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ORIGINAL ARTICLE

Caries, gender and socio-economic change in the Xavante Indians from Central Brazil

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Abstract

Background: The oral health conditions of indigenous peoples in Amazonia are closely associated with ecological and dietary changes related to interaction with non-Indians.

Aim: The study investigated the incidence of caries in an indigenous community from Central Brazil focusing on gender differences.

Subjects and methods: The research was conducted among the Xavante Indians and was based on longitudinal data collected in two surveys (1999 and 2004). The study included 128 individuals, 63 (49.2%) males and 65 (50.8%) females, divided in four age brackets (6–12, 13–19, 20–34, 35–60 years of age). The DMFT (decayed, missing and filled teeth) index and incidences (difference between 1999 and 2004) were calculated for each individual. The proportion of incidence was also calculated. Differences in caries risk between gender and age brackets were compared by parametric and non-parametric tests.

Results: There were statistically significant differences in relation to caries incidence between age brackets and gender. The greatest incidence was observed in the 20–34 age bracket, which presented 3.30 new decayed teeth, twice the risk of the 6–12 age bracket ($p < 0.01$), chosen as reference. While females in most age groups did not show higher risk for caries when compared to males, there was a 4.04-fold risk in the 20–34 age bracket ($p < 0.01$).

Conclusion: It is concluded that factors related to the social functions of each sex (gender issues) and differential access to information, health services, and education may help to understand the differences observed in the incidence of caries.

Keywords: *Caries, health, Amazonia, indigenous people, longitudinal study*

Introduction

The indigenous population of Latin America and the Caribbean is highly diverse, comprising more than 400 different ethnic groups and roughly 10% of the total population

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of the region (Montenegro and Stephens 2006). In Brazil, although the indigenous population is small relative to the total population (less than 0.5% of the national population), it includes more than half of all Latin American indigenous societies - around 225 different peoples (Pagliaro et al. 2005).

Throughout five centuries of Western colonization the indigenous peoples of Brazil have experienced very different patterns of contact, with the result that health profiles and determinants of health and disease vary considerably from one society to another (Coimbra and Santos 2004). Because of this there is no satisfactory way to generalize about the health/disease profile of indigenous peoples in Brazil. However, the few studies carried out tend to emphasize precarious health conditions that compare unfavourably with those of other segments of Brazilian society (Coimbra et al. 2002; Garnelo et al. 2003; Coimbra and Santos 2004).

Concerning dental health, very few investigations have focused on indigenous peoples in Brazil (Arantes 2003). All those that have been done were cross-sectional; there are no prospective studies. It is especially important to follow changing conditions of dental health in indigenous peoples because the epidemiological transition may take different tracks, depending on the ethnic group and the socio-economic and environmental context. While national surveys in general have documented a tendency toward reduction in the prevalence of dental caries in the Brazilian schoolchildren population (Narvai et al. 2006), studies in specific indigenous communities have noted an increase, which may be explained by dietary changes and limited access to health services (Donnelly et al. 1977; Arantes et al. 2001; Rigonatto et al. 2001). However, the notion that these peoples formerly had a low prevalence and are necessarily moving to higher rates of dental disease should be examined with care. Some case studies fail to corroborate this tendency, indicating that consumption of sugar and length of contact are not the only determining factors of caries epidemiology in indigenous peoples (Arantes 2003).

The Xavante are one of the most numerous indigenous societies in Brazil. They live in hundreds of villages in the central western region of the country. The Xavante constitute an exception in the context of bioanthropological and health studies among indigenous peoples in the country. Since the 1960s, starting with the research conducted by James Neel and collaborators (Neel et al. 1964), epidemiological and human biological studies have been carried out, so the process of health transition in this population is relatively well documented, both in terms of socio-demographic changes and the resulting repercussions on morbidity and mortality (Coimbra et al. 2002). In regard to dental health, available information indicates a significant increase in the prevalence of caries since the 1960s (Neel et al. 1964; Niswander 1967; Arantes et al. 2001), which has been attributed especially to the increase in consumption of sugar. More recent cross-sectional studies indicate that there are important differences in dental health among Xavante villages, apparently related to different forms of interaction with the surrounding national society (Arantes 2005).

