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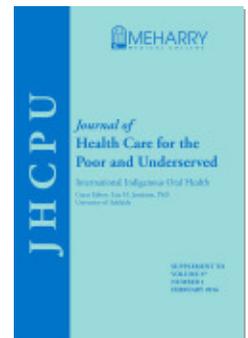
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Income as a Protective Factor for Dental Caries among Indigenous People from Central Brazil

Rui Arantes, PhD
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Abstract: The objective of this paper was to evaluate the association between eligibility for a conditional cash transfer program, based on household income, and dental caries in 12-year-old children from three Indigenous ethnic groups living in Mato Grosso do Sul state, Central Brazil. A population-based cross-sectional study was performed in three ethnic groups: Kaiwoá, Guarani, and Terena. The study population was drawn by stratified sampling according to each ethnic group with a probability proportional to the village size. The number of untreated decayed permanent teeth as a count variable was the outcome measure. Ethnic group and eligibility for the conditional cash transfer program showed significant association with untreated caries. Children from Guarani and Terena presented respectively two-fold and 2.8-fold higher caries rate ($p < .001$) compared with Kaiwoá in the adjusted model, while children from no eligible cash transfer program households had a 40% lower caries rate ($p = .034$).

Key words: Indigenous people, Brazil, dental caries, oral health, socioeconomic determinants.

About 305 Indigenous ethnic groups speaking nearly 274 native languages were registered in Brazil in 2010.¹ These groups constitute a complex epidemiologic picture related to sociocultural diversity and socioeconomic and environmental changes due to interaction between these groups and the dominant Brazilian society shaping particular patterns of oral health transition derived from developing world contact.² In general, significant increases in dental caries has been observed, resulting from changes in subsistence patterns and habitual diet, especially the use of sugar and other industrialized products.^{3,4}

Among the changes that occurred after developing world contact the enhancement of monetary income generated by the acquisition of non-cognitive and cognitive skills, among other forms of modern human capital (education and experience) has been demonstrated by several researchers. The rise of modern human capital has been associated with a range of factors that permit increased or decreased participation in the regional market, in domains such as schooling, cognitive skills, and socialization.⁵

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Moreover, access to social programs, pensions, and retirements are also important for earnings of Indigenous people in Brazil. An example is the Bolsa Família Programme (BFP) directed to extremely poor and poor families including Indigenous households, being considered the world's largest conditional cash transfer program. The cash transfer is conditioned by compliance of measures for ensuring education, immunization, health check-ups, and monitoring of nutritional status among other conditions related to children, pregnant women, and mothers.^{6,7} In 2011, the BFP covered 13.4 million families and distributed nearly U.S.\$11.2 billion. Studies have shown an impact on reduction of income inequalities^{8,9} and of under-five mortality rates.¹⁰ As the criterion for such cash transfers is household income per person per month, the eligibility for BFP may be used as an income proxy.

The objective of this paper was to evaluate the association between eligibility for the conditional cash transfer program, based on the per capita household income, and dental caries in 12-year-old children from three Indigenous ethnic groups living in Mato Grosso do Sul state, Central Brazil.

Methods

The study protocol followed the standards set by the National Council on Ethics in Research, record by the number 16.632, 3rd October 2011.

A population-based cross-sectional study was performed in three ethnic groups: Kaiwoá, Guarani, and Terena. The three ethnic groups comprised more than 67,000 individuals, constituting 97.4% of the total Indigenous population from Mato Grosso do Sul, a Brazilian state located in the Central-West region of the country. According to the Indigenous Health Special Secretariat (SESAI) in the Brazilian Health Ministry, the 12-year-old child population in 2011 was estimated to be 1,197 Kaiwoá, 309 Guarani, and 603 Terena, living at different villages and territories in the Mato Grosso do Sul state, Brazil¹¹ (figure 1).

The study population was drawn by stratified sampling according to each ethnic group with a probability proportional to the village size. The calculation of the study power was performed *a posteriori*. The sample size should comprise at least 500 participants in order to detect a difference in rate ratios from 1.17 to 1.35 with exposure frequencies ranging from 10% to 50% at 80% power and a two-tailed level of significance of .05.

