Original Articles

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Inequalities in untreated dental caries prevalence in preschool children in Brazil

ABSTRACT

OBJECTIVE: To evaluate the influence of social inequalities of individual and contextual nature on untreated dental caries in Brazilian children.

METHODS: The data on the prevalence of dental caries were obtained from the Brazilian Oral Health Survey (SBBrasil 2010) Project, an epidemiological survey of oral health with a representative sample for the country and each of the geographical micro-regions. Children aged five (n = 7,217) in 177 municipalities were examined and their parents/guardians completed a questionnaire. Contextual characteristics referring to the municipalities in 2010 (mean income, fluorodized water and proportion of residences with water supply) were supplied by the *Fundação Instituto Brasileiro de Geografia e Estatística* (Brazilian Institute of Geography and Statistics). Multilevel Poisson regression analysis models were used to assess associations.

RESULTS: The prevalence of non-treated dental caries was 48.2%; more than half of the sample had at least one deciduous tooth affected by dental caries. The index of dental caries in deciduous teeth was 2.41, with higher figures in the North and Northeast. Black and brown children and those from lower income families had a higher prevalence of untreated dental caries. With regards context, the mean income in the municipality and the addition of fluoride to the water supply were inversely associated with the prevalence of the outcome.

CONCLUSIONS: Inequalities in the prevalence of untreated dental caries remain, affecting deciduous teeth of children in Brazil. Planning public policies to promote oral health should consider the effect of contextual factors as a determinant of individual risk.

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

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INTRODUCTION

Applying measures which are effective in preventing and controlling disease requires the factors which influence the population's state of health to be identified. Social inequalities have been highlighted as an important determinant in the health-disease process and have been recognized at the level of the individual, as well as at the level of social context.[14]

The link between socioeconomic conditions and the prevalence of dental caries has been highlighted in studies which interpret this association as the source of inequalities in oral health.[1,7,19] This affirmation has also been made for children of pre-school age.[21] In this age group, the early development of dental caries is considered a public health problem, due to its high prevalence and because it affects the individual's quality of life.[11]

The relationship between individual determinants and different health conditions, dental caries among them, is influenced by the context in which the individuals dwell.[10] Previous studies have discussed the occurrence of these health problems as being related to a complex causal network which includes determinants related to individual characteristics and the social and geographical context in hierarchically organized levels.[1,4,9] The action of these factors on the risk of disease does not occur in isolation; on the contrary, multiple interactions should be reflected in conceptual models which organize the distal and proximal levels in order to explain the disease's distribution.[10] Analyzing epidemiological data without considering variance in the hierarchical levels on which the population is organized may be source of bias and lead to erroneous conclusions.[1,24] To deal with this difficulty, recent studies have used multilevel analysis in order to integrate individual characteristics and geographical variables into one explanatory model.[1,4,9,13]

In Brazil, epidemiological surveys assessing the oral health of the population have been carried out on a national scale since the 1980s. Analysis of the results of these surveys has highlighted the influence of contextual factors, incorporating socioeconomic and environmental indicators such as the Human Development Index, measures of access to health care services and the availability of a fluoridated water supply. Moreover, these surveys have shown a decrease in dental caries indices in 12-year-old children.[17] However, few studies have evaluated the distribution of early childhood caries and its associated individual and contextual factors.[1,3,13]

This study aimed to assess the influence of social inequalities at the individual and contextual level on untreated dental caries in Brazilian children. Identifying the current epidemiological situation of dental caries in five-year-old children may aid in defining public policies for oral health aiming at decreasing social differences.

METHODS

This cross-sectional study used information on the prevalence of dental caries provided by the epidemiological *Pesquisa Nacional de Saúde Bucal* (Projeto SBBrasil 2010 - Brazilian Oral Health Survey). The methodological procedures used in this survey, as well as the technical report are available online.[a]

The methodology used by the SBBrasil 2010 followed international standards set by the World Health Organization (WHO)[26] and aimed to evaluate deciduous teeth of a sample of five-year-olds, representative at the national level, each state capital and towns in the interior of each macro-region.

The SBBrasil 2010 carried out oral exams on 7,217 five-year-old children in 177 municipalities and applied a questionnaire to their parents or guardians. The sample was obtained using a complex cluster sampling design, and the respective sampling weights were recorded in the database. The primary sampling unit was the cluster, constituted of census tracts in the state capitals and hinterland towns in each macro region, while the children examined were the secondary sampling unit. This database enabled the prevalence and severity of the main oral health problems to be evaluated, as well as the distribution of the sociodemographic factors in question.

