

Maria do Carmo Matias Freire<sup>I</sup>

Sandra Cristina Guimarães Bahia Reis<sup>II</sup>

Nilcema Figueiredo<sup>III</sup>

Karen Glazer Peres<sup>IV,V</sup>

Rafael da Silveira Moreira<sup>VI</sup>

José Leopoldo Ferreira Antunes<sup>VII</sup>

# Individual and contextual determinants of dental caries in Brazilian 12-year-olds in 2010

## ABSTRACT

**OBJECTIVE:** To estimate the prevalence and severity of dental caries in Brazilian children and the association with individual and contextual factors.

**METHODS:** Data were taken from the Brazilian Oral Health Survey (SBBrasil 2010) a sample of 7,247 12-year-olds. The data were collected using clinical examinations and interviews. The dependent variables were the prevalence of dental caries (decayed, missing and filled teeth [DMFT]  $\geq 1$  and DMFT  $\geq 4$ ). Bivariate (Rao Scott test) and multivariate (Poisson regression) analyses were carried out. The individual variables were sociodemographic variables, periodontal health and reporting discomfort while brushing. Contextual factors were the presence of water fluoridation, the percentage of residences connected to the water supply and median income of the municipality.

**RESULTS:** The prevalence of DMFT  $\geq 1$  was 56.0%. Mean DMFT was 2.04 (95%CI 1.76;2.31) and 22.2% of children had DMFT  $\geq 4$ . Caries experience was significantly more common in children with black, brown or yellow skin; in low-income families; in children with dental calculus or bleeding gums and in those who reported discomfort while brushing. Living in towns with fluoridated tap water, with low coverage of water supply and with low median income were contextual factors associated with the disease.

**CONCLUSIONS:** The prevalence of dental caries in Brazilian 12-year-olds was low, according to World Health Organization criteria. There were significant geographical and socioeconomic inequalities in levels of the disease.

**DESCRIPTORS:** Child. Dental Caries, epidemiology. Socioeconomic Factors. Health Inequalities. Dental Health Surveys. Oral Health.

<sup>I</sup> Departamento de Ciências Estomatológicas. Faculdade de Odontologia. Universidade Federal de Goiás. Goiânia, GO, Brasil

<sup>II</sup> Secretaria de Estado da Saúde de Goiás. Goiânia, GO, Brasil

<sup>III</sup> Departamento de Medicina Social. Programa de Pós-Graduação Integrado em Saúde Coletiva. Universidade Federal de Pernambuco. Recife, PE, Brasil

<sup>IV</sup> Programa de Pós-Graduação em Saúde Coletiva. Universidade Federal de Santa Catarina. Florianópolis, SC, Brasil

<sup>V</sup> Australian Research Centre for Population Oral Health. School of Dentistry. University of Adelaide. Adelaide, SA, Australia

<sup>VI</sup> Centro de Pesquisas Aggeu Magalhães. Fundação Oswaldo Cruz. Recife, PE, Brasil

<sup>VII</sup> Departamento de Epidemiologia. Faculdade de Saúde Pública. Universidade de São Paulo. São Paulo, SP, Brasil

### Correspondence:

Maria do Carmo Matias Freire  
Faculdade de Odontologia  
Universidade Federal de Goiás  
Praça Universitária, s/n - Campus I  
Setor Universitário  
74605-220 Goiânia, GO, Brasil  
E-mail: mcmfreire@yahoo.com.br

Received: 04/23/2012

Approved: 03/19/2013

Article available from: [www.scielo.br/rsp](http://www.scielo.br/rsp)

## INTRODUCTION

Dental caries is a global public health problem due to the pain and suffering it causes individuals, the high treatment costs and the impact on quality of life.<sup>17</sup> Although many countries have experienced decreasing levels of the disease in children in recent decades, in some countries the prevalence remains high, with prevalence above 50% in 12-year-olds. Moreover, some countries have even seen increases in prevalence.<sup>17</sup>

There is evidence that the distribution of dental caries within populations is unequal and strongly linked to socioeconomic conditions. Thus, enduring inequalities in oral health conditions are found between countries and between different social groups within the same country.<sup>18</sup> Studies on social determinants of oral health problems have become more important and they usually include socioeconomic factors, such as levels of schooling, individual and family income and individual's occupation.<sup>5</sup>

In recent years, the influence of contextual factors on the prevalence of dental caries has been analyzed, incorporating socio-economic and environmental indicators, such as per capita income, Human Development Index (HDI), Gini index, access to health care services and access to a water supply with added fluoride. In Brazil, national oral health surveys have shown differences in the distribution of dental caries, with higher levels of the disease in population which are economically disadvantaged.<sup>13</sup> The association between contextual variables and school age children affected by dental caries has been reported in studies carried out since the beginning of this century in some municipalities<sup>2,9,15</sup> and in the country as a whole.<sup>3,12</sup>

Health care inequalities suggest the need for developments or changes to existing national and local systems, concurrently with efforts to eliminate disparities in the populations' socioeconomic conditions.<sup>21</sup> Thus, research seeking to assess the magnitude of the problem of dental caries and to clarify factors related to existing inequalities may contribute to public policies aimed at reducing inequalities.<sup>19</sup>

The aim of this study was to estimate the prevalence and severity of dental caries in permanent teeth in 12-year-olds and to analyze the association with individual and contextual factors in Brazil.