There is a rich body of literature that demonstrates male–female differences in prevalence rates of caries. These findings are generally true for diverse human societies with different subsistence systems and for a wide range of historical periods, being attributed to a multitude of economic and socio-cultural factors (see review in Hillson 1996). In addition to these influences, recent studies have emphasized the critical role of female hormones and life-history events in the aetiology of dental caries. These studies suggest that hormonal fluctuations can have an effect on the oral health of women, and constitute an important causal factor in male–female differences caries rates (Lukas and Largaespada 2006).

The present study, which is the first longitudinal study of dental health carried out in a Brazilian indigenous society, assesses the incidence of caries in a Xavante community,

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focusing on gender differences in the adult population. Whereas 'sex' refers to biological differences between males and females, a perspective based on 'gender' goes further, seeking to take into consideration the socially constructed roles, behaviour, activities, and attributes that a particular society attributes to males and females. Gender differences, expressed in a multitude of social and cultural dynamics, can influence health status and access to health care (Verbrugge 1985).

Population and methods

Population

Xavante territory is located in the central region of Brazil, characterized by tropical scrub vegetation known as 'cerrado'. Since the 1960s the rapid development of this region as a cattle raising and agricultural frontier has been stimulated by public policies and international financing. As the Xavante came into contact with outsiders starting in the 1940s, they not only suffered high mortality from epidemics but were forced to reduce the characteristic mobility that allowed them to exploit wide areas of their environment (Maybury-Lewis 1967; Santos et al. 1997; Coimbra et al. 2002). This necessarily meant a reduction in collective economic activities (hunting and gathering), leading to an increase in the importance of agriculture and sedentarization. Despite several decades of contact the Xavante retain their language (Jê linguistic branch).

The Xavante diet, formerly based on gathered fruits, nuts and wild roots, game and some horticulture, principally maize, has been replaced by a diet based on rice cultivated in communal fields. This new dietary pattern has had unfortunate consequences for the nutritional status and for the health of the Xavante (Coimbra et al. 2002). Data collected since the 1960s show an increase in health problems related to a starchy diet that is increasingly monotonous and poor in nutrients. Among these consequences are a high prevalence of undernutrition anaemia in children, increased dental caries levels, obesity, diabetes mellitus, and hypertension in adults (Arantes et al. 2001; Gugelmin and Santos 2001; Coimbra et al. 2002; Leite et al. 2006).

At present the Xavante number approximately 12 000 distributed over seven separate 'Indigenous Territories' (Figure 1). In 2003 the villages in these territories totalled 144. Most of them (about 80%) had a population under 100; 16% had a population between 100 and 300, and only 4% (six villages) had a population between 300 and 500. Most of the villages do not have easy access; to reach them from a main highway requires hours of travel over poorly maintained dirt roads.

The Xavante village of Etẽnhiritipá, or Pimentel Barbosa, the site of the present study, is located in the indigenous territory of the same name. With 328 000 hectares, it is the largest Xavante territory. In 2004 the population was 1535, distributed over six villages. Etẽnhiritipá (13°18′59″S, 051°40′48″W) was the largest one, with 511 people, of whom around 50% are children under 15 years of age.

Levels of caries in the Xavante community at Etẽnhiritipá have been documented in several studies carried out over the past 40 years, demonstrating a trend toward increase. The main factors determining the higher levels of caries have been modifications in the productive system and use of the environment, growing participation in the market economy, and greater dependence on consumption of industrialized foods (including refined sugar), all of which intensified after the 1970s (Neel et al. 1964; Arantes et al. 2001).