The indicators of dental caries prevalence were assessed using the dmft index (decayed, missing or filled teeth – deciduous teeth). The prevalence of untreated dental caries was defined by the appearance of at least one deciduous tooth with this condition, that is, with the component 'd' of the dmft index equal to or greater than one. The examiners were trained and instructed in using the criteria proposed by the WHO (1997)[26] for diagnosing dental caries. The principal outcome variable in this study was the prevalence of untreated dental caries, into which was integrated information on the prevalence of the disease and the lack of dental treatment.[3]

Individual-level sociodemographic characteristics were gathered using the SBBrasil 2010 questionnaire: sex, skin color and household income. The categories used by the *Fundação Instituto Brasileiro de Geografia e Estatística* (IBGE, Brazilian Institute of Geography and Statistics) were used to classify skin color; information on household income was collected

by considering the sum of the income (in *reais*, R$) of all members of the household.

The contextual characteristics of the municipalities were obtained by consulting the results of the 2010 IBGE census. This included indicators of household income (median for the municipality) and the percentage of residences connected to the water supply (categorized by quartiles of distribution). The National Basic Sanitation Survey, carried out by the IBGE[12] showed, as of 2008, which towns did and did not add fluoride to the public water supply.

The data were analysed using the Stata 12 program. Firstly, descriptive analysis was carried out for the dmft index, prevalence of dental caries (dmft ≥ 1) and the prevalence of untreated dental caries (d ≥ 1) for each state capital and for the towns in the interior of each macro-region. Poisson multilevel regression analysis was used to evaluate the link between indicators of dental caries and the individual and contextual factors. Both the descriptive estimates and the analyses were carried out considering the complex cluster sample design and the respective sampling weight. To assess association between variables, prevalence ratios and confidence intervals (95%) were used.

Mixed effect multilevel analysis was used,[24] estimating the fixed effect of the measures of association between the outcome and the first level factors (children), and the random effect between the outcome and the second level factors (clusters of the sampling design). In the bivariate analysis, the two outcome were compared: the prevalence of dental caries and the prevalence of untreated dental caries. In the multiple regression analysis, only one outcome was selected: the prevalence of untreated dental caries.

The multiple analysis was carried out in three stages. First, the empty mode ("model 1") was estimated, without factors, only sharing the variance in the two levels of analysis. "Model 2" included only factors at the individual level. "Model 3" included all of the factors adjusted according to the individual and contextual variables. The models' goodness of fit was evaluated using the statistic -2 log likelihood; significant changes in the goodness of fit were analyzed using the likelihood ratio test.[24]

The SBBrasil 2010 Project followed the standards set by the Declaration of Helsinki and was approved by the *Conselho Nacional de Ética em Pesquisa*, record no. 15,498, 7th January 2010.

RESULTS

A total of 7,217 five-year-old children participated in the study; the no-response rate (sample loss) was 1.8%.

The dmft index was 2.41 (95%CI 2.19;2.63) for the country as a whole. The "d" component of the dmft corresponded to 84.3% of the total value for the index; this values indicates that, for each 100 teeth with signs of current or previous experience of the disease, around 85 have not been restored. The prevalence of dental caries was 53.1% (95%CI 50.1%;56.1%), in other words, more than half of the children in this age group suffered from the disease. The prevalence of untreated dental caries was 48.2% (95%CI 45.2%;51.2%), suggesting that almost half of Brazilian children in this age group have this condition.

Dental caries indices were markedly unequal in their geographic distribution. The prevalence of untreated caries, for example, varied between 27.0% in Rio de Janeiro to 68.9% in towns in the interior of the Northeast. Overall, the poorer regions of the country (the North and Northeast) had worse indices of dental caries in deciduous teeth. Compared with the Southeast, the North had a dmft index around 63% higher. In each macro-region, the towns in the interior had worse indices of dental caries than the respective state capitals. With regards the prevalence of untreated dental caries, the lowest percentages were obtained in the state capitals in the South and Southeast (Figure 1, Table 1).

The same factors which are associated with the prevalence of dental caries (dmft ≥ 1) are also associated with the prevalence of untreated dental caries (d ≥ 1). At the individual level, skin color and household income were the socio-demographic characteristics significantly associated with the two measures. At the contextual level, the indices of dental caries were associated with: fluoride added to the water supply, percentage of households connected to the water supply and median household income in the municipality (Table 2).