## METHODS

Primary data from the National Oral Health Survey (SBBrasil) 2010 was used. This survey was carried out by the Brazilian Ministry of Health and the primary

objective was to describe the oral health conditions of the urban population of Brazil in 2010. The methodology and principal results of the research have been published<sup>20,a</sup> and the principal characteristics are described below. This study includes all of the 12-year-old individuals who took part in the SBBrasil 2010 project.<sup>a</sup>

A probabilistic cluster sampling technique was used, with two stages in the 26 state capitals and the Federal District, and three stages in municipalities in the interior of the five regions of Brazil. All of the state capitals were included in the survey and were considered domains (representative strata), as was each region, making a total of 27 domains for the state capitals and five domains for the interior. The region domain was composed of 30 municipalities in the interior, randomly selected using the technique of probability proportional to size. The primary sampling units were census tracts ( $n = 30$ ) in state capitals and municipalities ( $n = 30$ ) in the regions. There were 176 Brazilian municipalities which participated in the survey of 12-year-olds.

For the 12-year-olds, a sample size of 8,000 individuals to be interviewed and examined in their homes was calculated. More information on the sampling process can be obtained in another publication.<sup>20</sup>

The dependent variables were the two levels of severity of dental caries, as measured by the DMFT index,<sup>25</sup> the prevalence of dental caries ( $DMFT \geq 1$ ) and the prevalence of a high burden of dental caries, deemed to be the case in children with four or more teeth affected by the disease ( $DMFT \geq 4$ ). These oral health outcomes were estimated for each survey domain (state capitals and municipalities in the interior of each region)

The independent variables were organized into two levels of analysis: those assessed for each individual (socio-demographic characteristics and factors related to dental caries) and those assessed for each town, referring to socio-economic conditions and to the water supply in each municipality (median household income, percentage of residences connected to the water supply and the condition of the supply of fluoridated water in the municipality).

The socio-demographic characteristics of the individuals and their families were obtained using a questionnaire applied to the parents or guardians: child's sex and skin color and household income. Self-reported skin color was classified according to the categories used by the *Instituto Brasileiro de Geografia e Estatística* (IBGE, Brazilian Institute of Geography and Statistics) – white, black, brown, yellow and

<sup>a</sup> Ministério da Saúde (BR). Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Coordenação Nacional de Saúde Bucal. Projeto SB Brasil 2010: condições de saúde bucal da população brasileira em 2010. Resultados principais. Brasília (DF); 2011.

indigenous). Household income was classified into the following groups: up to R\$ 500.00; from R\$ 501.00 to R\$ 1,500.00; from R\$ 1,501.00 to R\$ 2,500.00 and over R\$ 2,500.00.

The following oral health problems analyzed in the clinical exams were included as related explanatory factors: bleeding gums 10 to 30 seconds after use of the dental probe and dental calculus. These conditions reflect the quality and regularity of oral hygiene. Data on bleeding gums and calculus were collected according to their presence or absence in at least one sextant of the mouth, after using a ball pointed dental probe (WHO model). For each tooth in each sextant, six points were examined and the worst situation identified. When analyzing the data, the categories of these variables were “yes” or “no”. Another explanatory variable in this group was reporting discomfort when brushing, obtained through the following question in the questionnaire: “In the last six months, have your teeth caused you discomfort when brushing?”, also categorized as “yes” or “no”.

Second level explanatory variables included contextual factors related to the municipalities, in other words, characteristics of the children’s physical and social environment which may influence dental caries. Data for each municipality participating in the SBBrazil were obtained from the IBGE 2010 census, providing information on median household income and the percentage of residences linked to the water supply. The National Survey of Basic Sanitation carried out by the IBGE in 2008,<sup>b</sup> provided information on fluoridation (yes or no) of the public water supply in each municipality.

In the 2010 SBBrazil Project, two pilot tests were carried out in Florianópolis, SC, and João Pessoa, PB, in order to verify the planned coherence, field logistics and feasibility of the study’s instruments and methodology.

Before the data were collected, instructors trained and instructed around 570 dentists and 570 recording clerks. The training workshops took place in various cities all over the country, lasted 32 hours and included theory and practice. In order to standardize the team, the consensus technique was used.<sup>8</sup> The model proposed by the WHO<sup>24</sup> was used as the reference, with only those dentists who obtained a kappa statistic of 0.65 or above for inter-observer concordance allowed to participate as examiners in the survey.

