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Contextual and individual indicators associated with the presence of teeth in adults

Indicadores contextuais e individuais associados à presença de dentes em adultos

ABSTRACT

OBJECTIVE: The objective of this study was to analyze whether socioeconomic conditions and the period of availability of fluoridated water are associated with the number of teeth present.

METHODS: This cross-sectional study analyzed data from 1,720 adults between 20 and 59 years of age who resided in Florianópolis, SC, Southern Brazil, in 2009. The outcome investigated was the self-reported number of teeth present. The individual independent variables included gender, age range, skin color, number of years of schooling, and *per capita* household income. The duration of residence was used as a control variable. The contextual exposures included the period of availability of fluoridated water to the households and the socioeconomic variable for the census tracts, which was created from factor analysis of the tract's mean income, education level, and percentage of households with treated water. Multilevel logistic regression was performed and inter-level interactions were tested.

RESULTS: Residents in intermediate and poorer areas and those with fluoridated water available for less time exhibited the presence of fewer teeth compared with those in better socioeconomic conditions and who had fluoridated water available for a longer period (OR = 1.02; 95%CI 1.01;1.02). There was an association between the period of availability of fluoridated water, *per capita* household income and number of years of education. The proportion of individuals in the poorer and less-educated stratum, which had fewer teeth present, was higher in regions where fluoridated water had been available for less time.

CONCLUSIONS: Poor socioeconomic conditions and a shorter period of availability of fluoridated water were associated with the probability of having fewer teeth in adulthood. Public policies aimed at reducing socioeconomic inequalities and increasing access to health services such as fluoridation of the water supply may help to reduce tooth loss in the future.

DESCRIPTORS: Adult. Tooth Loss, epidemiology. Water Supply. Fluoridation. Socioeconomic Factors. Health Inequalities.

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RESUMO

OBJETIVO: Analisar se condições socioeconômicas contextuais e tempo de disponibilidade de água fluoretada estão associados ao número de dentes presentes.

MÉTODOS: Neste estudo transversal, foram analisados dados de 1.720 adultos entre 20 e 59 anos residentes em Florianópolis, SC, em 2009. O desfecho investigado foi o autorrelato do número de dentes presentes. As variáveis independentes individuais incluíram sexo, faixa etária, cor da pele, anos de estudo e renda *per capita* familiar. Como variável de controle, utilizou-se o tempo de residência. As exposições contextuais foram o tempo de disponibilidade da água fluoretada nos domicílios e a variável socioeconômica para os setores censitários, elaborada a partir da análise fatorial da renda média do setor, escolaridade média e percentual de domicílios com água tratada. Foi realizada regressão logística multinível e foram testadas interações interníveis.

RESULTADOS: Residentes nas áreas intermediárias e mais pobres e aqueles com menos tempo de disponibilidade de água fluoretada apresentaram menos dentes presentes comparados àqueles em melhor posição socioeconômica e com disponibilidade de água fluoretada por maior período (OR = 1,02; IC95% 1,01;1,02). Houve interação entre o tempo de disponibilidade de água fluoretada, renda *per capita* familiar e anos de estudo. A proporção de indivíduos do estrato mais pobre e menos escolarizado, que apresentou menos dentes presentes, foi maior nas regiões com menor tempo de disponibilidade de flúor na água.

CONCLUSÕES: As piores condições socioeconômicas contextuais associaram-se à chance de ter menos dentes presentes na idade adulta, da mesma forma que o menor tempo de fluoretação da água. Políticas públicas que visem a reduzir desigualdades socioeconômicas e ampliem o acesso à saúde, como a fluoretação da água de abastecimento podem, futuramente, contribuir para reduzir as perdas dentárias.

DESCRITORES: Adulto. Perda de Dente, epidemiologia. Abastecimento de Água. Fluoretação. Fatores Socioeconômicos. Desigualdades em Saúde.