Caries scoring was carried out under natural illumination using a ballpoint probe. Caries experience was measured by the decayed, missing, filled teeth index (DMFT). Criteria recommended by the World Health Organization for oral health surveys were used to classify the teeth as decayed, missing, or filled.¹² Structured questionnaires were answered in face-to-face interviews with the children's mothers or guardians. The interviews were conducted by trained fieldworkers. Twenty-four examiners performed the observations. Inter-examiner agreement showed a minimum kappa-value of 0.64 for permanent teeth. Intra-examiner agreement showed a minimum kappa-value of 0.72 for permanent teeth.

The number of untreated decayed permanent teeth as a count variable was the outcome measure. Sex (male and female), access to dental services (never and one or more visits) and eligibility for conditional cash transfer program were also investigated. The

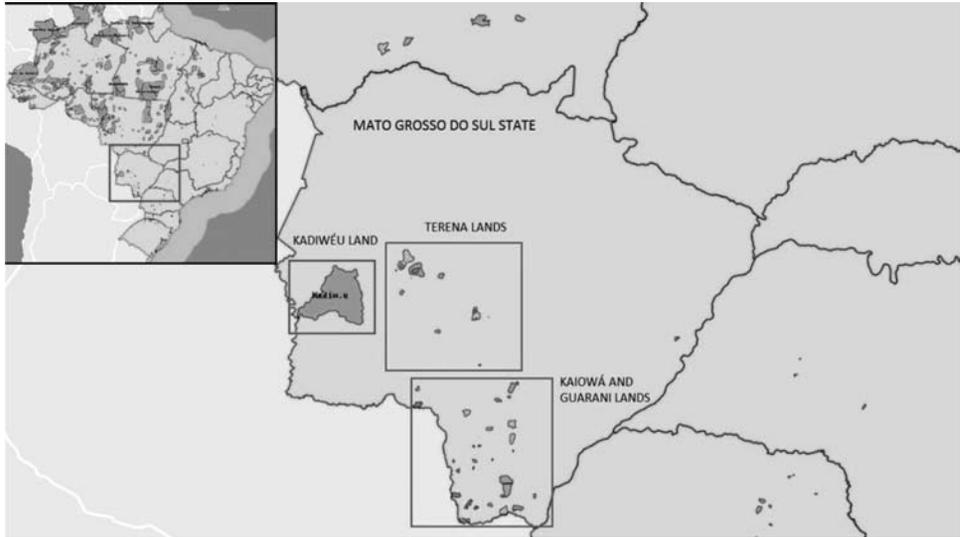


Figure 1. Brazilian Indigenous Lands and Indigenous Lands from Mato Grosso do Sul State.

Source: National Indigenous Foundation (FUNAI), 2014.

households were divided in two categories: those eligible for the cash transfer program and those not eligible. The former represent households of monthly per capita income equal to or lower than U.S.\$70 (R\$140 Brazilian Reais in 2012).

Mean, standard deviation, median and interquartile values for the number of untreated decayed permanent teeth were calculated, and Kruskal-Wallis and Mann-Whitney tests were used to identify differences between groups.

Crude analyses between the dependent variable and each independent variable were performed, and rate ratios with 95% confidence intervals were calculated. Robust Poisson regression was used for variable entering and selection. We hypothesized that socioeconomic variable could be associated with the outcome. Variables with p-values higher than .20 were not included in adjusted models. The analyses were performed using Stata/SE for Windows, Version 12.1¹³ (College Station, Texas 77845 USA).

Results

From the 544 randomly selected children, 35 (6.4%) could not be followed-up for assessment. The final sample included 509 Indigenous children: 195 Kaiwoá, 141 Guarani, and 173 Terena. The percentage of caries-free children was 54.4%, 43.3%, and 30.6% respectively. The percentage of filled teeth in relation to DMF teeth showed that the Indigenous children had low incorporation of restorative services: 14% for Kaiwoá and Guarani and 24% for Terena.