The field work teams were made up of an examiner (dentist) and a recording clerk, both working for the public health care services in the participating municipalities. The dental exams were carried out within the home, using natural light, a dental mirror and a ball

point dental probe.<sup>a</sup> Interviews with the head of the household were also carried out. The data gathering tool allowed demographic and socioeconomic information to be collected, as well as other data related to oral health (reported oral morbidities, use of dental services, self-perception and impact).

First, descriptive statistics of dental caries indices and its spatial distribution in the municipalities (state capitals and interior) was carried out. Associations between the prevalence of dental caries and each of the independent variables was verified using the Rao-Scott test. Subsequently, Poisson multiple regression analysis was carried out, using the prevalence ratio as the measure of association. Mixed multilevel analysis models were estimated,<sup>22</sup> considering the children as the first level of analysis and the selected towns as the second. The statistical analyses were carried out using the STATA® 12.0, 2011 software, considering the complex sampling cluster design and sampling weights.

The SBBrazil 2010 Project followed the requirements of the Declaration of Helsinki and was approved by the *Conselho Nacional de Ética em Pesquisa*, record no. 15,498, 7<sup>th</sup> January 2010.

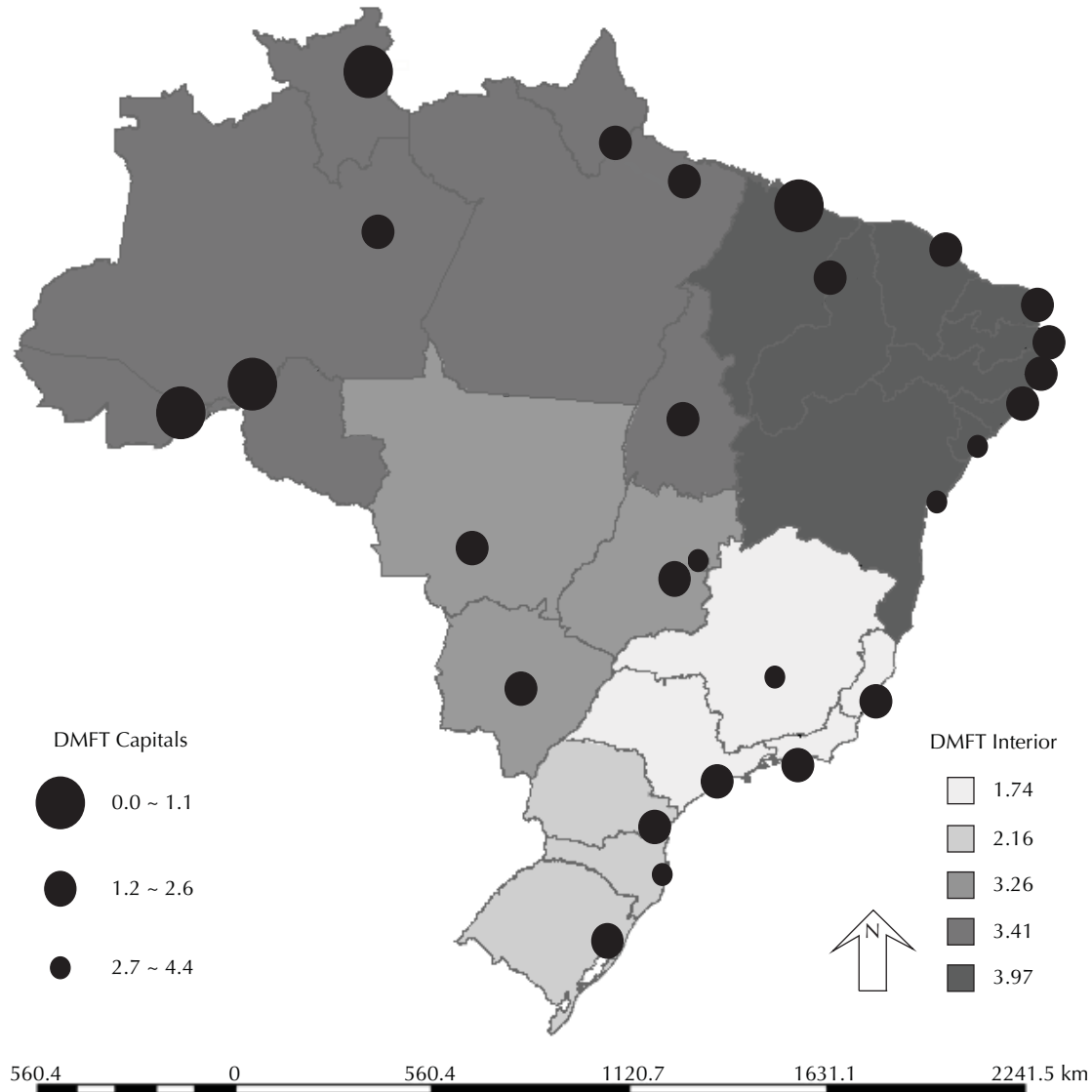
## RESULTS

A total of 81 children (1.1%) were not examined for dental caries for a variety of reasons (the examination was not authorized or not permitted, no resident was found at home or the presence of at least five teeth with orthodontic bands) and were therefore considered to be sample loss. The final sample was of 7,247 individuals.