INTRODUCTION

Tooth loss is a serious threat to oral and general health⁸ and primarily results from the progression of dental caries and periodontal disease. In a study on global disease burden in 2010, severe tooth loss (fewer than nine permanent teeth present) was considered the 36th most prevalent condition with an overall estimate of 2.3%.¹³

Tooth loss is a known marker of health inequalities⁵ and can be considered a public health problem because it impacts the quality of life by causing loss of functional capacity, pain, and suffering.¹⁹ Social gradients have been reported to be associated with inequalities in oral health, indicating the need to better understand how these inequalities manifest in society.¹⁵ Tooth loss is determined by several factors, including educational level, family income, oral hygiene habits, and food intake²² as well as the use of and access to dental care

services.^{21,25} Changes in lifestyle and social conditions are essential to reduce the inequalities caused by tooth loss among the socially disadvantaged population.⁷ Another important factor that needs to be addressed is the influence of fluoridated water on tooth loss in individuals and their time of residence in the same location, considering the limited number of studies on the availability of this resource. Because it results from caries, tooth loss may also be influenced by the availability of fluoridated drinking water.

Contextual factors related to the place of residence can also influence tooth loss. Socioeconomic conditions expose individuals to environments that are more or less favorable. Therefore, it is essential to understand the social stratifications and the exposures and vulnerabilities that are associated with these stratifications.^{15,20} Inequalities between social strata may cause

risk or protective factors to emerge, thereby affecting the population in a heterogeneous manner.²

Another contextual aspect to consider is water fluoridation. Even among adults, the effect of fluoride in drinking water as a measure to prevent dental caries may be similar among individuals born before or after this measure was implemented.²⁴ Therefore, because of its universal use, water fluoridation may help reduce inequalities in oral health,¹⁶ including tooth loss in adults.¹⁸

However, only few studies have addressed the contextual factors associated with tooth loss.^{1,6,10,17,23,26} This knowledge is important because the place of residence can influence tooth loss when some factors are considered, including the availability of healthcare services, behaviors resulting from the individuals' habits and way of life, and the interactions of these factors.

It is also important to understand the potential interaction between the individual and contextual levels in the development of dental caries for the complete assessment of the risk of dental caries by the analysis models.^{23,26}

To the best of our knowledge, no previous studies have addressed this topic which considers the conditions surrounding a municipality in Latin America, where income inequality levels are among the highest in the world,^a and particularly in Brazil, where profound social and economic inequalities are observed.

The objective of this study was to evaluate the effect of contextual socioeconomic conditions and the period of availability of fluoridated drinking water on the number of teeth present.

METHODS

A cross-sectional study was conducted. This study utilized a population-based cohort study as a baseline, which included adults aged 20-59 years of age residing in the city of Florianópolis, SC, Southern Brazil, in 2009. Data on general and oral health conditions were recorded, and variables such as weight, height, waist circumference, and blood pressure were measured.

Because various outcomes were investigated, the formula for calculating prevalence was used to define the sample size, considering outcome as an unknown prevalence (50.0%). The significance level adopted was 5%, with an expected sampling error of 3.5 percentage points. A relative value was used to compensate for expected losses (10.0%) and for the estimated design effect of 2 in the sample function cluster. The EpiInfo

6.04 program was used in the calculations, resulting in a final sample of 2,016 individuals.

Considering the prevalence of tooth loss in the study population (18.0%), the sample size was calculated *a posteriori* to test associations using the other parameters of the initial sample. A sample of 974 individuals was obtained. Considering the associations evaluated, the sample did not show high power for demographic variables, which were 29.4% for gender and 4.6% for skin color.

Because the study used cluster sampling, the first-stage units were census tracts. According to the 2000 census,^b 420 urban household tracts in Florianópolis were stratified in an ascending order based on the income of the family head. Of these, 60 tracts were systematically chosen, six for each income decile.

Households were used as second-stage units. Because the number of households evaluated dated back to the year 2000, these data needed to be updated. Therefore, the supervisors of this study visited the selected census tracts and counted the number of dwellings, which ranged from 61 to 810. To reduce the coefficient of variation among the tracts, these sectors were reorganized by mergings and subsequent divisions. The initial coefficient of variation was 55.0% (n = 60 sectors) and the final coefficient was 32.0% (n = 63 sectors). The 63 sectors comprised 16,755 households. For each of the 63 sectors, 18 households were systemically selected, thus totaling 1,134 households.

The questionnaire was tested by its preliminary application to a selected census tract that was not included in the sample. Each interviewer performed at least three interviews, totaling approximately 100 interviews; however, these interviews were not included in the analysis.

During the period of September 2009 - January 2010, data were collected through individual household interviews. Thirty-five interviewers were selected and trained. Losses included the households that were visited at least four times, in which the interviewer could not find the tenant (including one visit on the weekend and another at night) or if the tenant refused to participate. Thirty-five laptop computers were provided to conduct the interviews.