In the multilevel analysis, adjusted for sex, it was observed that children with brown and yellow skin had, respectively, 9% (95%CI 1.0%;17.0%) and 26% (95%CI 1.0%;58.0%) higher prevalence of dental caries than children with white skin. It was also observed
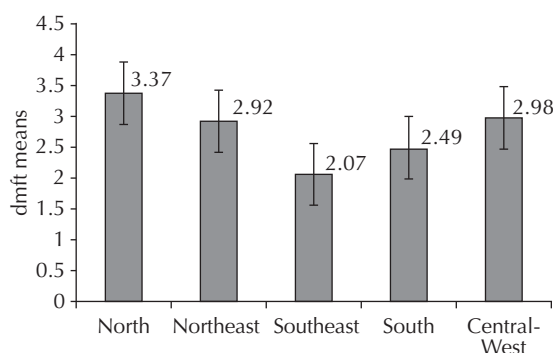

Figure. dmft index and 95% confidence intervals in five-year-olds by macro-region. SBBrasil, 2010.

Table 1. dmft index, prevalence of dental caries (one or more teeth affected) and the prevalence of untreated dental caries (evaluated using the "d" component of the dmft index) in five-year-old children, by state. SBBrasil, 2010.

State capitals	n	dmft index	dmft ≥ 1 (%)	D ≥ 1 (%)
North				
Porto Velho, RO	171	2.89	63.2	58.8
Rio Branco, AC	163	3.20	64.2	58.9
Manaus, AM	200	2.88	56.7	53.7
Boa Vista, RR	194	3.51	66.6	65.6
Belém, PA	291	2.14	53.6	51.1
Macapá, AP	230	2.57	64.4	60.9
Palmas, TO	180	1.53	46.5	42.5
Northeast				
São Luís, MA	166	1.86	40.7	36.6
Teresina, PI	174	2.55	56.7	55.6
Fortaleza, CE	232	1.39	42.7	41.5
Natal, RN	187	2.29	53.2	52.4
João Pessoa, PB	139	2.61	60.1	56.5
Recife, PE	267	2.09	52.7	48.5
Maceió, AL	167	2.76	60.5	58.2
Aracaju, SE	232	2.23	52.5	48.6
Salvador, BA	228	1.70	43.5	42.3
Southeast				
Belo Horizonte, MG	200	2.40	54.6	51.5
Vitória, ES	205	1.47	42.8	38.2
Rio de Janeiro, RJ	265	1.44	29.0	27.0
São Paulo, SP	224	1.99	41.8	37.6
South				
Curitiba, PR	235	2.46	56.2	50.3
Florianópolis, SC	187	1.56	39.1	33.8
Porto Alegre, RS	225	1.71	39.7	37.9
Central-West				
Campo Grande, MS	209	2.62	57.1	44.1
Cuiabá, MT	105	3.18	63.2	58.4
Goiânia, GO	256	1.96	48.0	40.6
Brasília, DF	179	1.85	47.2	45.2
Towns in the interior	n	dmft index	dmft ≥ 1	D ≥ 1
North Region	345	3.73	70.2	68.4
Northeast Region	317	3.99	69.1	68.9
Southeast Region	389	2.19	50.5	44.8
South Region	280	2.56	62.8	55.8
Central-West Region	375	3.39	66.0	61.8
Brazil	7217	2.41	53.1	48.2
95%CI		2.19;2.63	50.1;56.1	45.2;51.2

that, in poorer children (household income below R$ 500.00), the prevalence of untreated dental caries was 2.45 (95%CI 2.07;2.93) times higher than that of children from better off families (household income over R$ 2,500.00) (Table 3).

When contextual variables are fitted in the multilevel model, the prevalence of the outcome was significantly lower in municipalities which add fluoride to the public water supply (prevalence ratio, PR 0.88; 95%CI 0.79;0.98) and in those municipalities with higher

Table 2. Multilevel analysis of individual and contextual factors associated with the prevalence of dental caries and the prevalence of untreated dental caries (component "d" of the dmft index) in five-year-old children. SBBrasil, 2010.