The prevalence of the disease was estimated to be 56.0% (95%CI 51.1%;61.0%), with 22.2% (95%CI 18.1%;26.2%) of the children severely affected by dental caries (four or more teeth affected). Even when considering the 44.0% of caries-free children, the mean number of teeth which were decayed, filled or missing was higher than two per person: DMFT index = 2.04 (95%CI 1.76;2.31) (Table 1).

Inequalities in the geographic distribution of the disease were found; in the North and Northeast, dental caries indices were higher for both the state capitals and towns in the interior. The state capitals with the lowest DMFT values were Florianópolis, Salvador, Aracaju and Brasília. The state capitals with the worst indicators were Porto Velho, Boa Vista, Rio Branco and São Luís. The DMFT in the interior towns of the Northeast (3.97) ranked more than double the index in the Southeast (1.74) (Figure, Table 1).

<sup>b</sup> Instituto Brasileiro de Geografia e Estatística (BR). Coordenação de População e Indicadores Sociais. Pesquisa Nacional de Saneamento Básico 2008. Rio de Janeiro; 2010.



**Figure.** Spatial distribution of the DMFT index in 12-year-old children, circles mark the state capitals and the shades of grey refers to the towns in the interior of the five geographical macro-regions of Brazil. SBBrazil, 2010.

The association between the prevalence of dental caries ( $DMFT \geq 1$ ) and socioeconomic conditions, as assessed by household income, was identified. The prevalence of dental caries was significantly higher in black, brown and yellow skinned children than in white children. However, this association lost its significance when adjusted for the other factors in the multivariate analysis, suggesting that the variation in prevalence of dental caries among racial strata reflects differences in socioeconomic conditions between these groups (Tables 2 and 3).

The prevalence of dental caries ( $DMFT \geq 1$ ) was also significantly higher among children with dental calculus or bleeding gums on probing. Considering adjustment for the other variables, included in the multivariate analysis, children who complained of discomfort when brushing had a higher prevalence of dental caries 18% (8% to

29%) higher than their peers without this condition (Tables 2 and 3).

The same individual and household characteristics associated with the prevalence of dental caries were also recognized as being statistically associated the prevalence of severe cases of dental caries (four or more teeth) (Tables 2 and 4).

All of the contextual factors included in the study were associated with the prevalence of dental caries. The proportion of children affected by the disease was significantly higher in towns which did not add fluoride to the public water supply ( $p < 0.001$ ) and in those with the lowest median incomes ( $p < 0.001$ ). These associations remained statistically significant in the multivariate analysis (Tables 2 and 3).

The factors associated with the prevalence of dental caries were also recognized as being significantly associated with the prevalence of severe attacks of dental caries (four or more teeth affected) at the contextual level of analysis (Table 2 and 4).

## DISCUSSION

This study shows the continuing trend for declining levels of dental caries in Brazilian children and that this decline was unequal across the population, with a higher burden of the disease affecting deprived children.

When comparing these results with those of the national epidemiological survey carried out in 2003, the values described in this study indicate a continuing decline in 12-year-olds affected by dental caries, observed in the 1990s. In 2003, the DMFT index was 2.78; the prevalence (CPO  $\geq 1$ ) was 68.9%; and the prevalence of DMFT  $\geq 4$  was 33.5%.

Despite the overall decline in the prevalence of dental caries, significant inequalities were observed in levels of the disease. The worst indicators of the disease were observed in children from families on the lowest levels of income and those who lived in municipalities with the worst economic indicators and poor access to fluoridated water. The socioeconomic and geographic inequalities in dental caries remain since the first national survey in 1986, when a higher prevalence of the disease was also observed in those regions of Brazil which were more economically disadvantaged.<sup>13</sup>

Children with black and brown skin color had a higher prevalence of dental caries and of a severe attack of dental caries than white children. This finding indicates that previously reported inequalities between racial strata and dental caries remain.<sup>13</sup> However, the association between skin color and dental caries indices lost its significance in the multivariate analysis, which suggests that this difference is largely due to the poorer socio-economic conditions of black and brown children in the Brazilian population.

The poorer conditions of black and brown children with regards to dental caries prevalence also needs to be assessed, studying the components of the DMFT index, something not done in this study. Specifically dealing with the prevalence of untreated dental caries in Brazilian adolescents, Bastos et al<sup>4</sup> (2009) reported higher levels of the disease in groups with black and brown skin compared with those with white skin.

This study recorded and quantified the association between the prevalence of dental caries in children and indicators of access to fluoridated water in the municipality. This observation has a positive aspect, as it shows the need to continue and expand this strategy in the present.<sup>11,14</sup> However, this association also highlights

**Table 1.** DMFT index, prevalence of dental caries (one or more teeth affected) and prevalence of a severe attack of dental caries (four or more teeth affected) in 12-year-old children in the state capitals and in the interior, according to macro-region of Brazil. SBBrazil, 2010.

