								
Sangradouro/Ref	3,15	2,62 a 3,79	0,30	0,00	2,35	2,00 a 2,77	0,19	<0,00
Areões/Ref	1,48	1,31 a 1,66	0,09	0,00	1,54	1,43 a 1,65	0,06	<0,00
M. Rondon/Ref	1,57	1,46 a 1,68	0,05	0,00	1,42	1,36 a 1,49	0,03	<0,00
Obturado								
Sangradouro/Ref	2,01	1,50 a 2,69	0,30	0,00	2,11	1,60 a 2,79	0,30	<0,00
Areões/Ref	0,75	0,56 a 1,01	0,11	0,06	n.a.	n.a.	n.a.	n.a.
M. Rondon/Ref	0,97	0,82 a 1,15	0,08	0,73	0,53	0,41 a 0,68	0,07	<0,00

n.a. - not applicable because there are no filled surfaces in this category

DMFS - decayed, missing and filled surfaces

SD - Standard Deviation



munities are not only frequently situated in areas of difficult access, but there is also the question of the small size of villages and the fact that, in truth, there are more than 200 distinct indigenous ethnic groups. In the sphere of research on indigenous health, one aspect that is practically unknown is the between-group differences, in terms of the disease-health process.

The present study, focused on the Xavante, one of the largest indigenous ethnic groups present in the country, with more than 10,000 individuals, aimed to investigate the occurrence of differences in oral health profile among Indigenous Reserves, with a focus on caries. This was the broadest investigation on oral health ever performed among the Xavante and one of the most far-reaching studies performed in an indigenous people in Brazil. To achieve this, the largest villages of the Xavante Reserves were selected. Although this strategy of selection of communities enables between-ethnic group differences to be pointed out, it is important to emphasize the fact that these are not considered to be representative of the Indigenous Reserves under analysis. Villages with greater population density can show different socioeconomic and ecological characteristics than those with a smaller size, situated in the same Indigenous Reserve<sup>6</sup>. For the purposes of the present study, this is based on the principle that the largest villages of each Indigenous Reserve, considering logistical possibilities, represent the best possible approximation to the diversity among reserves. As mentioned previously, the several Xavante Reserves, due to historical and political questions resulting from contact with Brazilian society, show specific socioeconomic characteristics.

Probably, the most important result of this study was the measurement of inequalities in the occurrence of caries among Xavante communities. In general, the caries experience was significantly higher in Sangradouro, Areões and Marechal Rondon, when compared to the reference group of Pimentel Barbosa. Untreated caries and missing teeth were the components respon-

sible for these differences, both in women and men.

Although the analysis of inter-gender differences in the Xavante was not a purpose of this study, findings showed greater burden of disease in women. On the disparities in oral health between Xavante women and men, Arantes et al.<sup>13</sup> performed a longitudinal study in Pimentel Barbosa, based on data collected in 1999 and 2004. In the 20-to-34-year age group, there was a risk of caries in women four times higher than that found in men. Authors argued that factors associated with social gender roles and differences in access to information, health services and education could explain the disparity observed.

The existence of differences in the disease-health profile among Xavante communities results from the distinct socio-cultural and historical trajectories from the contact with Brazilian society, which occurred from the 1940s onwards<sup>6,12,14</sup>. As an example, the Xavante IRs situated further South, such as Sangradouro and São Marcos, have had the presence of religious missionaries for many decades. This interaction could have influenced the process of socioeconomic, cultural and environmental changes, thus having a negative effect on the health conditions of these communities. They are also smaller areas, where the maintenance of fishing, hunting and gathering activities is difficult at times. In communities such as Pimentel Barbosa, with a significantly larger area, lower population density and better-preserved environment, activities such as hunting, fishing and gathering have been able to perform an important role in the daily subsistence of the population. The availability of financial resources from salaries and pensions is probably another relevant factor in the change of dietary pattern among the Xavante, of great importance in terms of caries. In the last decades, there has been significant consumption of manufactured foods, such as sugar, cooking oil, salt, wheat flour, pasta and sodas, among others<sup>6</sup>.

Considering the multiplicity of socio-historical trajectories, it is not surprising

that several Xavante communities show a significant diversity of oral health profiles, as revealed in the results of the present study. The differences in oral health patterns have parallels with those of other health conditions. Gugelmim & Santos (2001)<sup>15</sup> found substantial differences in the occurrence of overweight, obesity and diabetes between the villages of Pimentel Barbosa and Sangradouro

These authors highlighted important variations in the subsistence activities that predominate in each village, which is reflected in the diet and physical activity patterns. In the analysis of length of time spent on subsistence activities, the Xavante from Pimentel Barbosa used 94% of their time in activities associated with farming, hunting, fishing and gathering, and only 6% in paid activities. In contrast, in Sangradouro, paid activities totaled 39% of the time spent on subsistence. The most plausible explanation for this is the presence of a religious mission, which involves the creation of paid jobs to work in the missionary activities, such as teachers, cooks and cleaners thus requiring a lower level of physical activity and leading Indians to be more dependent on the regional market to obtain foods, with repercussions on their nutritional status.