Individual level (child)	n	dmf ≥ 1[a] (%)	PR (95%CI)[b]	Untreated dental caries[a] (%)	PR (95%CI)[b]
Sex					
Male	3,618	54.4	1	49.7	1
Female	3,599	51.6	0.97(0.91;1.03)	47.3	0.98(0.92;1.05)
Skin color					
White	3,229	50.0	1	44.2	1
Black	576	56.4	1.14(1.01;1.29)	54.1	1.20(1.06;1.36)
Brown	3,220	55.6	1.14(1.07;1.23)	52.0	1.17(1.09;1.26)
Yellow	140	56.1	1.23(1.00;1.53)	54.8	1.29(1.04;1.62)
Indigenous	52	69.0	1.36(0.98;1.90)	63.6	1.39(0.99;1.96)
Household income (R$)					
> 2,500.00	662	35.8	1	26.5	1
1,501.00 to 2,500.00	1,024	45.3	1.47(1.24;1.73)	38.1	1.70(1.41;2.05)
501.00 to 1,500.00	3,699	54.2	1.82(1.57;2.10)	49.9	2.21(1.88;2.61)
≤ 500.00	1,494	63.7	2.01(1.73;2.35)	62.7	2.53(2.13;3.01)
Contextual level (cities)	**n**	**dmf ≥ 1[a] (%)**	**PR (CI95%)[b]**	**Untreated dental caries[a] (%)**	**PR (95%CI)[b]**
Fluoridated water supply					
No		65.8	1	61.9	1
Yes		50.4	0.80(0.72;0.88)	45.7	0.76(0.68;0.85)
Residences connected to the water supply (%)					
Below 62%		70.0	1	66.6	1
62.1% to 82.5%		61.5	0.88(0.77;1.00)	56.9	0.87(0.75;1.01)
82.6% to 93.0%		59.6	0.85(0.74;0.98)	54.9	0.82(0.70;0.95)
Over 93%		45.2	0.70(0.62;0.79)	40.6	0.68(0.60;0.77)
Median income, municipality (R$)					
Below 255.00		72.0	1	69.9	1
256.00 to 450.00		61.6	0.82(0.72;0.94)	59.9	0.81(0.71;0.93)
451.00 to 510.00		56.2	0.79(0.69;0.91)	50.7	0.75(0.65;0.86)
Over 510.00		45.2	0.65(0.56;0.74)	39.9	0.59(0.51;0.67)

[a] Prevalence weighted by sample weight.
[b] Prevalence rates and the 95% confidence level, unadjusted for other factors, estimates using multilevel analysis Poisson regression.

median income. Comparison between the measures of goodness of fit (-2 log likelihood) obtained for the empty model (model 1), the multivariate model (model 2) and the complete multilevel model (model 3) shows that there was, at each stage of the analysis, significant gains in explaining the variance of the outcome (Table 3).

DISCUSSION

The report of high prevalence of untreated dental caries (48.2%) in five-year-old Brazilian children is consistent with research[18] showing that, in 2008, only one third of children (33.2%) of children under six had seen a dentist at least once in their lives. On the other hand, although high, the prevalence of untreated dental caries was lower than the estimate for 2003, which was 54.0%.[3]

With regards the dmft index, the national estimate for 2010 (2.41) corresponds to a 14% decrease, when compared with that observed in 2003 (2.80).[3]

In addition to documenting actual levels of dental treatment needs in deciduous teeth, this study assessed the inequality in its distribution between Brazilian regions and between children with different socio-demographic characteristics. The epidemiological situation for dental caries was worse for children living in poorer regions of the country; the association between socio-economic conditions and the disease remained even after adjusted for individual characteristics. These results corroborate previous assessments[1,3,13] and show that socio-economic inequalities relative to the context are still important factors in influencing oral health in pre-school aged children.

Table 3. Multilevel analysis of individual and contextual factors associated with the prevalence of untreated dental caries in five-year-old children, adjusted model. SBBrasil, 2010.

Variable	Model[a] 1	Model[a] 2	Model[a] 3
	PR (95%CI)[b]	PR (95%CI)[b]	PR (95%CI)[b]
Intercept	0.53(0.50;0.56)	0.24(0.21;0.29)	0.31(0.24;0.41)
Individual level (child)			
Sex			
Male		1	1
Female		0.98(0.92;1.05)	0.98(0.92;1.05)
Skin color			
White		1	1
Black		1.10(0.97;1.25)	1.08(0.96;1.23)
Brown		1.09(1.01;1.17)	1.06(1.00;1.14)
Yellow		1.26(1.01;1.58)	1.26(1.01;1.58)
Indigenous		1.26(0.90;1.78)	1.20(0.86;1.69)
Household income (R$)			
> 2,500.00		1	1
1,501.00 to 2,500.00		1.68(1.40;2.03)	1.67(1.39;2.02)
501.00 to 1,500.00		2.17(1.84;2.56)	2.14(1.82;2.53)
≤ 500.00		2.45(2.07;2.93)	2.35(1.98;2.80)
Contextual level (cities)			
Fluoridated water supply			
No			1
Yes			0.88(0.79;0.98)
Residences connected to the water supply (%)			
Below 62%			1
62.1% to 82.5%			0.90(0.78;1.03)
82.6% to 93.0%			0.94(0.80;1.09)
Over 93%			0.87(0.75;1.01)
Median income, municipality (R$)			
Below 255.00			1
256.00 to 450.00			0.97(0.84;1.13)
451.00 to 510.00			0.93(0.89;1.10)
Over 510.00			0.82(0.68;0.99)
- 2 log likelihood	12.190	12.020	11.980