State capitals	n	DMFT index	DMFT $\geq 1$	DMFT $\geq 4$
		Mean	%	%
North Region				
Porto Velho, RO	168	4.15	74.5	49.6
Rio Branco, AC	172	2.68	73.5	34.3
Manaus, AM	146	2.34	66.2	35.0
Boa Vista, RR	205	2.83	73.0	35.0
Belém, PA	251	2.45	64.4	29.9
Macapá, AP	226	2.46	73.1	26.7
Palmas, TO	176	2.35	67.9	25.1
Northeast Region				
São Luís, MA	143	2.66	68.4	31.6
Teresina, PI	191	1.55	50.0	17.4
Fortaleza, CE	189	1.44	52.7	16.1
Natal, RN	161	2.08	57.6	25.5
João Pessoa, PB	140	2.45	70.4	34.0
Recife, PE	197	1.66	53.6	17.4
Maceió, AL	172	2.46	62.1	26.9
Aracaju, SE	250	1.13	41.8	10.0
Salvador, BA	255	1.07	40.9	11.2
Southeast Region				
Belo Horizonte, MG	262	1.10	43.6	9.2
Vitória, ES	213	1.45	68.8	10.3
Rio de Janeiro, RJ	245	1.40	49.4	14.2
São Paulo, SP	233	1.41	47.7	14.0
South Region				
Curitiba, PR	268	1.53	55.3	14.2
Florianópolis, SC	237	0.77	31.6	6.7
Porto Alegre, RS	210	1.49	51.2	14.7
Central-West Region				
Campo Grande, MS	206	1.79	59.8	17.3
Cuiabá, MT	146	2.40	62.3	27.0
Goiânia, GO	267	1.76	51.1	19.5
Brasília, DF	195	1.14	43.4	9.6
Towns in the Interior				
North Region	361	3.41	73.7	40.1
Northeast Region	323	3.97	76.1	45.8
Southeast Region	386	1.74	51.5	17.5
South Region	290	2.16	59.3	27.6
Central-West Region	365	3.26	72.4	37.4
Brazil	7,247	2.04	56,0	22,2
95%CI		1.76;2.31	51.1;61.0	18,1;26,2

the difficulty in overcoming health care inequalities which are both unfair and avoidable.<sup>16</sup> Although fluoridating the water supply has been compulsory in Brazil since the 1970s, in 2008 39.4% of Brazilian municipalities did not provide this, the majority of them being situated in the poorest areas of the country.<sup>b</sup>



**Table 2.** Prevalence of dental caries (one or more teeth affected) and prevalence of a severe attack of dental caries (four or more teeth affected) according to population factors in 12-year-old. Brazil. SBBrazil. 2010.

Contextual level (cities)	n	Prevalence of dental caries %	p-value <sup>a</sup>	Prevalence of a severe attack of dental caries (%)	p-value <sup>a</sup>
Fluoridated tap water			0.002		0.011
Yes	117	53.9		20.6	
No	59	67.8		30.7	
Residences connected to the water supply (%)			< 0.001		< 0.001
Fewer than 62.0	45	73.5		37.0	
from 62.1 to 82.5	43	69.4		31.5	
From 82.6 to 93.0	43	62.3		28.3	
Over 93.0	45	47.2		14.7	
Median income (R\$)			< 0.001		< 0.001
Up to 255.00	45	74.3		39.9	
from 256.00 to 450.00	44	64.3		32.3	
from 451.00 to 510.00	48	62.2		25.1	
Over 510.00	39	47.2		14.6	
Individual level (children)					
Demographic characteristics					
Sex			0.732		0.329
Female	3,645	55.6		21.0	
Male	3,602	56.5		23.4	
Skin color			0.206		0.222
White	2,868	51.7		19.0	
Black	706	60.5		24.1	
Brown	3,470	58.0		24.4	
Yellow	142	56.4		38.4	
Indigenous	61	44.6		35.9	
Socio-economic condition			0.001		0.098
Household income (R\$)					
≤ 500.00	1,378	68.8		27.3	
501.00 to 1,500.00	3,663	56.4		22.8	
1,501.00 to 2,500.00	1,069	52.0		20.3	
> 2,500.00	748	40.4		15.9	
No information	389	52.4		17.1	
Oral health conditions / quality of brushing					
Bleeding gums on probing			< 0.001		< 0.001
Yes	2,164	71.5		32.8	
No	5,083	50.4		18.3	
Dental calculus			0.024		0.003
Yes	2,002	63.8		30.0	
No	5,245	53.5		19.7	
Report discomfort when brushing			< 0.001		0.183
Yes	898	69.6		26.4	
No	6,318	53.9		21.5	
No information	31	76.3		25.2	

<sup>a</sup> Rao-Scott test

Access to fluoridated water is clearly influenced by socioeconomic conditions, as it is the poorest municipalities which have the most difficulty in implementing this measure. In the Southeast, only 16.1% of

municipalities did not fluoridate tap water; in the South this percentage was even smaller: 4.9%. In the other regions, however, the percentages are much higher: North - 81.0%, Northeast - 68.8% and Central-West

**Table 3.** Multilevel analysis of the association between the prevalence of dental caries (one or more teeth affected) and individual and contextual factors. Children aged 12, Brazil. SBBrazil, 2010.