For quality control, approximately 15.0% (n = 248) of the participants were interviewed twice; the second interview was a simplified version of the questionnaire and was administered by the supervisors by telephone.

^a Lopez J, Perry G. Inequality in Latin America: determinants and consequences. Washington (DC): World Bank; 2008. (Policy Research Working Paper, 4504).

^b Instituto Brasileiro de Geografia e Estatística. Censo demográfico 2000. Rio de Janeiro (RJ); 2000 [cited 2015 Feb 12]. Available from: http://www.ibge.gov.br/home/estatistica/populacao/default_censo_2000.shtm

The outcome variable was the self-reported number of teeth present. Originally collected as the number of teeth present in each of the dental arches, the following options were offered to the respondents during the interviews: ≥ 10 natural teeth, < 10 natural teeth, and no natural teeth. To create the outcome variable, the number of teeth present from the original variables was grouped to produce a dichotomous outcome: ≥ 10 teeth present in both arches and < 10 teeth in at least one arch or edentulous individuals.

The exploratory and individual variables included demographic variables (gender, age, and skin color) and socioeconomic variables (*per capita* income, education level according to the number of years of study, and length of residence in the same location).

For the skin color variable, the classification from the Brazilian Institute of Geography and Statistics (IBGE) was used, with self-description of skin color as white, brown (*pardo*), black, yellow, and indigenous. With reference to yellow and indigenous skin colors, which together corresponded to only 0.46% of the sample size (four occurrences for each category), descriptive and multiple analyses were not presented in the results, although both categories were maintained in all the analyses.

The age range was divided into two categories: 20-39 years and 40-59 years.

The variable income was collected as a continuous variable and was divided by the number of residents in each household, resulting in the variable *per capita* family income, which was further categorized into tertiles. This variable was expressed in Brazilian currency (real, R\$)^c and was evaluated in tertiles (1st tertile: \leq R\$555.00; 2nd tertile: R\$555.01-R\$1,266.67; and 3rd tertile: \geq R\$1,266.68). The educational level was measured by the years of study completed and was classified according to the following categories: ≥ 12 years, 9-11 years, 5-8 years, and ≤ 4 years.

In addition, the length of residence in the same location in months was used as a control variable.

The contextual variable used to assess the impact of the socioeconomic aspects of the census tract on the health of individuals was the composite socioeconomic index.

For the first contextual variable, the following variables used in the 2000 census were utilized: mean income for those living in each census tract, average length of education, and percentage of households with access to treated water. Because of the complementary nature of the different measures of socioeconomic status, we used the factor analysis method to evaluate this variable, with polychoric processing and orthogonal rotation,

which allowed the construction of a single socioeconomic variable. The resulting factor loads were 0.89, 0.94, and 0.38 for income, education, and availability of treated water, respectively. Based on the results of the factor analysis, from which the extraction of only a single factor was satisfactory for the proposed multi-level analysis, the socioeconomic variable resulting from the sum of the three 2000 census variables (Eigenvalue 2.44, proportion of variance explained of 97.7%, Cronbach's alpha of 0.74) was created and was subsequently divided into tertiles. These tertiles represented three geographical areas: a richer area (better socioeconomic conditions), intermediate area, and poorer area (worse socioeconomic conditions).

For the second contextual variable, the period of availability of treated fluoridated water in the census tract was utilized. To create this variable, we consulted the company responsible for the distribution of treated water in the region (Santa Catarina Company for Water and Sanitation – CASAN) about the period of availability of treated water in each of the city's census tracts. These periods were included in the sample and analyzed under the following categories: beginning in 1982 and in 1996.

The statistical model used was multilevel logistic regression, which consisted of a generalized linear model in which the census tracts were included in the second level of analysis and the study participants were included in the first level. The multilevel analysis was conducted using Stata 11.0 software. All the analyses included the sample weight ($w = 1/f$; $f = f1 * f2$). In addition, the command *xtlogit* was used to perform the multilevel logistic regression, and the subcommand *re* was used to create random effects. Initially, the association between the contextual socioeconomic variable and the outcome of interest was tested. Subsequently, the period of availability of treated fluoridated water was included, and the length of residence in the same location was included as a control variable. The effect of the individual variables on the association of the contextual socioeconomic variable was measured by the sequential addition of the groups of demographic and socioeconomic variables and by the calculation of changes in the odds ratio (OR) and their 95% confidence intervals (CI). The terms of interaction between the contextual and individual variables were created to analyze the cross-level interaction. The cluster effect was measured using the intraclass correlation, which consisted of the proportion of variance explained for the second level.