The distribution of children by study variables are presented in Table 1. On average 0.93 (s.d. 1.31), 1.53 (s.d. 2.04) and 2.17 (s.d. 2.41) permanent teeth were respectively affected by caries among Kaiowá, Guarani, and Terena, with statistically significant differences among the ethnic groups (Table 1). In relation to the study variables, no

Table 1.**CHARACTERISTICS OF ETHNIC GROUPS ACCORDING TO STUDY VARIABLES. MATO GROSSO DO SUL, BRAZIL, 2013**

Variables	Ethnic Groups					
	Kaiwoá		Guarani		Terena	
	n	%	n	%	n	%
Sex						
Female	92	47,2	78	55,3	91	52,6
Male	103	52,8	63	44,7	82	47,4
Cash Transfer Program ^a						
Eligible or beneficiary	168	86,2	129	91,5	148	85,5
Ineligible	27	13,8	12	8,5	25	14,5
Dental visit						
Never	64	32,8	46	32,6	42	24,3
One or more	125	67,4	95	67,4	126	72,8
Not informed	6	0,0	0	0	5	2,9
TOTAL		100.0		100.0		100.0
Caries experience	Mean (s.d.)	Median	Mean (s.d.)	Median	Mean (s.d.)	Median
DMFT*	0,93 (1,31)	0,00	1,53 (2,04)	1,00	2,17 (2,41)	2,00

* $p < .001$ —Kruskal-Wallis Test.^aHousehold units.

statistically significant differences were observed in distribution of each variable category according to the ethnic groups (Table 1).

Table 2 shows the average values of untreated caries according to the study variables. No significant differences were observed between boys and girls and between those that never had visited a dentist compared with those that had visited at least once. Ethnic group and eligibility for the cash transfer program were associated with untreated caries.

The crude and adjusted effects of associated independent variables are shown on Table 3. Children from Guarani and Terena presented respectively two-fold and 2.8 higher caries rate ($p < .001$) compared with Kaiwoá in the adjusted model, while children from no eligible cash transfer program households had 40% lower caries rate ($p = .034$).

Discussion

The ethnic determinant had a significant role on caries rates among investigated Indigenous groups. Guarani children had twice-higher disease level and Terena almost three times more, compared with Kaiwoá presenting lower disease levels. This determinant overlies specific sociocultural and socioeconomic traits of each Indigenous group that should be considered, given a historical perspective on contact and interaction with the dominant society.

Table 2.**DESCRIPTIVE STATISTICS FOR UNTREATED DENTAL CARIES^a ACCORDING TO STUDY VARIABLES. MATO GROSSO DO SUL, BRAZIL, 2013**

Variables	n	%	Mean (s.e.)	Median	IQV	p value
Ethnic Groups						<.001 ^b
Kaiwoá	195	38,3	0,46	0,0	0,0–1,0	
Guarani	141	27,7	0,98	0,0	0,0–1,0	
Terena	173	34,0	1,32	1,0	0,0–2,0	
Sex						.983 ^c
Female	261	51,3	0,98	0,0	0,0–1,0	
Male	248	48,7	0,83	0,0	0,0–1,0	
Cash Transfer Program ^d						.044 ^c
Eligible or beneficiary	445	87,4	0,94	0,0	0,0–1,0	
No Eligible	64	12,6	0,58	0,0	0,0–1,0	
Dental visit						.904 ^a
Never	152	29,9	1,00	0,0	0,0–1,0	
One or more	346	68,0	0,86	0,0	0,0–1,0	
Not informed	11	2,2	0,73	0,0	0,0–1,0	

^aUntreated decayed permanent teeth.^bKruskall-Wallis Test.^cMann-Whitney Test.^dHousehold units.

SE = Standard error.

IQV = Interquartile values.

The Guarani people belong to the Tupi linguistic trunk, and the Tupi-Guarani language family. The literature traditionally names the Mby'a, Nhandeva, and Kaiwoá subgroups as Guarani. These subgroups bear major linguistic and cultural similarities to one another as well as similarities in economic and social organization. The three groups are historically hunter and gatherer communities structured in small autonomous family groups, who adopt a high mobility pattern as a strategy of environmental management to ensure their economic sustainability.^{14,15} The Terena are from the Aruak (also spelled *Arawak*, also known as *Maipurean*) language family. They have an economy based on agriculture. Unlike the Guarani and Kaiwoá, they are open to mainstream society, maintaining historical relationships of commercial exchange and political agreements with other Indigenous groups and with the surrounding non-Indigenous population.^{16,17,18} These differences among the investigated groups shape diverse subsistence strategies that might influence the dietary pattern of each one and have major reflections on determination of caries rates. Archeological studies have demonstrated that hunter and gatherer groups present lower caries prevalence than agricultural groups for whom availability of fermentable carbohydrates is higher.^{19,20}

Table 3.