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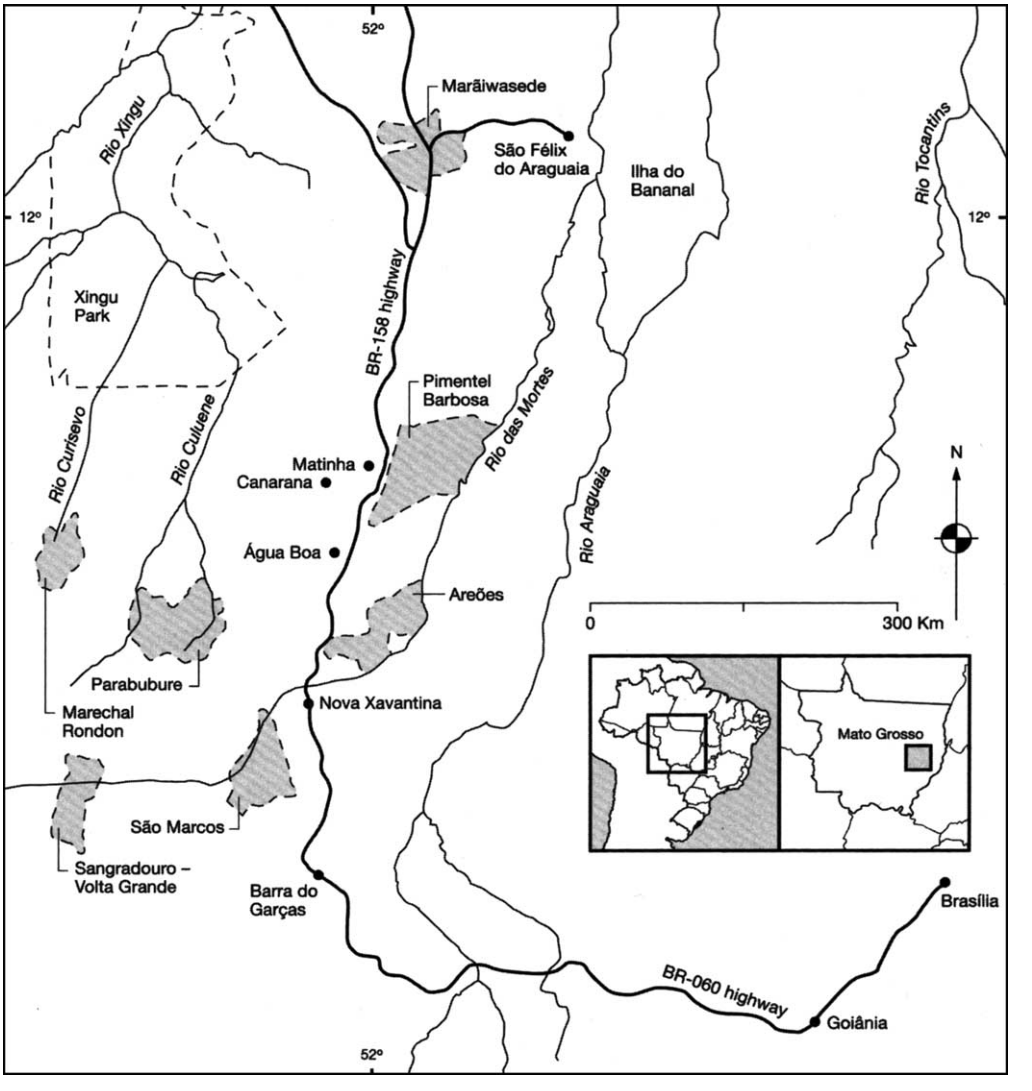

Figure 1. Geographic location of Xavante reservations in Mato Grosso State, Brazil. Source: Coimbra et al. (2002).

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Methods

This study is based on longitudinal dental data collected at Etẽnhiritipá village at two points in time, in 1999 and 2004. All individuals over 6 years of age who agreed to participate in the study (or, in the case of children, whose parents agreed) were considered eligible for the 1999 baseline survey. In 2004, the aim was to locate and examine as many of the subjects who had been surveyed in 1999 as possible.

A single examiner trained in the use of the criteria recommended by WHO (1997) performed all the examinations (Arantes). They were made under natural outdoor light during visits to participants' households. A tooth was categorized as 'sound' if it showed no evidence of treated or untreated clinical caries; 'decayed' if it had an unmistakable cavity,

undermined enamel, or a detectably softened floor or wall; 'filled' if it had one or more permanent restorations; and 'missing' if it had been extracted previously because of caries.

Intra-observer reproducibility was assessed using the Kappa coefficient. A total of 22 individuals were examined twice, which yielded a kappa value of 0.94, thus indicating very high agreement.

