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# Tooth loss in Brazil: analysis of the 2010 Brazilian Oral Health Survey

## ABSTRACT

**OBJECTIVE:** To estimate the mean number of missing teeth, lack of functional dentition and total tooth loss (edentulism) among adolescents, adults and the elderly in Brazil, comparing the results with those of 2003.

**METHODS:** Data from 5,445 adolescents aged 15-19, 9,779 adults aged 35-44 and 7,619 elderly individuals aged 65-74, participants in the Brazilian Oral Health Survey (SBBrasil) 2010, were analyzed. The mean missing teeth, proportion of lack of functional dentition (< 21 natural teeth) and proportion of edentulism (total tooth loss) were estimated for each age group, each state Capital and each macro region. Multivariable logistic regression (tooth loss) and Poisson (absence of functional dentition and edentulism) analyses were performed in order to identify socioeconomic factors and demographic characteristics associated with each outcome.

**RESULTS:** The prevalence of tooth loss among adolescents was 17.4% (38.9% in 2002-03) ranging from 8.1% among those earning higher income to almost 30% among those with less schooling. Among adolescents, females, those with black or brown skin and those with the lowest levels of income and schooling had a higher prevalence of tooth loss. Lack of functional dentition affected nearly ¼ of adults, it was higher among women, among those with black and brown skin and among those with the lowest levels of income and schooling. Mean missing teeth in adults decreased from 13.5 in 2002-03 to 7.4 in 2010. More than half of elderly is edentulous (similar to the 2002-03 findings); higher prevalence of edentulism was found among women and those with the lowest levels of income and schooling. Among adolescents the mean missing teeth ranged from 0.1 (in Curitiba, South Brazil and Vitória, Southeast Brazil) to 1.2 (in the North countryside). Among adults the lowest mean missing teeth was found in Vitória (4.2) and the highest in Rio Branco, North Brazil (13.6).

**CONCLUSIONS:** A remarkable reduction in tooth loss among adolescents and adults was identified between 2010 and 2003. Among the elderly, tooth loss figure remained the same. In spite of important achievements in tooth loss figures, social and regional inequalities persist.

**DESCRIPTORS: Tooth Loss, epidemiology. Socioeconomic Factors. Health Inequalities. Dental Health Surveys. Oral Health**

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## INTRODUCTION

Tooth loss is considered to be one of the principal oral health problems due to its high prevalence and the aesthetical, functional, psychological and social effects it brings with it.[3,9,26] However, in many cases tooth loss is avoidable. It reflects oral health problems accumulated throughout life, cultural aspects and the decision to extract a tooth as an orthodontic treatment option.[15,18] Epidemiological studies show that tooth loss constitutes a marker of social inequality in diverse societies; population groups at the bottom of the socio-economic hierarchy have higher rates of tooth loss than those situated at the top of the scale.[3,6,7,15,16]

In Brazil, the national oral health survey in 1986 revealed that, for adolescents (aged 15-19) the mean number of teeth lost was 1.9, representing 15.2% of the DMFT (decayed, missing and filled teeth) index. For adults aged 35-44, the rate was 14.9 (66.5%) and it was 23.4 (86%) of the index for individuals aged between 50 and 59. Regional disparities were present in all age groups, with the lowest percentages in the South and the highest in the North.[a] In the 2002-03 National Oral Health Survey, the mean number of teeth lost fell to 0.9 and 13.2 in adolescents and adults, respectively, and reached 25.8 in the elderly aged 65 to 74. The proportion of the "missing" component remained stable between the two studies: around 15% in adolescents and 65% in adults (aged 35-44 ) and more than 90% in the elderly. These observations show the magnitude and significance of tooth loss as a public health problem in this country.[b]

The measurement and presentation of the data in the studies on tooth loss varies according to the age group in question. In adolescents, it is preferable to measure the prevalence of loss instead of the number of teeth affected, as this health problem is relatively rare in this age group, even in Brazil.[4] In adults and the elderly, lack of functional dentition and edentulism have been proposed as ways of measuring tooth loss. Functional dentition is viewed as the minimum number of natural teeth which an individual needs in order to function adequately without the need for a prosthesis.[17] Individuals with fewer than 21 natural teeth may suffer problems chewing, restricting the food they can consume and their nutrient intake.[11,27] Edentulism is the loss of all natural teeth.[7]

The aim of this study was to analyze tooth loss based on estimates of the mean number of teeth lost, prevalence of lack of functional dentition and edentulism in Brazilians and compare these results with those of the 2003 survey. In addition, the association of these oral health problems with the participants' economic conditions and demographic characteristics was also investigated.

