Contextual and individual determinants of tooth loss in adults: population-based multilevel study

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Abstract

Background: Tooth loss represents a known marker of health inequality. The association between tooth loss and unfavorable socioeconomic conditions is evident when analyzed at an individual level. However, the effects of contextual characteristics on tooth loss need to be better investigated and understood. The objective of this study was to analyze tooth loss among Brazilian adults (35-44 years of age), in accordance with individual and contextual social characteristics.

Methods: This was a multilevel cross-sectional study with data from 8,837 adult participants from the National Oral Health Survey - SBBrazil 2010. The dependent variable was the number of lost teeth and the independent variables were grouped according to the theoretical model of Watt & Sheiham (2012). Negative Multilevel Hierarchical Binomial Regression was conducted and the Mean Ratio (MR) was estimated.

Results: Brazilian adults lost a mean of 7.31 (95% CI 6.9-7.8) teeth. Among the contextual variables, the number of teeth lost was lower among residents of municipalities with higher Municipal Human Development Index (MHDI), and was higher in municipalities that did not have public water fluoridation. Among the individual variables, dental loss was higher among those who declared themselves yellow/black/brown/indigenous, were older, who reported pain, who had not used dental services for more than a year and those whose reason for the consultation was due to oral health problems. On the other hand, dental loss was lower among adults with higher education levels, higher income and males.

Conclusions: The number of missing teeth was associated with unfavorable contextual and individual conditions, which reinforces the need to reduce social inequality and guarantee regular, lifetime access to dental services.

Introduction

Tooth loss is considered one of the major oral health issues [1,2], and represents an important public health problem [3]. Besides reflecting the accumulation of oral disease throughout life [4], tooth loss can also be influenced by social, behavioral and cultural factors [3,5]. Thus, tooth loss is the result of a complex interaction between biological and social factors [6].

Tooth loss is a known marker of health inequality [7], since a lower number of teeth is often observed among the socially disadvantaged [8]. This association is evident at the individual level [2,7,9–11]. However, the effects on tooth loss arising out of the place where people live (contextual effects) needs further investigation to be understood.

The need to recognize and distinguish contextual influences on oral health has been identified in the scientific literature. A systematic review conducted to identify the contextual socioeconomic factors associated with dental loss found that there are very few studies evaluating tooth loss in the contextual

perspective [12]. Such studies are essential, since not all determinants of the health-disease process can be captured at the individual level [13].

The aim of this study was to analyze tooth loss among Brazilian adults, its association with social inequalities and contextual characteristics; measured at the individual level, using a multilevel approach.

Methods

This was a cross-sectional multilevel study. In addition to individual variables, contextual variables were taken into account to explain an outcome assessed at the individual level. The individual variables were derived from the National Oral Health Survey - SBBrazil 2010 [14], and the contextual variables were obtained at the municipal level from official public databases.

SBBrazil 2010 was a nationally coordinated research survey funded by the Ministry of Health. Individuals belonging to the 5, 12, 15 to 19, 35 to 44 and 65 to 74 age groups were evaluated to represent the Brazilian population. The sampling plan consisted of domains related to the capitals of the Brazilian States, the Federal District, and municipalities in the interior of each of the national geopolitical macro-regions (North, Northeast, Central West, Southeast and South), accounting for 177 Brazilian municipalities. The selection of the conglomerates was by probabilistic sampling in multiple stages with a design effect (DEFF) equal to 2. The primary sampling units were: (a) municipality, for the interior of the regions and (b) census sector for the capitals. The intra-oral examinations were conducted in the subjects' homes, under natural light, by trained and calibrated dental surgeons ($Kappa \geq 0.65$), using handheld computers to record the information. The diagnostic criteria of the 4th edition of Oral Health Surveys: Basic Methods, WHO [15] was adopted. Besides assessing oral complaints, respondents were given a survey questionnaire was applied containing questions related to socioeconomic characterization, use of dental services, self-reported oral morbidity and self-perception of oral health. Additional information about the methodology employed in SBBrazil 2010 can be obtained in a previous study [16]. In the present study, SBBrazil 2010 data was used for the 9,779 individuals evaluated between the ages of 35 and 44 years old; this age group is a standard for evaluating oral health conditions in adults [15].