The response rate was 85.3% (1,720 respondents). Losses were distributed homogeneously with respect to the income deciles of the census tracts. The proportion of individuals evaluated in each age group was

^c For the period of data collection, one US dollar was the equivalent of 1.70 reais.

similar to that of the last census, which was conducted in 2010. The mean age of the participants was 38 years (95%CI 37.5;38.6).

The study was approved by the Human Research Ethics Committee of the Universidade Federal de Santa Catarina (Protocol 351/08 of December 15, 2008). All study participants signed a free and informed consent form. Individuals who were diagnosed as hypertensive or who reported feeling any pain or discomfort were informed of a healthcare unit nearest their place of residence and were instructed to consult them for assistance.

RESULTS

Approximately 20.0% of the participants presented with < 10 teeth in at least one arc; 2.4% (95%CI 1.7;3.4) of the participants were edentulous.

Most of the participants were women who also showed higher prevalence for the outcome of interest when compared with that of men. Participants aged ≥ 40 years had nearly seven times the prevalence of having fewer teeth. A gradient was observed between the prevalence of having < 10 teeth in at least one arc or being edentulous and the individual and contextual socioeconomic variables. With respect to the availability of fluoride in the water supply, there was no significant difference in the prevalence of having < 10 teeth in at least one arc, considering the period that this variable was measured (Table 1).

The association between the socioeconomic contextual variable and the tooth loss or edentulous status remained statistically significant even after adjusting for other variables (Table 2). It was initially noted that the individuals in the poorer tertile were three times more likely to experience tooth loss, whereas those in the intermediate tertile were more than two times more likely when compared with the individuals in the richer tertile. The inclusion of the demographic variables in model 3 increased the magnitude of the association between the outcome of interest and the contextual socioeconomic index. The inclusion of the individual socioeconomic variables in model 4 reduced the magnitude of the association, although statistical significance was maintained. Individuals for whom fluoridated drinking was available for a short period showed little probability of tooth loss compared with those for whom fluoridated drinking water was available for 27 years. Among the variables evaluated, skin color was the only one that showed no statistical significance ($p = 0.513$); therefore, it was not included in the subsequent models.

Intraclass correlation, which indicates the contextual effect on tooth loss, decreased with model adjustment. For the socioeconomic contextual variable, the magnitude of association decreased by approximately 50.0%

after adjusting for the individual variables, whereas this magnitude decreased by 3% after adjusting for availability of fluoridated drinking water (Table 2).

The variable fluoridated water modified the effect of *per capita* household income (Figure 1) and educational level (Figure 2) on tooth loss. Among the poorer and less-educated population, the availability of fluoridated drinking water significantly decreased the rate of tooth loss or edentulousness, whereas this protective effect was not observed among those with better income and education.

DISCUSSION

Poorer contextual socioeconomic conditions and living in census tracts with a short period of availability of fluoridated water showed an association with tooth loss, even after adjusting for individual risk factors.

The results of this study are consistent with those found by Turrel et al²⁶ (2007) and Sanders et al²³ (2008), in which the effect of neighborhoods with better socioeconomic conditions reduced the proportion of tooth loss compared with those in intermediate and poor conditions. The socioeconomic characteristics of neighborhoods have been associated with tooth loss regardless of the population's socioeconomic status, particularly for residents of disadvantaged neighborhoods. According to Turrel,²⁶ the effect of poorer socioeconomic conditions persist after adjusting for educational level and income in each area. Thus, exposure of individuals to distinct socioeconomic conditions can either pose risks or benefits to their health status.²⁸ Through the differentiated access to goods and services, resources and social equipment, as well as social interaction, the socioeconomic environment involves risks and benefits to individuals that may affect their health status.¹⁴ Therefore, our environment is a combination of social, economic, structural, demographic, and geographic factors that affect the lives and health status of the inhabitants.²⁸