For the purpose of this analysis, the population was divided into four age brackets: 6–12, 13–19, 20–34, and 35–60 years of age. The decayed, missing, or filled permanent teeth index (DMFT) and the incidence of new attacked teeth (difference between 1999 and 2004) were calculated for each individual. For both males and females and for each age bracket the mean variation of the DMFT index was calculated, as well as the mean increase during the period. New lesions (increase) were scored only when they occurred in teeth not previously affected by caries. We did not include in the analyses subjects >60 years of age because there were only two of them who were evaluated both in 1999 and 2004.

In order to calculate the increment in caries among individuals of several ages, differences in number of erupted teeth must be taken into consideration, since there is a greater risk with a higher number of exposed sound teeth. To compensate differences in number of exposed teeth, the mean proportional increment was calculated for each individual. This measure, also called proportion of incidence, is the ratio between the number of new teeth affected by caries during the period by the total number of exposed sound teeth, multiplied by 100. On a scale from 0 to 100, it expresses the degree of caries increase in a determined time period according to number of at-risk teeth (Beck et al. 1997). The number of exposed teeth was obtained from the number of healthy teeth found in the first survey (in 1999). In this way the increment of individuals from different age brackets, with different numbers of teeth exposed to risk of caries, could be compared.

For the 6–12 age bracket an additional adjustment was made in relation to number of exposed teeth to caries. In this age bracket permanent teeth are erupting, and the number of exposed teeth is very variable. For example, one individual who was 6 years old in 1999 had four times as many exposed teeth when he was 11 years old in 2004. To adjust for this variation, the proportion of incidence was calculated using the mean number of exposed teeth between 1999 and 2004. For example, if an individual had 10 exposed teeth in 1999 and 20 in 2004, the mean number of teeth exposed during the period was 15.

As well as analysing the increment by age bracket, a comparison by gender was made to test the hypothesis that there is a difference in risk between males and females. The proportion of incidence was also calculated. Mean and standard deviation were computed. For the calculation of relative risk, 6–12 age bracket and male were used as reference categories.

The ratio between caries incidence of each age bracket and gender with reference group was calculated. Male gender and 6–12 age bracket were considered as reference groups. The results express the relative risk, i.e. the magnitude of caries occurrence's probability in each age bracket/gender related to reference group. Ninety-five per cent confidence intervals were calculated following Fieller (1940).

Statistics

Data analysis was carried out using the EPI-Info 6.04b and SPSS 11.0 statistical packages. Assumptions of normality were checked for each variable in order to determine whether to use parametric or non-parametric statistical tests. The following non-parametric tests were applied: Mann–Whitney (to compare the DMFT index values from the 1999 baseline

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survey and from the study sample and to compare caries increment between males and females from 1999 to 2004); Wilcoxon (for paired group comparisons of DMFT index values in 1999 and 2004 by age brackets); and Kruskal–Wallis (to compare DMFT mean increments and mean proportional increments among the four age brackets from 1999 to 2004). As for parametric tests, Student's *t*-tests were applied to compare differences in caries mean increment and mean proportional increment between males and females from 1999 to 2004. A level of 5% to reject the null hypothesis was adopted for all tests.

Ethics

This study was approved by the Committee for Ethics in Research of the National School of Public Health, Oswaldo Cruz Foundation, and by the National Committee for Ethics in Research (Process Number 25000.083934/2003-51).

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Results

In 1999, the total population between 6 and 60 years of age at Etẽnhiritipá village was 265. Two hundred and twelve individuals were examined in 1999 (80.0% of the eligible population at the time) as part of the baseline survey. Of those, 128 were re-examined in 2004 (60.4% of 1999 baseline survey sample).

The study sample (individuals examined in both 1999 and 2004) consisted of 48.3% (46.7% for females and 50.0% for males) of the total population between 6 and 60 years of age at Etẽnhiritipá village in 1999 (Table I).

We compared the mean DMFT index values for the 212 individuals examined in 1999 and the study sample ($n = 128$), according to age brackets and gender (Table II). Statistically significant differences ($p > 0.05$) were not observed. Therefore, the loss of nearly 40% seems not to have significantly altered the caries profile of the study sample compared to the 1999 baseline survey sample.

Considering the study sample, we tested for possible differences in the mean age of each age bracket by gender. Only in the 20–34 age bracket there was a significant difference between gender in mean age, 23.9 years for women and 27.7 years for men ($p < 0.05$).