The variables of the contextual level were collected from official public databases for each of the 177 participating municipalities of SBBrazil 2010: Demographic Census of 2010 of the Brazilian Institute of Geography and Statistics (IBGE) [17], Atlas Brazil of the United Nations Development Program (UNDP) [18], National Survey of Basic Sanitation of the IBGE [19] and the Department of Informatics of the Unified Health System (DATASUS) [20]. The databases relating to Atlas Brazil [18] and the National Survey of Basic Sanitation [19] were generated from the demographic census of 2010 with data collection carried out between August 1 and 30 October 2010, using the territorial basis which consisted of 316,574 census sectors [17].

The dependent variable was total number of lost teeth, it was defined as any natural tooth absent due to extraction, for any reason corresponding to codes 4 and 5 of the DMFT index (decayed, missing and filled

teeth) [15]. This was assessed according to its discreet numerical nature.

The conceptual model for inequities in oral health of Watt & Sheiham (2012) [21] was adopted for the grouping of contextual and individual independent variables. This theoretical model takes into account the social determinants of inequalities in oral health, in contrast to preventive approaches, that focus on the behavioral changes of the individual. According to this conceptual model, the variables that influence the oral health can be grouped into structural (socioeconomic & political context) and intermediary (socioeconomic position, behavioral & biological factors, and health services) determinants (Figure 1).

In the socioeconomic & political context, all the contextual variables were taken into account: geographical location of the municipality (capital; interior) [14], Municipal Human Development Index (MHDI) [18], and the Gini coefficient [18], percentage of the population with access to garbage collection [17], percentage of the population with access to a bathroom and piped water [17], coverage of oral health teams [20], the number of dentists per 1000 inhabitants [20] and public water fluoridation (yes; no) [19]. The MHDI is an indicator that aggregates information about income, level of education and longevity in each municipality. The scale varies from zero to one, where higher values reflect a higher level of human development. The Gini Coefficient measures inequality in income distribution, ranging from zero (absolute equality) to one (absolute inequality) [18]. The coverage of oral health teams refers to the proportion of oral health teams who work in primary care of municipalities. Apart from the geographic location of the municipality and public water fluoridation variables, all other contextual variables were analyzed in numerical form.

In the socioeconomic position, the following individual variables were taken into account: declared skin color (white; yellow/black/brown/indigenous), education levels (years of study), family income in dollars (up to 142; 143 to 284; 285 to 852; 853 to 1,421; 1,420 to 2,556; 2,557 to 5,397; above 5,397) and location of the household (urban; rural). The minimum salary in force at the time of data collection was \$290.0.

In relation to behavioral & biological factors, the following individual variables were included: sex (female; male), age (in years), self-perception of the need for treatment (yes; no) and pain in the teeth and gums in the last six months (no; yes). Also at this level, considering health services, the following individual variables were included: time since last consultation (less than 1 year; more than 1 year), the reason for consultation (review/prevention; oral problems), type of dental service (public; not public) and satisfaction with dental services (satisfied; dissatisfied).

Analyses conducted

To explore the dependent variable, a map was drawn with the average number of lost teeth for each one of the five Brazilian geopolitical macroregions and for the capitals of the States and the Federal District. For each Brazilian macroregion, besides mean teeth lost, a 95% Confidence Interval (95% CI) was

estimated, accounting for the correction of sample design. The free software *Quantum Gis* was used, which enables georeferencing, editing and data analysis.

The data relating the individual and contextual variables was initially organized in the statistical software *Predictive Analytics Software* (SPSS/PASW®) version 18.0 for Windows®. Only the municipal data was used for the descriptive analysis of the contextual variables. The descriptive analysis of the individual variables was conducted according to the need of correction for the effect of sample design, because they are from samples by conglomerates. For such, the *Complex Samples* module was used, which considers the planning variables and inclusion of basic weights resulting from the sampling process. Measures of central tendency and variability were estimated for the independent variables and simple numerical (n) and relative (%) frequencies for categorical independent variables. The association between the total number of lost teeth and the individual characteristics was verified by the Pearson correlation (r) for independent numerical variables, and the Student's t -test was used for dichotomous variables and analysis of variance (ANOVA) for the polytomous variables.