The contextual socioeconomic variable was associated with the outcome of interest in all models evaluated. However, the magnitude of this association decreased when individual socioeconomic variables were included. According to Listl¹² (2011), there is a socioeconomic gradient in dental health (worse oral conditions among the poorest), suggesting that this gradient is the result of the limited access to healthcare services. In the present study, some characteristics associated with the distribution of dental care services (public or private) may have affected the outcome of interest or the environment, which limited the access and consequent use of these services. A longitudinal study conducted in Denmark¹¹ showed that school-based dental care in childhood and regular care in adulthood contributed

Table 1. Descriptive statistics and prevalence of tooth loss among adults according to sociodemographic variables at the individual and contextual levels. Florianópolis, SC, Southern Brazil, 2009. (N = 1,720)

Variable	n	%	Fewer teeth present	
			%	95%CI
Individual Level				
Sex (N = 1,720)				
Masculine	761	44.2	17.2	14.7;20.1
Feminine	959	55.8	20.1	17.6;22.7
Age group (years) (N = 1,720)				
20 to 39	932	54.2	4.7	3.1;7.0
40 to 59	788	45.8	34.6	29.7;39.9
Skin color (N = 1,712)				
White	1,534	89.6	18.3	16.5;20.4
Brown (<i>pardo</i>)	99	5.8	25.2	17.7;34.6
Black	79	4.6	19.0	11.9;29.0
Years of education (N = 1,704)				
≥ 12	737	43.3	7.7	6.0;9.9
9 to 11	568	33.3	17.2	14.4;20.6
5 to 8	253	14.8	32.1	26.7;38.1
≤ 4	146	8.6	55.9	47.7;63.7
Household income <i>per capita</i> (N = 1,719)				
3 rd tertile	573	33.4	10.3	8.1;13.1
2 nd tertile	573	33.3	19.6	16.5;23.0
1 st tertile	573	33.3	26.6	23.2;30.4
<hr/>				
Length of residence in the same location in months	N	Mean	SD	
	1,720	164.7	158.9	
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Contextual level				
Period of availability of fluoridated water (years) (N = 1,720)				
27 (1982)	1,224	71.2	18.4	16.3;20.7
13 (1996)	496	28.8	19.8	16.5;23.5
Socioeconomic variable for the census tract (N = 1,720)				
Richer area	683	39.7	11.3	9.1;13.9
Intermediate area	469	27.3	19.7	16.3;23.5
Poorer area	568	33.0	27.2	23.7;31.0

to tooth maintenance, whereas individuals without regular care in adulthood were 10 times more likely to become edentulous. In the Brazilian context, the use of public healthcare services increased the probability of tooth loss by approximately 10.0%.³ In addition, the continued use of tooth extractions as a therapeutic measure contributed to tooth loss and edentulous status among older individuals.

The analysis of demographic variables indicated a higher probability of tooth loss among women,

corroborating the findings of other studies,^{10,11} and this result may be due to better oral care among women.³ The age group comprising individuals 40 years or older exhibited a higher probability of tooth loss or edentulousness compared with those aged between 20 and 39 years. Other studies involving Brazilian populations corroborated this finding.^{3,10} Because this health problem can aggravate during the life cycle, it is expected that tooth loss will increase over the years because of the presence of other oral diseases, including dental caries and periodontal disease.

Table 2. Multilevel logistic regression analysis of individual and contextual variables associated with tooth loss. Florianópolis, SC, Southern Brazil, 2009.

Variable	Model 1*		Model 2*		Model 3*		Model 4*	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Contextual								
Socioeconomic variable								
Richer area	1		1		1		1	
Intermediate area	2.13	2.05;2.21	2.13	2.05;2.22	2.26	2.17;2.35	1.68	1.61;1.75
Poorer area	3.00	2.89;3.10	3.00	2.89;3.11	3.65	3.52;3.79	1.56	1.50;1.62
Period of availability of fluoridated water (years)								
27			1		1		1	
13			0.99	0.99;1.00	1.01	1.00;1.01	1.02	1.01;1.02
Individual								
Gender								
Masculine					1		1	
Feminine					1.12	1.09;1.15	1.07	1.03;1.10
Age group (years)								
20 to 39					1		1	
40 to 59					11.21	10.82;11.61	11.50	11.08;11.94
Skin color								
White					1			
Brown (<i>pardo</i>)					1.15	1.10;1.21		
Black					0.89	0.83;0.95		
Years of education								
≥ 12							1	
9 to 11							2.25	2.16;2.34
5 to 8							4.22	4.03;4.42
≤ 4							5.66	5.36;5.97
Household income <i>per capita</i>								
3 rd tertile							1	
2 nd tertile							1.66	1.60;1.73
1 st tertile							2.34	2.24;2.44
2 nd level variance	0.31	0.29;0.33	0.31	0.29;0.33	0.25	0.22;0.27	0.21	0.18;0.25
ICC (%)	2.90	2.56;3.29	2.90	2.56;3.29	1.84	1.50;2.25	1.35	0.97;1.87