The variation or mean increment in the DMFT index for the study sample is presented in Table III. The lowest increments were observed in the younger age brackets. The mean DMFT index increased 1.61 teeth in the 6–12 age bracket, and 2.41 in the 13–19 age bracket. The greatest increase was at 20–34 age bracket, with an average number of 3.30 new decayed teeth, twice the risk (2.04) of that among children 6–12 years old

Table I. Age and gender composition of study sample from longitudinal dental caries investigation (1999 and 2004), Xavante village of Etẽnhiritipá, Mato Grosso, Brazil.

	Male		Female		Both	
Age bracket (years)	*n*	%	*n*	%	*n*	%
6–12	34	56.7	26	43.3	60	100.0
13–19	10	58.8	7	41.2	17	100.0
20–34	13	32.5	27	67.5	40	100.0
35–60	6	54.5	5	45.5	11	100.0
Total	63	49.2	65	50.8	128	100.0

Table II. Descriptive statistics of the DMFT (decayed, missing and filled teeth) index values from the 1999 baseline survey sample and the study sample, according to age bracket, Xavante village of Etẽnhiritipá, Mato Grosso, Brazil.

Age bracket (years)	Gender	Examined in 1999 (baseline survey sample)				Re-examined in 2004 (study sample)				*p*-value*
		n	Mean	SD	95% CI	*n*	Mean	SD	95% CI	
6–12	M	44	0.59	1.08	0.26–0.92	34	0.53	1.05	0.16–0.89	$p=0.77$
	F	38	0.66	1.28	0.24–1.08	26	0.38	0.85	0.04–0.72	$p=0.38$
13–19	M	13	1.85	1.23	1.11–2.59	10	1.80	1.55	0.69–2.91	$p=0.92$
	F	20	4.75	4.62	2.59–6.91	7	2.71	2.93	0.02–5.42	$p=0.37$
20–34	M	20	4.60	4.26	2.61–6.59	13	4.38	4.23	1.82–6.93	$p=0.98$
	F	29	10.21	6.44	7.76–12.66	27	8.30	5.93	5.95–10.64	$p=0.26$
35–60	M	12	12.50	5.50	9.00–15.99	6	11.00	6.57	4.10–17.89	$p=0.31$
	F	8	14.38	6.35	9.07–19.69	5	9.40	6.19	1.71–17.08	$p=0.14$

*Mann–Whitney test.

($p<0.01$). The second greatest increase was in adults over 35, who had 2.82 new decayed teeth. The highest values of the proportional increment were also found in adults over 20, indicating that the increment in the DMFT index was smallest among young people even taking into account the relation between number of exposed teeth of each individual.

Variation in increment of the DMFT index by gender for the study sample is shown in Table IV. Among men the greatest increment was at 13–19 age bracket and those over 35. Among women, the greatest increase was at 20–34 age bracket. In this age bracket there was a statistically significant difference between gender. In 1999 the men had a mean number of 4.38 DMFT and women had 8.30. In 2004 the same group of men had a mean number of 5.46 DMFT, and the women had 12.67. This means that the men had an increment of only 1.08 decayed teeth, while the women showed an increase of 4.37 decayed teeth ($p<0.01$). At 20–34 age bracket, women had a risk of caries at least 1.92 times higher than men (see confidence interval).

Women also had higher values for proportion of incidence (the mean proportional increment of the DMFT index). When we compare the mean increment during the period with the number of teeth exposed for each individual, the women have higher values than in men in all categories. For the 20–34 age bracket, the difference was statistically significant, meaning that between-gender differences continue to hold true when we take into account the individual differences in number of exposed teeth.

Discussion

As in several other parts of the world (Grim et al. 1994; Niendorff and Jones 2000; Jamieson et al. 2006), the oral health of indigenous peoples in Brazil, exemplified by several cases showing a trend toward increased rates of caries and other pathological conditions, attest the interplay of dietary changes, insufficient access to preventive resources, and limited availability of health care. Notwithstanding those limited data, all too little is known about the human biological and epidemiological conditions of indigenous peoples related to changes in oral health conditions in Brazil (Arantes 2003).

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Table III. Descriptive statistics of the DMFT (decayed, missing and filled teeth) index values, mean increment, and mean proportional increment from dental caries study (1999 and 2004), according to age bracket, Xavante village of Etẽnhiritipá, Mato Grosso, Brazil.