The data was exported to the STATA® version 14.0 software and the Hierarchical Multilevel Negative Binomial Regression (stepwise backward method) model was used, using contextual and individual data. The Negative Binomial Regression model is appropriate when the dependent variable is quantitative and with integer and non-negative values (counting data) and when there is overdispersion in the data (the variance of the dependent variable should be greater than the mean) [22]. Before starting the modeling, the adequacy of the dependent variable for this regression modality was verified and confirmed. For the estimation of the adjustment between outcome (total number of teeth lost) and explanatory variables of first (contextual) and second (individual) levels of analysis, the fixed-effect scheme was used [23]. Initially, an empty model was used with only a random intercept and the dependent variable, without the other variables. Subsequently, a hierarchical block design was used as proposed by the adopted theoretical model [21] (Figure 1). Model 1 included only the contextual variables (socioeconomic & political context). From the second model, the individual variables were taken into account. Model 2 considered the socioeconomic & political context, and added the socioeconomic position. Model 3 comprised the socioeconomic & political context, the socioeconomic position, and added behavioral & biological factors, in addition to the variables related to health services. The *menbreg, irr* function was used to obtain the Mean Ratio (MR), the 95% CI, and the best fit version was obtained in the final model.

The analysis of the fit of the models was performed through *Deviance*, obtained through the Log Likelihood multiplied by (-2) , where it is expected that there will be significant differences between the models (difference greater than 3.84) [24]. In addition, multicollinearity was tested by verifying the correlations of independent variables through Pearson's correlation (r), with no values above 0.7 being identified.

The SBBrazil 2010 was conducted in order to meet the ethical principles of the Resolution of the National Health Council (CNS) (n°196/96), relating to research on human beings. It was approved by the Research Ethics Committee of the Ministry of Health and was registered at the National Bioethics Commission of

Brazil (CONEP), of the CNS, under the number 15.498/2009. The participants were informed about the research and agreed to participate by signing an Informed Consent Form [16].

Results

Among the 9,779 adults evaluated by SBBrasil 2010, 942 (9.6%) were excluded for not having used dental services and/or lack of information related to the dependent variable in the analysis. Thus, a total of 8,837 individuals were included in the analyses in this study. The mean tooth loss among Brazilian adults was 7.31 (95% CI 6.9–7.8), being higher in the North (10.55) and Northeast (8.61) regions. In relation to the Brazilian state capitals, those with lower levels of tooth loss were Vitória—Espírito Santo (4.43), Porto Alegre—Rio Grande do Sul (4.49), Belo Horizonte—Minas Gerais (5.17) and Florianópolis—Santa Catarina (5.07) (Figure 2).

The descriptive analysis of the contextual variables are presented in Table 1. Among the 177 municipalities analyzed, one third had no fluoridated water and the Gini coefficient was 0.62 (± 0.12). In the descriptive analysis of the individual variables, there was a predominance of females and those who self-declared themselves as yellow/black/brown/indigenous. The mean age of the adults investigated was 39.37 years (± 3.07 /SE = 0.08) with an average of 8.76 years of education (± 3.91 /SE = 0.20). Most of the adults utilized public dental services and understood the need for dental treatment (Table 2). The bivariate analysis can also be observed in Table 2.

Table 3 presents the hierarchical multilevel negative binomial regression analysis. Considering the contextual variables, adults from municipalities with higher MHDl had lower tooth loss (MR = 0.29). Residing in municipalities that did not have fluoridated water increased the probability of tooth loss by 25% compared to residents in municipalities that had public water fluoridation (MR = 1.25). Among the individual variables, the total number of lost teeth was higher among those who declared to be yellow / black / brown / indigenous (MR = 1.08) and lower among adults with higher education levels (MR = 0.93). Regarding family income, the probability of dental loss was lower for those with a family income range equal to or higher than US \$853.00 compared to adults whose family income range was less than or equal to US \$142.00. Additionally, being male represented a protection for tooth loss compared to female adults (MR = 0.84). The total number of missing teeth was higher among older individuals (MR = 1.09), who reported tooth and gum pain in the last six months (MR = 1.05), who used the dental service more than one year ago (MR = 1.04) and the reason for the consultation was oral problems (MR = 1.42). A significant reduction in *Deviance* was observed between the models, with the addition of each new block of variables.

Discussion

A higher tooth loss was observed among the residents of municipalities with lower MHDl and who did not have public water fluoridation, even after adjustment for individual variables. Among the individual variables, the number of lost teeth was influenced by declared skin color, education levels, income, sex,

age, reported pain in the last six months, time elapsed since the last dental consultation and the reason for this consultation. In general, the highest number of missing teeth was related to unfavorable individual and contextual conditions.