ICC: intraclass correlation coefficient; OR: odds ratio

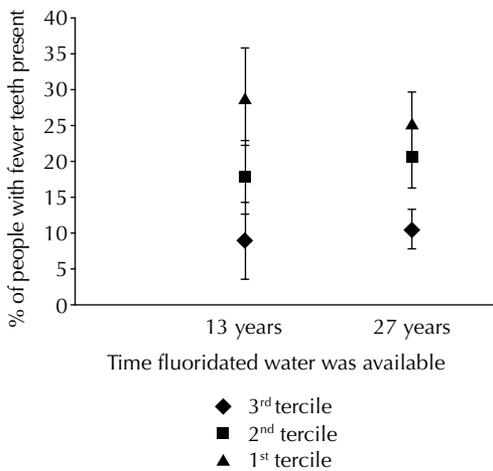
* $p > 0.001$ for all model variables, except for the period of availability of fluoridated water in model 2 ($p = 0.006$) and skin color in model 3 ($p = 0.513$).

All models were adjusted for the length of residence in the same location.

This study found an association between decreased availability of fluoridated drinking water and the probability of tooth loss, although the magnitude of this correlation was small. The strategy used to implement water fluoridation in the municipal context may have contributed to this result. In Florianópolis, most of the tracts (71.2%) have been supplied with fluoridated water for approximately 30 years. In the intra-municipal context, this measure was implemented in two distinct periods based on the geographical features of Florianópolis, water catchment sites, and treatment plants, and supplied privileged and poorer areas

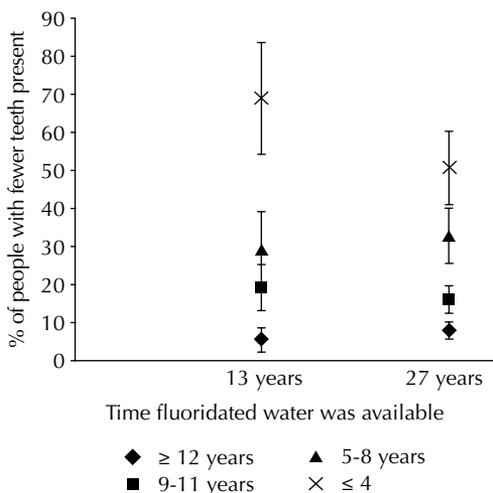
indiscriminately. Consequently, considering the mean income tertiles in each census tract, approximately 30.0% of the residents in the first tertile have had fluoridated water for 13 years, approximately 40.0% in the second tertile, and only 17.0% in the third tertile (data not shown).

Two studies have reported the effect of living in urban areas and in municipalities with better socioeconomic conditions on the retention of teeth in addition to the importance of water fluoridation in maintaining functional dentition,^{10,18} however, one study¹⁰ used only the



* Interaction adjusted by the other variables in model 4.

Figure 1. Interaction between period of availability of fluoridated water and household income *per capita* with tooth loss and edentulousness. Florianópolis, SC, Southern Brazil, 2009.



* Interaction adjusted by the other variables in model 4.

Figure 2. Interaction between period of availability of fluoridated water and years of education completed *per capita* with tooth loss and edentulousness. Florianópolis, SC, Southern Brazil, 2009.

exposure to fluoride water without considering the period of availability, whereas the other study¹⁸ did not present hierarchical analysis. Contextual factors can affect population groups differently. Therefore, the identification of possible interactions between contextual and individual factors is essential.⁹ The interactions between the period of availability of fluoridated water and the individual socioeconomic variables indicated a protective effect of fluoridation on tooth retention among individuals with lower *per*

capita household income and lower education levels. Water fluoridation is an extremely important measure for reducing dental caries. Considering that dental caries is the leading cause of tooth loss, reduction of caries may result in reduced tooth loss. Tooth loss can also be observed in younger populations, considering that the impact of fluoridated water is greater among poorer individuals. In Brazil, this particularly applies to the northeastern region, which has the worst socioeconomic conditions in the country.⁴

One of the limitations of the present study involves the use of the self-reported number of teeth. Although the measurement of tooth loss is recognized internationally,²⁷ no previous studies have validated this measure in Brazil. Another possible limitation is the time of exposure to contextual variables because it is not known if the contextual level is the same as the individual, which could constitute an ecological fallacy. In an attempt to decrease this possibility, the length of residence in the same location was used as a control variable.