	Age bracket (in years)											
	6–12 ($n=60$)			13–19 ($n=17$)			20–34 ($n=40$)			35–60 ($n=11$)		
DMFT index	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median
First exam (1999)	0.46	0.96	0.00	2.18	2.18	2.00	7.02	5.69	6.00	10.27	6.13	10.00
Second exam (2004)	2.07	2.26	1.00	4.59	3.18	3.00	10.32	7.08	9.50	13.09	6.74	13.00
p-value⋆	<0.01			<0.01			<0.01			<0.01		
Mean increment†	1.61	1.77	2.00	2.41	1.62	3.00	3.30	2.73	5.00	2.82	1.83	4.00
Relative risk[a]	1.00			1.49			2.04			1.75		
Confidence interval (95%)				0.94–2.31			1.39–3.06			0.85–2.96		
Mean proportional increment‡	8.80	9.42	6.00	9.23	6.66	8.00	16.32	17.27	14.00	14.63	11.65	10.00

[a]6–12 age group as group of reference.

⋆Wilcoxon test, †Kruskal–Wallis one-way analysis of variance, $p<0.01$, ‡Kruskal–Wallis one-way analysis of variance, $p<0.05$.

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Table IV. Descriptive statistics of the DMFT (decayed, missing and filled teeth) index values, mean increment, and mean proportional increment from dental caries study (1999 and 2004), according to age bracket and gender, Xavante village of Etẽnhiritipá, Mato Grosso, Brazil.

		6–12 years ($n=60$) (34 males, 26 females)			13–19 years ($n=17$) (10 males, seven females)			20–34 years ($n=40$) (13 males, 27 females)			35–60 years ($n=11$) (six males, five females)		
DMFT	Gender	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median
First exam (1999)	M	0.53	1.05	0.00	1.80	1.55	2.00	4.38	4.23	3.00	11.00	6.57	11.00
	F	0.38	0.85	0.00	2.71	2.93	1.00	8.30	5.93	7.00	9.40	6.19	7.00
	p value*	0.53			0.69			0.02			0.78		
Second exam (2004)	M	1.82	2.15	1.00	4.00	2.40	3.00	5.46	4.65	5.00	13.00	6.45	13.50
	F	2.38	2.33	2.00	5.43	4.11	3.00	12.67	6.91	12.00	13.20	7.85	9.00
	p value*	0.19			0.58			0.00			0.85		
Mean increment	M	1.29	1.53	1.00	2.20	1.68	2.00	1.08	1.65	1.00	2.00	0.63	2.00
	F	2.00	2.02	2.00	2.71	1.60	3.00	4.37	2.50	4.00	3.80	2.38	4.00
	p value†	0.13			0.53			0.00			0.10		
Relative risk[a]	M	1.00			1.00			1.00			1.00		
	F	1.55			1.09			4.04			1.90		
Confidence interval (95%)		0.85–2.86			0.57–2.77			1.92–2201.2			0.68–3.47		
Mean proportional increment	M	7.20	8.43	5.50	8.00	5.96	7.50	4.38	6.51	3.00	10.33	4.76	8.50
	F	10.88	10.37	10.50	11.00	7.66	10.00	22.07	17.95	19.00	19.80	15.80	15.00
	p value†	$p=0.13$			$p=0.37$						$p=0.19$		

[a]Males in each age group as group of reference.
*Mann–Whitney test; †Student's t-test.

The Xavante population (nearly 12 000) is considerably larger than that of the majority of indigenous peoples in Brazil, as over half (65%) of the 225 indigenous peoples have total populations under 1000. At the same time Xavante population is characterized by widely dispersed villages, usually with difficult access and relatively low density (most villages present with less than 100 individuals). People are highly mobile in their subsistence activities (horticulture, hunting, and gathering) and they also have a predilection for visiting other villages and nearby urban centres. These characteristics make research difficult, especially studies that involve following individuals over time. Despite these difficulties, about 50% of the population in each of the relevant age brackets, evenly divided by gender, participated in the study.