The mean number of tooth loss among Brazilian adults was 7.31, very close to the published value in the final report of the SBBrasil 2010 (7.48) [14]. This small variation is related to the inclusion criteria adopted in the present study, which resulted in a reduction in the “n” of the sample (8,837 adults considered among the 9,779 assessed by SBBrasil). Historically, a reduction in the number of lost teeth among Brazilian adults has been observed [25,26,14]. However, the number of lost teeth remains higher in less developed regions of the country (North and Northeast - 10.55 - 8.61). It should be emphasized that this pattern of regional differences has remained over time, in all age ranges [25,26,14]. In addition, levels of tooth loss among adults in Brazil are still higher than those observed in developed countries such as Canada (6.7) [27], Bulgaria (6.7) [28] and Ireland (5.7) [29]. This variation in the number of lost teeth for the different localities reinforces the idea of contextual influences on tooth loss and validates the findings of the present study that unfavorable contexts increase the occurrence of tooth loss.

The contextual variables MHDl and public water fluoridation remained associated with the number of lost teeth, even after adjustment for important individual variables known to be associated to tooth loss. Moreover, the association of contextual variables was even stronger after controlling for individual variables. The association between contextual variables and the presence of functional dentition [30,31], number of self-reported teeth [7,27,32,33] and edentulism [34] has already been reported among adults. However, no studies have evaluated this relationship considering the number of lost teeth as numerical in nature. This option offers the advantage of observing the magnitude of the impact per number of lost teeth, without the need for categorization of the variable, this allows the analysis to be more sensitive.

Adults living in municipalities with higher MHDl had a lower number of lost teeth. Previous studies had already verified the effect of MHDl on the higher prevalence of functional dentition [31] and lower need for dental treatment among adults [35]. Municipalities that have greater MHDl possibly offer better opportunities for the maintenance of oral health, especially through increased access to dental services [32]. Furthermore, it is known that other important aspects for the maintenance of dentition, such as higher education levels, better eating habits, greater access to information and provision of health services, are commonly more available in developed areas [32,36].

The public water fluoridation was associated with a lower number of lost teeth, which corroborates previous studies [30,31,33]. The effect of water fluoridation in reducing the prevalence and incidence of dental caries [37], the main cause of tooth loss [2], is widely recognized. Although we did not determine the time of availability of fluoride in the water supply to the municipalities, individuals may benefit from access to fluoridated water throughout their life, rather than at a specific time point. The results emphasize the importance of water fluoridation as a public health measure. It was found that the impact

of the addition of fluoride in the public water supply is higher for individuals of lower socioeconomic level [38], which reinforces the importance of this measure as a way to compensate for inequalities in oral health [37].

In relation to individual variables, adults with higher education levels and with higher income had lower tooth loss. This association is consistent in the national [2,3,11,30,31,33] and international literature [5,7,27,28]. It is noteworthy that the variable range of family income presented a gradient relationship with the outcome, in that the higher the family income, the greater the protection against tooth loss. Adults who declare being yellow, black, brown or indigenous displayed a higher probability of tooth loss compared to whites. A study conducted among Brazilian adults also found racial inequity associated with tooth loss, with greater vulnerability of blacks and browns compared to whites [39]. The variable declared skin color was allocated in the block of socioeconomic position, since genetic studies have identified that there may not be a significant association between skin color and genomic ancestry [40,41]. Thus, in countries where there is a large miscegenation, as is the case for Brazil, the variable of declared skin color seems to reflect more a socioeconomic condition than a genetic aspect.

A lower number of tooth loss among men [2,3,10,11,28,30,31,33] and higher among older individuals [3,5,11,28,30,31,33] had already been observed in previous studies. Moreover, adults who reported pain in the teeth and gums in the last six months also had a higher probability of tooth loss. Pain of dental origin is experienced mainly by individuals with unfavorable socioeconomic conditions [42]. This situation frequently leads to the extraction of dental elements to relieve pain [3,9,10] and may contribute to a mutilating practice in health services, which ends up replicating health inequities. With the exception of rare cases of dental self-extraction, the only way to experience dental loss is by using dental services. A 48-month follow-up study conducted in the United States found that African-Americans with low socioeconomic status were less likely to use dental services. When they used dental services they had less access to alternative treatments for extraction and information on behaviors that could prevent tooth loss [9].