## METHODS

The database from the *Pesquisa Nacional de Saúde Bucal* (Brazilian Oral Health Survey) – (SBBrasil) 2010 was used. The sampling plan was made up of domains regarding the state capitals and municipalities in the interior. Each state capital and the Federal District was one domain and the municipalities in the interior of each macro-region of Brazil (North, Northeast, Central-West, Southeast and South) was another. There were 27 geographical domains (state capitals and the Federal District) and five from the interior of each macro-region, making 32 in total. Thirty municipalities in the interior of each region were randomly selected. The primary sampling units were: (a) municipality in the interior of the regions and (b) census tracts for each of the capitals. Individuals aged five, aged 12 and those in the 15 to 19-year olds age group, those +aged 35 to 44 and those aged 65 to 74 were interviewed and examined within their homes.[c] Detailed information on the sampling procedure can be obtained elsewhere.[25] This study used data from adolescents aged 15 to 19 (n = 5,888), adults aged 35 to 44 (n = 10,199) and elderly individuals between 65 and 74 (n = 8,000).

Data collection involved oral examinations and interviews. Tooth loss in adolescents was considered due to dental caries, whereas in adults and the elderly it was defined as any loss of natural teeth due to extraction, for any reason (codes 4 and 5 of the DMFT index).[30]

The number of teeth lost (component M in the DMFT index $\geq 1$), the prevalence of individuals without functional dentition (presence of < 21 natural teeth) and of edentulism (loss of all natural teeth) were estimated for adolescents, adults and the elderly for each macro-region and state capital.

Interviews within the home were carried out using a structured questionnaire with questions on sex, age, self-reported skin color, schooling and household income, which were considered to be the independent variables. Age was collected and analyzed in complete years; skin color followed the classification of the Brazilian Institute of Geography and Statistics – Instituto Brasileiro de Geografia e Estatística (white, brown-skinned, black, yellow and indigenous). Household income was collected in reais, considering

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[b] Ministério da Saúde (BR). Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Projeto SB Brasil 2003: condições de saúde bucal da população brasileira 2002-2003. Resultados principais. Brasília (DF); 2004.
[c] Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Coordenação Nacional de Saúde Bucal. SB2010. Pesquisa Nacional de Saúde Bucal. Resultados principais. Brasília (DF); 2011.

**Table 1.** Description of the sample and the prevalence of tooth loss according to socio-demographic variable for 15 to 19-year olds, 35 to 44-year-olds and 65 to 74-year-olds. SBBrasil 2010.

| Variable | Sample | | | | | | Tooth loss | | No functional dentition | | Edentulism | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 to 19 years old | | 35 to 44 years old | | 65 to 74 years old | | 15 to 19 years old | | 35 to 44 years old | | 65 to 74 years old | |
| | n | % | n | % | n | % | % (95%CI) | p | % (95%CI) | p | % (95%CI) | p |
| Sex (n = 22,843) | 5,445 | 100.0 | 9,779 | 100.0 | 7,619 | 100.0 | 17.4 (14.7;20.4) | 0.017 | 22.4 (19.9;25.2) | < 0.001 | 53.7 (49.8;57.6) | 0.043 |
| Male | 2,497 | 45.9 | 3,374 | 34.5 | 2,903 | 38.1 | 13.8 (10.4;18.1) | | 18.1 (15.1;21.4) | | 49.64 (45.10;54.19) | |
| Female | 2,948 | 54.1 | 6,405 | 65.5 | 4,716 | 61.9 | 20.7 (17.0;25.0) | | 21.4 (22.0;28.1) | | 56.16 (50.93;61.26) | |
| Skin color (n = 22,843) | 5,445 | 100.0 | 9,779 | 100.0 | 7,619 | 100.0 | 17.4 (14.7;20.4) | 0.039 | 22.4 (19.9;25.2) | 0.019 | 53.7 (49.8;57.6) | 0.662 |
| White | 2,203 | 40.5 | 4,137 | 42.3 | 3,577 | 46.9 | 14.5 (10.9;19.0) | | 20.0 (17.1;23.4) | | 52.5 (47.5;57.4) | |
| Brown skinned | 2,491 | 45.7 | 4,386 | 44.9 | 2,970 | 39.0 | 20.3 (16.9;24.1) | | 24.4 (20.6;28.6) | | 54.2 (48.0;60.3) | |
| Black | 598 | 11.0 | 1,020 | 10.4 | 879 | 11.5 | 20.1 (14.8;26.6) | | 27.4 (22.0;33.6) | | 55.8 (46.4;64.9) | |
| Yellow | 104 | 1.9 | 164 | 1.7 | 121 | 1.6 | 9.6 (4.1;21.1) | | 13.8 (8.5;21.6) | | 61.6 (43.8;76.7) | |
| Indigenous | 49 | 0.9 | 72 | 0.7 | 72 | 1.0 | 18.0 (4.8;48.6) | | 20.0 (9.5;37.3) | | 72.4 (40.8;90.9) | |
| Household income (n = 21,998) | 5,125 | 100.0 | 9,535 | 100.0 | 7,338 | 100.0 | 17.3 (14.6;20.4) | 0.018 | 22.5 (20.0;25.3) | < 0.001 | 53.7 (49.6;57.7) | < 0.001 |
| Over R$ 4,500.00 | 246 | 4.8 | 519 | 5.4 | 461 | 6.3 | 8.1 (2.5;23.7) | | 7.0 (3.2;14.5) | | 10.2 (5.6;17.9) | |
| R$ 4,500.00-R$ 1,501.00 | 1,363 | 26.6 | 2,813 | 29.5 | 1,999 | 27.2 | 11.9 (7.2;19.2) | | 15.1 (11.9;19.0) | | 49.8 (43.4;56.1) | |
| R$ 1,500.00-R$ 501.00 | 2,650 | 51.7 | 4,783 | 50.2 | 4,029 | 54.9 | 18.9 (15.7;22.6) | | 25.3 (22.0;28.8) | | 57.4 (52.7;62.0) | |
| Below R$ 500.00 | 866 | 16.9 | 1,420 | 14.9 | 849 | 11.6 | 24.3 (19.0;30.4) | | 33.0 (28.1;38.3) | | 58.1 (46.2;69.1) | |
| Years of schooling (n = 22,543) | 5,429 | 100.0 | 9,693 | 100.0 | 7,421 | 100.0 | 17.3 (14.6;20.4) | < 0.001 | 22.4 (19.9;25.1) | < 0.001 | 53.6 (49.7;57.4) | < 0.001 |
| 12 or more | 761 | 14.0 | 2,297 | 23.7 | 738 | 9.9 | 13.3 (8.3;20.7) | | 7.7 (5.2;11.1) | | 21.8 (13.0;34.2) | |
| 9 to 11 | 2,643 | 48.7 | 3,025 | 31.2 | 870 | 11.7 | 13.8 (10.6;17.6) | | 16.9 (13.2;21.2) | | 37.0 (28.2;46.7) | |
| 5 to 8 | 1,821 | 33.5 | 2,718 | 28.0 | 1,568 | 21.2 | 23.8 (19.6;28.5) | | 26.1 (22.2;30.5) | | 54.1 (47.1;60.8) | |
| 4 or fewer | 204 | 3.8 | 1,653 | 17.1 | 4,245 | 57.2 | 29.6 (19.0;43.0) | | 40.2 (35.3;45.3) | | 59.4 (54.1;64.4) | |