In longitudinal studies, loss of subjects is a major methodological problem, in particular when it affects the outcome variables. In this study, although there was a 40% loss between the first and second examinations (1999 and 2004, respectively), it was observed that the study sample presented comparable DMFT index values by age bracket and gender when compared to those examined in 1999 (Table II). It is important to note that the losses were not due to refusal to participate in the study, but rather resulted from absences from the village due to geographically disperse subsistence and economic activities.

Most of what is known about the development of caries is based on cross-sectional studies. This is the first longitudinal one about caries in an indigenous community in Brazil. In general terms we know that caries attacks teeth most intensely in the post-eruptive period, and that it diminishes after the second decade of life, as the tooth enamel matures (Kotsanos and Darling 1991). However, many factors are involved on occurrence of caries that may determine greater or less exposure to the risk of developing the disease over the course of a person's life. Diet, especially the consumption of fermentable carbohydrates, the flow and composition of saliva, oral hygiene, exposure to fluoride, socio-economic and educational level, are some of the variables that may affect the process. Several studies have reported an increase in the risk of caries among adults and the elderly related to a decline in the flow of saliva, inadequate oral hygiene, a caries-promoting diet, low socio-economic status, and difficult access to health services (Anusavice 2002; Moreira et al. 2005; Broadbent et al. 2006).

The present study found exposure to risk that varied significantly according to age brackets and gender. Higher incidence was found in women compared to men, and in adults over 20 years of age compared to the 6–12 and the 13–19 age brackets. These risk differentials may be related to a protective factor active in the younger age bracket, and to a vulnerability factor that intensifies the incidence of caries in adults over 20 years of age. The protective factor possibly refers to regular access to preventive measures. These measures have been implemented in Etẽnhiritipá since 1997 through a dental health programme that consists of monitoring caries lesions, regular use of fluoride topical application and varnishes, supervised tooth-brushing, and distribution of dental hygiene materials (tooth-brushes, toothpaste and dental floss). Preventive measures have been routinely carried out by Xavante health agents. From the beginning, more young people, in particular those 6–15 years of age, participated in the programme and followed it more regularly because it was based near the village school. This programme may have acted as a protective factor against the risk of caries in the younger age brackets (Arantes 2005).

The high incidence of caries among women observed in the Xavante community at Etẽnhiritipá is an important factor in raising the incidence of caries in adults over 20 years of age. When both sexes are combined in the analysis, the greatest increase is in the 20–34 age bracket, with a mean number of 3.3 new decayed teeth, twice as many as in children of the 6 to 12 age bracket. When the sexes are analysed separately, we find that for men the

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greatest increase is not in the 20–34 age bracket, while for women in the same age bracket the increase in the DMFT index is most striking. Men of the 20–34 age bracket showed an increase of only 1.08 teeth with caries, while women showed an increase of 4.37 teeth with caries. The mean increment in women was four times greater than that in men raising the increment of the age bracket as a whole. This difference remains significant when the proportion of incidence is calculated, taking into consideration the number for each individual of new decayed teeth relative to the number of teeth exposed to caries.

Analysis of the age structure of the sample indicates that there is no significant difference between the sexes in mean age except in the 20–34 age bracket. The mean age of the women in this group was 3.7 years younger than the mean age of the men, which should have been to the women's advantage, since the DMFT is a cumulative index that increases with age. Although the average age of their group was younger, women in the 20–34 age bracket had a greater increment in caries.

A gender-focused analysis may help clarify the socio-economic and cultural factors that determine different oral health profiles between Xavante males and females. These factors are associated with gendered socio-economic positions in Xavante society that emerge from production and consumption patterns and differential access to information, health services, and education. In a comparative study of the health determinants of indigenous women of the Americas based on data from seven countries (Canada, Ecuador, Guatemala, Mexico, Nicaragua, Peru, and USA), researchers have called attention to the centrality of gender to the understanding of health differences in indigenous communities (PAHO 2004). Overall, this study indicates that indigenous females show higher rates of school drop-outs and lower education levels, leading to lower rates of bilingualism and limited access to health services.

Socio-cultural and economic differences between men and women in Xavante society may be related to unequal exposure to factors responsible for the development of dental decay. Some of these factors are reproductive roles and access to education and health preventive measures.