Furthermore, the number of missing teeth was higher among adults who used dental services more than a year ago and whose reason for consultation was for oral health problems, to the detriment of preventive use. Previous studies have also reported an association between the use of dental services in the last year and lower tooth loss [5,30,31]. The adult population, especially workers, may have difficulties in accessing health facilities during the normal business hours [43]. This possibly leads these individuals to use dental services sporadically, seeking care for urgent dental conditions, in which restorative treatments may not be an option, increasing the likelihood of tooth loss. In addition, the preventive use (routine/review/check-up) of dental services is considered an indicator of oral health, and the most conservative dental treatments were performed in patients who used them regularly [44]. A prospective cohort study carried out in New Zealand found that adults who routinely used dental services had higher levels of oral health, with less decayed and lost teeth [45]. Thus, access to dental services on a regular basis must be encouraged in order to reduce the number of lost teeth among adults.

As to the limitations of this study, this is a cross-sectional survey, and temporal limitations are inherent to this type of study design. However, the representativeness of the sample investigated, and the multilevel approach of the variables are highlighted. This allowed the assessment of the importance of each block of variables on tooth loss, identifying the influence of individual and contextual factors in the outcome investigated. Additionally, a random effect for the contextual variables and for the variable sex were tested. There was no significant improvement in the adjustment of the model. Note that the variable time since the last consultation showed a borderline association with the outcome (p value = 0.064). Regardless, the quality of the fit of the model was significantly better with the maintenance of this variable in the final model.

Conclusions

Tooth loss still represents a major concern among Brazilian adults. The contextual variables MHDl and public water fluoridation remained associated with the number of lost teeth among adults, even after controlling for important individual variables known to be associated with tooth loss. Generally, a higher number of missing teeth was associated with contextual factors and individual effects: lower MHDl, absence of the public water fluoridation, less education levels, low family income, and greater time elapsed since the last dental consultation. Thus, the findings of this study reinforce the impact of social inequality in tooth loss and require a reflection on the need for expansion and better organization of dental services in order to promote equity between individuals. Regular, lifelong access to such services can ensure that a greater number of teeth can be recovered, minimizing the need for dental extractions.

Declarations

Ethics approval and consent to participate

National Bioethics Commission of Brazil (CONEP) - 15.498/2009

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

Not applicable.

Authors' contributions

LL Roberto carried out the analyses, data interpretation and writing of the paper. MF Silveira contributed in the data analysis. AMB Paula and EF Ferreira worked in critical review of the paper. AMEBL Martins worked on the data interpretation and critical review of the paper. DS Haikal acted in the design of the study, contributed in the analysis, data interpretation and critical review of the paper.

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Tables

Table 1. Distribution of municipalities (n=177). Public Databases, 2010.

Variables	N	%
<i>STRUCTURAL DETERMINANTS</i>		
<i>Socioeconomic & political context</i>		
Geographical location of the municipality		
Capital	27	15.3
Interior	150	84.7
MHDI [§]	(SD) = 0.75 (0.06)	
Gini coefficient [§]	(SD) = 0.62 (0.12)	
% of the population with access to garbage collection [§] .	(SD) = 89.9 (13.19)	
% of the population with access to the bathroom and piped water [§] .	(SD) = 95.53 (7.39)	
Coverage of oral health teams ^{§*}	(SD) = 31.0 (27.55)	
Number of dentists per 1000 inhabitants [§]	(SD) = 0.90 (0.45)	
Public water fluoridation		
Yes	118	66.7
No	59	33.3

- numerical variables.

* n is less than 177 municipalities, data not available.

Table 2. Distribution of adults (n=8,837) relative to the mean tooth loss. SBBrasil Project, 2010.