[a] Model 1 does not contain adjustment factors (empty model). Model 2 shows the fit of the outcome for individual-level variables. Model 3 shows the adjustment for individual-level and contextual variables.
[b] Prevalence ratios and 95% confidence intervals adjusted for the other factors, estimates using Poisson multilevel regression analysis.

Inequalities in oral health care have been demonstrated even against the background of decreasing prevalence of dental caries over the last few decades[17] and have been described as one of the great public health challenges to be faced.[23] In this sense, carrying out studies which include individual and contextual determinants to explain the distribution of dental caries are suggested as a propitious strategy in guiding initiatives aimed at reducing inequalities in health care.[23] This study identified racial and socioeconomic differences as individual determinants in untreated dental caries. Racial differences in dental caries indices have been reported in previous studies of the Brazilian population.[2,21] The association between skin color and health care is complex and appears to reflect difference in access to health care between the racial strata,[2] motivation in oral health care activities,[22] and the stigma and material privation associated with racial condition.[8]

Income was associated with the prevalence of untreated dental caries, both at the level of the children examined (household income) and at the level of the municipality

in which they live (median income). The link between income and oral health has been well documented in the literature.[6-9,22] Previous studies of the Brazilian population report low income to be associated with higher levels of intake of sugary foods,[15] less access to health care services[22] and poorer standard of oral hygiene.[5] These factors mediate the effect of material privation on the increased risk of dental caries.

The multilevel model meant that the addition of fluoride to the public water supply could be recognized as a contextual protective factor against the individual risk of dental caries. The negative association between these variables remained significant even after adjusting for individual-level covariates. The benefits of fluoridating the water supply have been well documented in population based studies in Brazil.[17,20] A systematic review[25] of the literature concluded that this measure is the most effective and socially acceptable resource in preventing dental caries.

In addition to being a low cost strategy, it may contribute to diminishing health care inequalities between the socioeconomic strata.[6] However, the preventative action of fluoridated tap water has not benefitted all of the population equally. There is a socioeconomic gradient to the implementation of this measure in different states and regions of Brazil, which contributes to increasing the social bias of this disease.[6,20] Therefore, the findings of this study reinforce the need to promote the expansion of fluoridation to towns that have not yet adopted it.

This study documents current levels of epidemiological indicators of dental caries in deciduous teeth of Brazilian children, as well as the persistent inequalities in suffering from dental caries at regional and socioeconomic levels. These records can be seen as a strong point of the study. It is important to bear in mind that the database used was created through an extensive research effort sponsored by the Brazilian Ministry of Health. It was the first nationwide epidemiological survey of oral health, carrying out home visits in order to examine the children and interview their parents and guardians. There was no chronological difference between the contextual variables and the outcome used in this study, as the information from the most recent general census was collected in the same period in which the data on dental caries were gathered. Moreover, the analysis took into account the complex structure of the cluster sample and the sample weights, issues whose importance has been recognized in epidemiological analysis.[16]

It is important to highlight that, as they were based on the "d" component (decayed deciduous teeth) of the dmft index, estimates of the prevalence of untreated dental caries do not reflect the immediate need for dental treatment, in function of the intrinsic characteristics of the instrument. Deciduous incisors with dental caries at age five, for example, are ready to exfoliate and, although they are affected by dental caries, they do not need to be treated. This observation is recognized as a limitation of the study.

This study reinforces the premise that contextual level inequalities continue to influence the prevalence of dental caries in pre-school aged children in Brazil. This affirmation is important in guiding public policies aimed at those geographical areas which are most materially deprived. Reducing inequalities in oral health should be a terget in planning preventative programs which aim to promote both health care and social justice.

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