Contextual level (cities)	Non-adjusted analysis		Adjusted analysis	
	PR	95%CI	PR	95%CI
Fluoridated tap water				
Yes	0.79	0.74;0.85	0.90	0.83;0.97
No	1		1	
Residences connected to the water supply (%)				
Fewer than 62.0	1		1	
from 62.1 to 82.5	0.80	0.73;0.87	0.92	0.83;1.01
From 82.6 to 93.0	0.84	0.78;0.92	0.93	0.84;1.03
Over 93.0	0.75	0.69;0.81	0.89	0.80;1.00
Median income (R\$)				
Up to 255.00	1		1	
from 256.00 to 450.00	0.91	0.82;1.02	0.99	0.87;1.12
from 451.00 to 510.00	0.83	0.74;0.93	0.93	0.85;1.09
Over 510.00	0.69	0.61;0.77	0.86	0.76;0.99
Individual level (children)	PR	95%CI	PR	95%CI
Demographic characteristics				
Sexo				
Female	1.05	0.99;1.12	1.04	0.87;1.12
Male	1		1	
Skin color	1		1	
White	1.17	1.05;1.30	1.05	0.98;1.13
Black	1.16	1.09;1.24	1.09	0.98;1.22
Brown	1.26	1.02;1.24	1.18	0.96;1.45
Yellow	0.90	0.62;1.29	0.78	0.54;1.13
Indigenous	0.90	0.62;1.29	0.78	0.54;1.13
Socioeconomic condition				
Household income (R\$)	1		1	
≤ 500.00	0.88	0.82;0.95	0.94	0.87;1.01
501.00 to 1,500.00	0.78	0.70;0.87	0.86	0.77;0.95
1,501.00 to 2,500.00	0.67	0.59;0.76	0.76	0.67;0.86
> 2,500.00	0.76	0.65;0.88	0.80	0.69;0.94
Oral health conditions / quality of brushing	RP	IC95%	RP	IC95%
Bleeding gums on probing				
Yes	1.26	1.18;1.34	1.18	1.10;1.27
No	1		1	
Dental calculus				
Yes	1.19	1.12;1.27	1.03	0.96;1.11
No	1		1	
Report discomfort when brushing				
Yes	1.26	1.16;1.37	1.18	1.08;1.29
No	1		1	
No information	1.14	0.74;1.76	1.18	0.75;1.84

-2 log likelihood (empty model) = 13003,951

-2 log likelihood (adjusted model) = 12817,065

PR: prevalence ratio

-54.9%.<sup>b</sup> As these regions are also those which have the lowest household incomes and coverage of the public water supply, the multivariate analysis attenuated the association found in the non-adjusted analysis.

In general, the contextual variables (principally fluoridated water) were as important as individual variables, because all of these, with the exception of skin

color, continued to be significantly associated with the prevalence of dental caries in the multi-level analysis. However, when the group of children who suffered from severe cases of dental caries (DMFT ≥ 4) were evaluated, the strength of the association increased for oral health problems (presence of dental calculus and bleeding gums) and reporting discomfort when brushing. This observation suggests that the quality

**Table 4.** Multilevel analysis of the association between a severe attack of dental caries (four or more teeth affected) and individual and contextual factors. Children aged 12, Brazil. SBBrazil, 2010.

Contextual level (cities)	Non-adjusted analysis		Adjusted analysis	
	PR	95%CI	PR	95%CI
Fluoridated tap water				
Yes	0.58	0.51;0.66	0.78	0.68;0.90
No	1		1	
Residences connected to the water supply (%)				
Fewer than 62.0	1		1	
from 62.1 to 82.5	0.61	0.51;0.72	0.82	0.68;0.98
From 82.6 to 93.0	0.68	0.57;0.80	0.81	0.67;0.97
Over 93.0	0.49	0.41;0.58	0.72	0.59;0.88
Mean income (R\$)				
Up to 255.00	1		1	
from 256.00 to 450.00	0.77	0.62;0.97	0.89	0.71;1.12
from 451.00 to 510.00	0.69	0.55;0.87	0.94	0.75;1.18
Over 510.00	0.40	0.32;0.50	0.64	0.50;0.82
Individual level (children)				
Demographic characteristics				
Sex				
Female	1.04	0.95;1.15	1.04	0.94;1.15
Male	1		1	
Skin color	1		1	
White	1.28	1.07;1.53	1.05	0.93;1.18
Black	1.24	1.10;1.39	1.15	0.96;1.37
Brown	1.87	1.39;2.51	1.72	1.29;2.30
Yellow	0.98	0.54;1.76	0.78	0.43;1.39
Indigenous	0.98	0.54;1.76	0.78	0.43;1.39
Socioeconomic condition				
Household income (R\$)	1		1	
≤ 500.00	0.84	0.74;0.96	0.93	0.82;1.05
501.00 to 1,500.00	0.72	0.61;0.86	0.86	0.72;1.02
1,501.00 to R\$ 2,500.00	0.51	0.41;0.64	0.64	0.51;0.81
> 2,500.00	0.58	0.44;0.76	0.64	0.48;0.85
Oral health conditions / quality of brushing				
Bleeding gums on probing				
Yes	1.57	1.41;1.75	1.32	1.18;1.48
No	1		1	
Dental calculus				
Yes	1.58	1.42;1.75	1.24	1.11;1.40
No	1		1	
Report discomfort when brushing				
Yes	1.48	1.30;1.69	1.33	1.16;1.51
No	1		1	
No information	1.09	0.53;2.26	1.26	0.61;2.60