The sample size representative of the adult population of Florianópolis as well as the high response rate (85.3%) and the homogeneous distribution of losses among the income deciles are strengths of this study.

The universal availability of fluoridated water seems to reduce tooth loss. However, other possible causative factors associated with this outcome, including access to and use of healthcare services, the therapeutic use of extractions in the public healthcare service, and other clinical measures adopted for tooth maintenance, need to be investigated. In addition, other social, economic, and cultural barriers should be considered.

Poorer socioeconomic contextual conditions were associated with the probability of tooth loss, and the period of availability of fluoridated water was inversely associated with the number of teeth in adulthood. These findings suggest that the implementation of public policies involving structural measures to reduce inequalities related to income and educational level and improved access to public health policies such as fluoridation of the public water supply can contribute to the reduction of tooth loss.

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REFERENCES

- Aida J, Hanibuchi T, Nakade M, Hirai H, Osaka K, Kondo K. The different effects of vertical social capital and horizontal social capital on dental status: a multilevel analysis. *Soc Sci Med*. 2009;69(4):512-8. DOI:10.1016/j.socscimed.2009.06.003
- Antunes JLF, Narvai PC. Dental health policies in Brazil and their impact on health inequalities. *Rev Saude Publica*. 2010;44(2):360-5. DOI:10.1590/S0034-89102010005000002
- Barbato PR, Nagano HCM, Zanchet FN, Boing AF, Peres MA. Perdas dentárias e fatores sociais, demográficos e de serviços associados em adultos brasileiros: uma análise dos dados do Estudo Epidemiológico Nacional (Projeto SB Brasil 2002-2003). *Cad Saude Publica*. 2007;23(8):1803-14. DOI:10.1590/S0102-311X2007000800007
- Barbato PR, Peres MA. Tooth loss and associated factors in adolescents: a Brazilian population-based oral health survey. *Rev Saude Publica*. 2009;43(1):13-25. DOI:10.1590/S0034-89102009000100003
- Bernabé E, Marcenes W. Income inequality and tooth loss in the United States. *J Dent Res*. 2011;90(6):724-9. DOI:10.1177/0022034511400081
- Celeste RK, Nadanovsky P, Ponce de Leon A, Fritzell J. The individual and contextual pathways between oral health and income inequality in Brazilian adolescents and adults. *Soc Sci Med*. 2009;69(10):1468-75. DOI:10.1016/j.socscimed.2009.08.005
- Chestnutt IG. Addressing oral health inequalities in the United Kingdom: the impact of devolution on population-based fluoride policy. *Br Dent J*. 2013;215(1):11-2. DOI:10.1038/sj.bdj.2013.626
- Holm-Pedersen P, Schultz-Larsen K, Christiansen N, Avlund K. Tooth loss and subsequent disability and mortality in old age. *J Am Geriatr Soc*. 2008;56(3):429-35. DOI:10.1111/j.1532-5415.2007.01602.x
- Kawachi I, Subramanian SV, Almeida-Filho N. A glossary for health inequalities. *J Epidemiol Community Health*. 2002;56(9):647-52. DOI:10.1136/jech.56.9.647
- Koltermann AP, Giordani JMA, Pattussi MP. The association between individual and contextual factors and functional dentition status among adults in Rio Grande do Sul State, Brazil: a multilevel study. *Cad Saude Publica*. 2011;27(1):173-82. DOI:10.1590/S0102-311X2011000100018
- Li KY, Wong MCM, Lam KF, Schwarz E. Age, period, and cohort analysis of regular dental care behavior and edentulism: a marginal approach. *BMC Oral Health*. 2011;11(9):1-14. DOI:10.1186/1472-6831-11-9
- Listl S. Income-related inequalities in dental service utilization by Europeans aged 50+. *J Dent Res*. 2011;90(6):717-23. DOI:10.1177/0022034511399907