It is worth emphasizing that the differences in oral health conditions among several Xavante populations can be traced back many decades, not being a recent phenomenon. Niswander (1967)<sup>30</sup> assessed oral health conditions of the Xavante group who lived in the *Posto Indígena Simões Lopes* (Simões Lopes Indigenous Post), from where the Xavante who currently live in the Marechal Rondon IR descend. It was observed that only 33% of individuals had no caries. This author refers to significant differences between the Simões Lopes and the São Domingos groups, from where the current Xavante of Pimentel Barbosa descend. Neel et al. (1964:107)<sup>31</sup> mentioned "the almost complete absence of disease" (caries) among the Xavante from São Domingos. This difference, or at least part of it, was attributed to the fact that, at that time, the Xavante from Simões Lopes

had incorporated the habit of sugar intake, in contrast to the group from São Domingos, who were still relatively isolated and with little change in their eating habits<sup>30</sup>. More recently, in the end of the 1980s, Pose (1993)<sup>32</sup> showed different caries levels among the Xavante Reserves, based on secondary data obtained from the routine dental service at the Brazilian Indigenous Foundation (FUNAI – *Fundação Nacional do Índio*), the organization responsible for indigenous health care at that time. This author found patterns that were similar to those observed in this study, i.e. higher levels of caries in Marechal Rondon, intermediate levels in Sangradouro and the lowest prevalences in Pimentel Barbosa.

The results from the present study not only point to important epidemiological differences among the Xavante villages, but also to the differences in received services that can be related to availability of oral health care services. The presence of dental services can be indirectly detected by the analysis of filled and missing DMFS components. The comparison of past need for treatment among groups with equivalent caries experience can be an indication of differences in the use of dental services and type of services provided (for example, a more mutilation-oriented profile where the M-component predominates or a more conservative profile where the F-component predominates). In this study, a strategy of analysis based on the calculation of the prevalence ratio was adopted, as a measure of relative inequality, considering the group with lower burden of disease as the reference group. In this way, it was possible to comparatively assess the distribution of components of the DMFS index.

Although the filled component was low in all villages, only in Sangradouro was the presence of filled surfaces higher, when compared to Pimentel Barbosa, which is in accordance with the greater burden of disease found. In Marechal Rondon and Areões, the prevalence ratios (PR) of the filled component for the 6-to-34-year age group are not equivalent to the burdens of disease found in these villages. In other

words, the relative difference for Pimentel Barbosa in relation to the number of decayed and missing surfaces is higher than the filled surfaces. Considering the fact that there is no documentation about self-dental extraction practices in Xavante villages, this pattern can be highly indicative of low availability of restorative services and exposure to mutilating dental practices in these IRs.

Since 1999, indigenous health care has become part of the Brazilian Unified Health System (SUS-*Sistema Único de Saúde*), through the Health Care Sub-System for Indigenous Peoples (*Subsistema de Atenção à Saúde dos Povos Indígenas*) (Decree 3,156 of 8/27/1999). In the period of this study, the Brazilian Health Foundation (FUNASA – *Fundação Nacional de Saúde*) managed this sub-system, organized in Special Indigenous Health Districts (*Distritos Sanitários Especiais Indígenas* - DSEI). The Xavante District was created in the sphere of this sub-system. The present study showed that, although oral health practices are included in the Xavante District activities, a significant heterogeneity of availability of services persists in the Xavante Reserves. There are areas, such as Areões, which remain practically without health care, observed by the absence of the filled component in women. Even in those where there is evidence of oral health care, the occurrence of dental restorative practices is very low. Results suggest that basic oral health care services provided by the Xavante District have been performed on an irregular basis and unequally distributed among the different communities.

Improvement of oral health care for the Xavante is a priority, especially when considering that there has been a trend of increase in the occurrence of caries and other diseases in this population, in the last decades<sup>6,7,13</sup>. Moreover, in contrast with the Brazilian population, in which a relevant trend of reduction in caries has been observed<sup>33,34,35</sup>, there is evidence that many indigenous populations, including the Xavante, are experiencing an opposite process of transition<sup>2</sup>. In Pimentel Barbosa, where data has been collected throughout

time, the mean DMFT increased from 1.16 in 1991 to 4.54 in 1997, in the 13-to-19-year age group<sup>7</sup>.

In this context of increase in the occurrence of caries, analyses such as the ones performed in this study, which indicate differences among Xavante sub-groups, gain particular relevance, because they can subsidize the planning and implementation of health actions.

In conclusion, results provide evidence that the transition in oral health care among the Xavante is not homogeneous, depending on the historical process of inclusion into and interaction with the non-indigenous Brazilian society. This process has been developing in a heterogeneous way among the Xavante sub-groups and the differences can be associated with several aspects, such as specific histories of interaction with non-Indians, socio-cultural aspects and access to health services. These are factors that have a local influence and result in unique disease-health processes, with important epidemiological changes among the Xavante sub-groups. Knowledge about local determinants associated with epidemiological information is an important aspect to define health policies that can help to structure more efficient health programs, with adequate allocation of resources and to establish the need for professionals or the creation of special programs, aimed at specific segments of the population of each DSEI.

## ACKNOWLEDGEMENTS

Authors would like to thank the Xavante for their interest in participating in this study. Resources for research were provided by Colgate and the *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq – National Council for Scientific and Technological Development – Doctoral scholarship granted to Arantes). Authors would also like to thank Alexandre Takashi and Rodrigo Portela for their help with the field work.

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