-2 log likelihood (empty model) = 8086,042

-2 log likelihood (adjusted model) = 7817,447

PR: prevalence ratio

of dental hygiene may reduce the severity of dental caries, although the scientific evidence on the effectiveness of hygiene as a way of preventing this disease is considered weak.<sup>23</sup> Other aspects which may influence this association, such as the presence of fluoride in toothpaste and the frequency and quality of brushing should also be considered.<sup>7,10</sup> As the cause-effect relationship could not be verified in this study, reverse causality can still be considered, in other words, more severe dental caries may be an exposure factor of

the other oral health problems (bleeding gums and discomfort when brushing).

The cross-sectional design of this study is recognized as a limitation. Therefore, the highlighted associations are merely references in the discussion of explanatory hypotheses. Even so, the data from this study are deemed to be the best information available for planning oral health care at a national level. Another limitation of this study was the lack of information on the mothers' or guardians' level of schooling in



the database, as these variables are recognized as important in analyzing the distribution of dental caries in childhood. The lack of official data on the HDI of Brazilian municipalities in 2010, a database of recognized importance in analyzing the distribution of dental caries, is also a limitation of this study as it is not possible to analytically explore these contextual factors of oral health problems.

The results found are important in consolidating knowledge of the distribution of dental caries, its decreasing trend and the inequalities which still affect the country. It is also important to assess the influence of individual and contextual factors in the prevalence of the disease. The existing inequalities, characterized by the higher prevalence of dental caries in the poorer groups of the

population are persistent and reflect marked inequalities in Brazilian society and their implications for the population's health.

Thus, the need for interventions which could reduce existing inequalities between and within countries is underlined, as proposed by the Commission on Social Determinants of Health.<sup>6</sup> The results of this study also show that oral health care policies which only focus on changing behavior are ineffective strategies in reducing inequalities in oral health care, especially with regards to the distribution of dental caries in children. Thus, in addition to activities aimed at structural determinants of the health-disease process,<sup>21</sup> universal access to fluoridated drinking water should continue to be one of the priorities of national oral health care strategies.