Demographic data have shown that after the impacts of the epidemics and social transformation imposed by contact with non-Indians in the 1960s subsided somewhat (Coimbra et al. 2002). In the 1970s the Xavante of Etẽnhiritipá began a process of recovery and demographic growth through an increase in women's fertility, and a decline in infant mortality. The analyses carried out by Coimbra et al. (2002) indicate that in the more recent period, between 1970 and 1990, the fertility rate of Xavante women increased relatively to earlier periods. The fertility rate for women between the ages of 15 and 40 was 7.9 births, with the highest age-specific fertility that of women between the ages of 20 and 30. It is worth to mention that recent demographic studies show that fertility rates in indigenous women in the Amazon tend to be very high (Pagliaro et al. 2005). Demographic research carried out in other high fertility indigenous societies in the Amazon (total fertility rate close to eight children) show that women might spend over 90% of their reproductive years either pregnant or nursing (Early and Peters 1990).

Clinical studies have shown that oral tissues may be affected by pregnancy (Laine 2002). Hormonal changes during pregnancy increase the susceptibility of gum tissues to local irritating factors and inflammatory processes. An increased concentration of oestrogen in the saliva produces more epithelial shedding, creating an environment propitious to bacterial growth. Levels of *Streptococcus mutans* and *Lactobacillus* spp. rise in the buccal milieu, and while there is no significant change in the flow of saliva, the saliva has a lowered pH and buffering capacity. The concentration of calcium and phosphate is slightly lowered during pregnancy, which may affect the remineralization of initial caries lesions. It appears

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that the effects of pregnancy are more closely related to the buccal milieu than to teeth themselves. These changes alter unfavourably the organism's capacity to resist the various risk factors for caries and gingivitis (Laine 2002; Lukas and Largaespada 2006).

In the case of the Xavante women, who due to their high fertility spend most of their reproductive years either pregnant or lactating, alterations in the buccal environment due to pregnancy may be both frequent and long-lasting since, on the average they go through eight pregnancies during their child-bearing period. This situation, related to the high value attributed to Xavante society to large families (Maybury-Lewis 1967, Coimbra et al. 2002), may make women more susceptible than the men to mouth diseases like caries and gingivitis.

Xavante economy was traditionally centred on seasonal cycles of horticulture, hunting and gathering, with well demarcated gender roles. In recent decades, reservation life has led to profound changes in the group's economy and food ecology, with the emergence of new social and economic gender roles. Xavante women continue playing a key role in gardening and gathering. In the past, Xavante families would spend part of the year trekking in their large territory in hunting and gathering activities. At present, women's life is very much centred in the village and in their households, where they spend most of their time in child care, handcraft production and food preparation. Although Xavante men continue to engage in subsistence activities, they have also developed several other forms of interaction with the outside world. At Etẽnhiritipá all jobs associated with the local school and the health post are occupied by men. Men also present a much higher mobility than women, with a large number of them visiting neighbouring towns for various reasons on a regular basis. This combination of factors result in that Xavante women have limited fluency of Portuguese in comparison to men, less years of schooling and are less exposed to new habits that might impact upon oral health, including brushing and dental flossing.

Xavante houses are not equipped with running water. Water for personal hygiene and cooking is fetched from communal taps located in the centre of the village or by the river. Given these circumstances, it is not difficult to observe villagers' daily errands that may include tooth brushing, as it takes place in public spaces. For instance, one observes that, even those few Xavante who brush their teeth on a regular basis, tend to do it once a day, early in the morning. It is also evident that, compared to women, much more men brush their teeth.

From the arguments outlined above, it seems that, in a changing dietary, ecological and socio-economic context, Xavante women are under augmented exposure to develop caries. The influence of gender issues upon oral health operates at several levels. The social expectations for large families result in that for Xavante women adulthood is closely associated with pregnancy and breastfeeding. Beyond, but in parallel, certain ecological and social determinants, highly influenced by gender roles, place women in a disadvantageous situation in regards to access to preventive measures that may prevent caries.

It is well recognized that human biological and epidemiological studies might generate information relevant to health interventions. The present study has found strong evidence that gender constitute an important dimension to be taken into consideration in the changing epidemiology of caries among the Xavante Indians. A gender-based approach to public health begins from the recognition of the socially determined differences between women and men and might help to identify the ways in which health risks, experiences, and disease outcomes might differ between women and men.

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