ETHNIC GROUP AND CASH TRANSFER PROGRAM HOUSEHOLDS: CRUDE AND ADJUSTED ANALYSIS FOR DENTAL CARIES^a IN 12-YEAR-OLD CHILDREN BY ROBUST POISSON REGRESSION. MATO GROSSO DO SUL, BRAZIL, 2013

Variables	Crude values			Adjusted values		
	RR	CI 95%	p value	RR	CI 95%	p value
Ethnic Group						
Kaiwoá (Ref.)	1.00			1.00		
Guarani	2.12	1.46–3.08	.000	2.08	1.43–3.01	.000
Terena	2.86	2.02–4.04	.000	2.86	2.03–4.04	.000
Cash Transfer Program						
Eligible or beneficiary (Ref.)	1.00			1.00		
No Eligible	0.61	0.38–1.00	.050	0.60	0.39–0.96	.034

^aUntreated decayed permanent teeth.

RR = Rate ratio.

Moreover, the Terena's greater openness to commercial exchanges also favors more access to industrialized products including sugar and cariogenic foods.

The other major finding concerns income. The categorization of households as eligible or non-eligible for the BFP was an important factor related to disease distribution among Indigenous children from Mato Grosso do Sul, Brazil. No eligible households have monthly per capita income above inclusion criterion to the program. Children from these households showed 40% less caries compared with children from eligible households, suggesting income as a protective factor. The total percentage of households non-eligible for BFP was 12.6%. The figures were 8.5% for Guarani, 13.8% for Kaiowá, and 14.5% for Terena, with no statistically significant differences among these Indigenous groups. These households had monthly per capita income higher than US\$70 probably provided by autonomous work or paid job. Employment and labour market involvement requires competence in written and spoken Portuguese. In addition, it also assumes a set of skills and behaviors that functions in contemporary society as human capital.⁵ The development of modern human capital for Indigenous people not only requires competencies in speaking, reading, and writing the dominant language, but also knowledge of the social rules and behaviors needed to work in a cultural context different from their own.^{5,21,22,23} In this sense, it is plausible to hypothesize that the Indigenous families of these higher-income households might have more human capital, providing room for investigations aimed to elucidate the main protective mechanisms for dental caries possibly associated with fluoride use, self-care, and diet among others.

Studies comprising non-Indigenous people have shown a higher prevalence and severity of tooth decay among population groups located in lower levels of socioeconomic

classes compared with classes from upper levels using variables relating to schooling and income of the individual, parents, or family. This association has been attributed, among other reasons, to the lack of access to fluoride and high frequency of ingestion of sugary foods and drinks to which these groups would be exposed.^{24,25,26} Studies of Indigenous people that examine associations between income, socioeconomic status, and other contextual indicators such as education, living conditions, and dental caries are very scarce in Brazil.^{27,28} The vast majority of them are caries prevalence cross-sectional studies with specific groups, and their methodological limitations hinder broader comparisons among populations and the formulation of oral health public policies^{3,29}.

Despite the increase in government spending on Indigenous people in various countries of Latin America, the proportion of socially-vulnerable Indigenous groups has not changed from the end of the last century until early 2000. Most of Brazil's Indigenous population still has low education, reflected in low income, little access to financial support or credit, to productive land, and to basic infrastructure material (such as drinking water and electricity).^{30,31,32} The precarious Indigenous living conditions give rise to difficulties in obtaining basic health care services, which in turn results in poor health indicators revealing an inequality and inequitable condition in relation to non-Indigenous people across South America.³³

The objective of this study was not to evaluate the cash transfer program's impact on Indigenous health, although it is very important to conduct this type of evaluation in future studies. These programs have had an important role in reducing inequalities and improving living conditions in poor populations, but it is unknown how they affect Indigenous people living in so specific, complex, and diverse contexts.

In summary, ethnic group and eligibility for the BFP showed significant association with caries, indicating the importance of socio-cultural and socioeconomic determinants of disease rates. The income assessed indirectly by eligibility for the cash transfer program proved to be a protective factor for dental caries. It seems worthwhile to suggest future investigations aimed at comparing indicators of human capital among these three Indigenous groups and to elucidate the main protective mechanisms for dental caries possibly associated with fluoride use, self-care, and diet, among others.

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