## REFERENCES

1. Antunes JL, Pegoretti T, Andrade FP, Junqueira SR, Frazão P, Narvai PC. Ethnic disparities in the prevalence of dental caries and restorative dental treatment in Brazilian children. *Int Dent J*. 2003;53(1):7-12. DOI: 10.1111/j.1875-595X.2003.tb00649.x
2. Antunes JLF, Jahn GM, Camargo MA. Increasing inequalities in the distribution of dental caries in the Brazilian context in Finland. *Community Dent Health*. 2005;22(2):94-100.
3. Antunes JLF, Peres MA, Mello TRC, Waldman EA. Multilevel assessment of determinants of dental caries experience in Brazil. *Community Dent Oral Epidemiol*. 2006;34(2):146-52. DOI: 10.1111/j.1600-0528.2006.00274.x
4. Bastos JL, Antunes JLF, Frias AC, Souza MLR, Peres KG, Peres MA. Cor/raça e desigualdades em saúde bucal entre adolescentes brasileiros. *Rev Bras Epidemiol*. 2009;12(3):313-24. DOI: 10.1590/S1415-790X2009000300003
5. Boing AF, Peres MA, Kovalesski DF, Zange SE, Antunes JLF. Estratificação sócio-econômica em estudos epidemiológicos de cárie dentária e doenças periodontais: características da produção na década de 90. *Cad Saude Publica*. 2005;21(3):673-8. DOI: 10.1590/S0102-311X2005000300002
6. World Health Organization. Commission on Social Determinants of Health. Closing the gap in a generation: health equity through action on the social determinants of health. Geneva; 2008[citado 2012 fev 04]. Disponível em: [http://www.who.int/social\\_determinants/thecommission/finalreport/en/index.html](http://www.who.int/social_determinants/thecommission/finalreport/en/index.html)
7. Creeth JE, Gallagher A, Sowinski J, Bowman J, Barrett K, Lowe S, et al. The effect of brushing time and dentifrice on dental plaque removal in vivo. *J Dent Hyg*. 2009;83(3):111-6.
8. Frias AC, Antunes JLF, Narvai PC. Precisão e validade de levantamentos epidemiológicos em saúde bucal: cárie dentária na Cidade de São Paulo, 2002. *Rev Bras Epidemiol*. 2004;7(2):144-54. DOI: 10.1590/S1415-790X2004000200004
9. Kitamura ES, Leite ICG. Correlação entre índice de desenvolvimento humano e cárie dentária em uma amostra de municípios mineiros: implicações para a inclusão da odontologia na Estratégia Saúde da Família. *Rev APS*. 2009;12(2):140-9.
10. Maserejian NN, Trachtenberg F, Link C, Tavares M. Underutilization of dental care when it is freely available: a prospective study of the New England Children's Amalgam Trial. *J Public Health Dent*. 2008;68(3):39-45. DOI: 10.1111/j.1752-7325.2007.00074.x
11. Ministério da Saúde (BR). Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Guia de recomendações para o uso de fluoretos no Brasil. Brasília (DF); 2009. (Série A. Normas e Manuais Técnicos).
12. Moreira RS, Nico LS. Aspectos contextuais da ausência de cárie em escolares de 12 anos no Brasil, em três períodos históricos. *Rev Odontol UNESP*. 2010;39(5):263-70.
13. Narvai PC, Frazão P, Roncalli AG, Antunes JLF. Cárie dentária no Brasil: declínio, polarização, iniquidade e exclusão social. *Rev Panam Salud Publica*. 2006;19(6):385-93. DOI: 10.1590/S1020-49892006000600004
14. Parnell C, Whelton H, O'Mullane D. Water fluoridation. *Eur Arch Paediatr Dent*. 2009;10(3):141-8. DOI: 10.1007/BF03262675
15. Pattussi MP, Marcenes W, Croucher R, Sheiham A. Social deprivation, income inequality, social cohesion and dental caries in Brazilian school children. *Soc Sci Med*. 2001;53(7):915-25. DOI: 10.1016/S0277-9536(00)00391-9
16. Peres MA, Antunes JLF, Peres KG. Is water fluoridation effective in reducing inequalities in dental caries distribution in developing countries? Recent findings from Brazil. *Soz Praventivmed*. 2006;51(5):302-10. DOI: 10.1007/s00038-006-5057-y
17. Petersen PE. World Health Organization global policy for improvement of oral health – World Health Assembly 2007. *Int Dent J*. 2008;58(3):115-21.

18. Petersen PE, Kwan S. Equity, social determinants and public health programmes—the case of oral health. *Community Dent Oral Epidemiol.* 2011;39(6):481-7. DOI: 10.1111/j.1600-0528.2011.00623.x
19. Pitts N, Amaechi B, Niederman R, Acevedo AM, Vianna R, Ganss C, et al. Global oral health inequalities: dental caries task group-research agenda. *Adv Dent Res.* 2011;23(2):211-20. DOI: 10.1177/0022034511402016
20. Roncalli AG, Moyses, SJ, Marques R, Pinto RS, Goes PSA, Figueiredo N, et al. Aspectos metodológicos do projeto SB Brasil 2010 de interesse para Inquéritos Nacionais de Saúde. *Cad Saude Publica.* 2012;28(Suppl):40-57. DOI: 10.1590/S0102-311X2012001300006
21. Sheiham A, Alexander D, Cohen L, Marinho V, Moyses S, Petersen PE, et al. Global oral health inequalities: task group—implementation and delivery of oral health strategies. *Adv Dent Res.* 2011;23(2):259-67. DOI: 10.1177/0022034511402084
22. Snijders TAB, Bosker RJ. Multilevel analysis. An introduction to basic and advanced multilevel modelling. London: SAGE Publication; 1999.
23. Sutcliffe P. Oral cleanliness and dental caries. In: Murray JJ, editor. The prevention of oral disease. 3. ed. Oxford: Oxford University Press; 1996. p. 68-77.
24. World Health Organization. Calibration of examiners for oral health epidemiological surveys. Geneva; 1993.
25. World Health Organization. Oral health surveys: basic methods. 4. ed. Geneva; 1997.

---

The *Pesquisa Nacional de Saúde Bucal 2010* (SBBrazil 2010, Brazilian Oral Health Survey) was financed by the General Coordination of Oral Health/Brazilian Ministry of Health (COSAB/MS), through the *Centro Colaborador do Ministério da Saúde em Vigilância da Saúde Bucal, Faculdade de Saúde Pública at Universidade de São Paulo* (CECOL/USP), process no. 750398/2010.

This article underwent the peer review process adopted for any other manuscript submitted to this journal, with anonymity guaranteed for both authors and reviewers. Editors and reviewers declare that there are no conflicts of interest that could affect their judgment with respect to this article.

The authors declare that there are no conflicts of interest.