Variables	n	%	Total tooth loss (SD)	p value
<i>INTERMEDIARY DETERMINANTS</i>				
<i>Socioeconomic position</i>				
Declared skin color				
White	3746	47.8	6.96 (7.78)	<0.001**
Yellow/Black/Brown/Indigenous	5091	52.2	8.82 (7.80)	
Education levels (in years) ^{§*}	(SD) = 8.76 (3.91)			<0.001 [#]
Family income (in US dollars)*				
Up to 142	259	2.5	12.04 (9.04)	<0.001†
143 to 284	939	10.0	10.17 (8.14)	
285 to 852	4335	53.7	8.98 (7.94)	
853 to 1420	1704	20.7	6.91 (7.27)	
1421 to 2556	904	9.4	5.15 (6.56)	
2557 to 5397	368	2.5	3.22 (5.44)	
Above 5397	130	1.2	2.85 (5.22)	
Location of the home				
Urban	8545	97.4	7.93 (7.78)	<0.001**
Rural	292	2.6	11.21 (9.09)	
<i>Behavioral & biological factors</i>				
Sex				
Female	5864	63.0	8.44 (8.13)	<0.001**
Male	2973	37.0	7.23 (7.19)	
Age (in years) [§]	(SD) = 39.37 (3.07)			<0.001 [#]
Perception of the need for treatment*				
Yes	6911	77.5	7.99 (7.22)	0.736**
No	1767	22.5	8.07 (9.79)	
Tooth pain*				
No	6573	71.7	7.88 (7.95)	0.088**
Yes	2218	28.3	8.18 (7.09)	
<i>Health services</i>				
Time since the last consultation*				
Less than 1 year	4446	49.3	6.99 (6.96)	<0.001**
Over 1 year	4293	50.7	9.06 (8.48)	
Reason for consultation*				

Review/prevention	1910	21.1	5.09 (6.28)	<0.001**
Oral health problems	6893	78.9	8.84 (8.03)	
Type of dental service*				
Public	5288	62.1	7.13 (7.60)	<0.001**
Not public	3524	37.9	9.38 (8.00)	
Satisfaction with dental services*				
Satisfied	7373	85.0	7.96 (7.92)	0.086**
Dissatisfied	1404	15.0	8.33 (7.33)	

- numerical variables.

* Number of respondents less than the sample size.

**Student's *t*-test

Pearson Correlation

†ANOVA

Table 3. Hierarchical multilevel negative binomial regression of the tooth loss. SBBrasil Project, 2010. (n=8,451)

VARIABLES	Model 1		Model 2		Model 3	
	MR (95% CI)	p value	MR (95% CI)	p value	MR (95% CI)	p value
STRUCTURAL DETERMINANTS						
<i>Socioeconomic & political context</i>						
MHDI	0.10 (0.04-0.23)	<0.001	0.26 (0.11-0.58)	0.001	0.29 (0.12-0.68)	0.005
Public water fluoridation						
Yes	Ref.	0.093	Ref.	0.005	Ref.	0.002
No	1.12 (0.98-1.28)		1.21 (1.06-1.38)		1.25 (1.08-1.44)	
INTERMEDIARY DETERMINANTS						
<i>Socioeconomic position</i>						
Declared skin color						
White			Ref.	0.004	Ref.	0.001
Yellow/Black/Brown/Indigenous			1.07 (1.02-1.12)		1.08 (1.03-1.13)	
Education levels (in years)			0.92 (0.92-0.93)	<0.001	0.93 (0.93-0.94)	<0.001
Family income (in US dollars)						
Up to 142			Ref.		Ref.	
143 to 284			1.01 (0.89-1.14)	0.918	0.93 (0.82-1.06)	0.292
285 to 852			0.99 (0.88-1.11)	0.847	0.90 (0.80-1.01)	0.089
853 to 1420			0.88 (0.77-0.99)	0.046	0.80 (0.71-0.91)	0.001
1421 to 2556			0.71 (0.62-0.81)	<0.001	0.66 (0.57-0.75)	<0.001
2557 to 5397			0.53 (0.45-0.62)	<0.001	0.48 (0.41-0.56)	<0.001
Above 5397			0.48 (0.38-0.60)	<0.001	0.43 (0.34-0.54)	<0.001
<i>Behavioral & biological factors</i>						
Sex						
Female					Ref.	<0.001
Male					0.84 (0.80-0.88)	
Age (in years)					1.09 (1.08-1.10)	<0.001
Tooth Pain						
Do not					Ref.	0.003
Yes					1.05 (1.03-1.08)	
<i>Health services</i>						
Time since the last consultation						
Less than 1 year					Ref.	0.064
Over 1 year					1.04 (1.00-1.08)	

Reason for consultation		
Review/prevention	Ref.	<0.001
Oral health problems	1.42 (1.35-1.50)	

MR: Mean ratio

Ref.: reference category.

Deviance of empty model=59956.396

Deviance of model 1=59911.356

Deviance of model 2=56949.154

Deviance of model 3=50313.208

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Figures

Figure 1

Adaptation of the conceptual model for inequities in oral health of Watt & Sheiham (2012).

Figure 2

Mean number of lost teeth in brazilian geopolitical macroregions. SBBrasil Project, 2010. (n=8837)