- Marcenes W, Kassebaum NJ, Bernabé E, Flaxman A, Naghavi M, Lopez A, et al. Global burden of oral conditions in 1990-2010: a systematic analysis. *J Dent Res*. 2013;92(7):592-7. DOI:10.1177/0022034513490168
- Marmot M. The influence of income on health: views of an epidemiologist. *Health Aff (Millwood)*. 2002;21(2):31-46. DOI:10.1377/hlthaff.21.2.31
- Marmot M, Bell R. Social determinants and dental health. *Adv Dent Res*. 2011;23(2):201-6. DOI:10.1177/0022034511402079
- McGrady MG, Ellwood RP, Maguire A, Goodwin M, Boothman N, Pretty IA. The association between social deprivation and the prevalence and severity of dental caries and fluorosis in populations with and without water fluoridation. *BMC Public Health*. 2012;12(1):1122. DOI:10.1186/1471-2458-12-1122
- Moreira RS, Nico LS, Barrozo LV, Pereira JC. Tooth loss in Brazilian middle-aged adults: multilevel effects. *Acta Odontol Scand*. 2010;68(5):269-77. DOI:10.3109/00016357.2010.494617
- Neidell M, Herzog K, Glied S. The association between community water fluoridation and adult tooth loss. *Am J Public Health*. 2010;100(10):1980-5. DOI:10.2105/AJPH.2009.189555
- Petersen PE. World Health Organization global policy for improvement of oral health - World Health Assembly 2007. *Int Dent J*. 2008;58(3):115-21. DOI:10.1922/IDJ_1930Petersen07
- Sabbah W, Tsakos G, Chandola T, Sheiham A, Watt RG. Social gradients in oral and general health. *J Dent Res*. 2007;86(10):992-6. DOI:10.1177/154405910708601014
- Sanders AE, Spencer AJ, Slade GD. Evaluating the role of dental behaviour in oral health inequalities. *Community Dent Oral Epidemiol*. 2006;34(1):71-9. DOI:10.1111/j.1600-0528.2006.00261.x
- Sanders AE, Lim S, Sohn W. Resilience to urban poverty: theoretical and empirical considerations for population health. *Am J Public Health*. 2008;98(6):1101-6. DOI:10.2105/AJPH.2007.119495
- Sanders AE, Turrell G, Slade GD. Affluent neighborhoods reduce excess risk of tooth loss among the poor. *J Dent Res*. 2008;87(10):969-73. DOI:10.1177/154405910808701006
- Slade GD, Sanders AE, Do L, Roberts-Thomson K, Spencer AJ. Effects of fluoridated drinking water on dental caries in Australian adults. *J Dent Res*. 2013;92(4):376-82. DOI:10.1177/0022034513481190
- Thomson WM, Poulton R, Kruger E, Boyd D. Socio-economic and behavioural risk factors for tooth loss from age 18 to 26 among participants in the Dunedin Multidisciplinary Health and Development Study. *Caries Res*. 2000;34(5):361-6. DOI:10.1159/000016610
- Turrell G, Sanders AE, Slade GD, Spencer AJ, Marcenes W. The independent contribution of neighborhood disadvantage and individual-level socioeconomic position to self-reported oral health: a multilevel analysis. *Community Dent Oral Epidemiol*. 2007;35(3):195-206. DOI:10.1111/j.1600-0528.2006.00311.x

27. Unell L, Söderfeldt B, Halling A, Paulander J, Birkhed D. Oral disease, impairment, and illness: congruence between clinical and questionnaire findings. *Acta Odontol Scand*. 1997;55(2):127-32. DOI:10.3109/00016359709115404
28. Weden MM, Bird CE, Escarce JJ, Lurie N. Neighborhood archetypes for population health research: is there no place like home? *Health Place*. 2011;17(1):289-99. DOI:10.1016/j.healthplace.2010.11.002

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The authors declare no conflict of interest.

ERRATUM

No artigo: “Contextual and individual indicators associated with the presence of teeth in adults” publicado no periódico “Revista de Saúde Pública”, 2015;49:27, nas Tabela 1, Tabela 2 e na Figura 1.

Where it reads, table 1:

“sex” and “household income *per capita*”

It should read:

“gender” and “*per capita* household income”.

Where it reads, table 2:

“household income *per capita*”

It should read:

“*per capita* household income”

Where it reads, figure 1:

“household income *per capita*” and “tercile”

It should read:

“*per capita* household income” and “tertile”