the total income of all members of the household in the month prior to the interview and categorized into the following groups (below R$ 500.00; R$ 501.00 to R$ 1,500.00; R$ 1,500.00 to R$ 4,500.00; over R$ 4,500.00). The participants' schooling was investigated according to the number of years successfully passed in the education system and categorized as up to four years, between five and eight years, between nine and 11 years and 12 or more years.

All oral examinations were carried out within the participants' homes. The field work trams were composed of an examiner (a dental surgeon) and a note taker, who had been trained in 32-hour regional workshops. The state capitals had ten field work teams and the municipalities in the interior between two and six, depending on the population size. In each of the workshops, up to ten teams took part at the same time; however, in the classes focusing on carrying out the oral examinations, the teams were divided into two groups – each with an instructor. The calibration procedures were planned so as to anticipate (simulate) the conditions which the examiners would encounter, especially with regards to the conditions in question and the different population groups. The calibration technique adopted was that of consensus,[14] calculating concordance between each examiner and the results obtained by group consensus. The reference was the model proposed by the World Health Organization (WHO)[29] and the weighted kappa coefficient was calculated for each examiner, age group and oral health problem, with the acceptable limit being 0.65.

The mean number of teeth lost and the respective 95% confidence intervals (95%CI) for each domain (state capital and the interior of each of the five macro-regions) in each age group were estimated. Next, the prevalence and the confidence interval were estimated for each outcome – loss of at least one tooth (no/yes), lack of functional dentition (no/yes) and edentulism (no/yes) – for adolescents, adults and the elderly, respectively. Finally, multi-level logistic regression (tooth loss) and Poisson regression (lack of functional dentition and edentulism) analyses were carried out to identify socioeconomic and demographic factors associated with each outcome. Logistic regression was used for tooth loss in adolescents, an outcome with prevalence lower than 20%, and Poisson regression for functional dentition and edentulism, outcomes with prevalence higher than 20%. Unadjusted analysis was carried out first for each outcome, with a p value of $\leq 0.20$ being the criterion for inclusion in the multivariable models. The inclusion of explanatory variables in the adjusted models was ordered by group, first the demographic variables (sex and skin color), followed by the socioeconomic variables (household income and years of schooling).

All of the analyses were carried out using STATA 11.0 (2009), taking into account the complex sampling plan and the sampling weights.

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

There were 5,445 adolescents aged 15-19, 9,779 adults aged 35 to 44 and 7,619 elderly individuals aged between 65 and 74 investigated in the study, indicating sampling losses of 7.6%, 4.2% and 4.8% respectively. Overall prevalence of tooth loss in adolescents was 17.4%, varying between 8.1% in those on higher incomes to almost 30% among those who had fewer than four years of schooling. Adolescents, women, those with black and brown skin and those with lower levels of schooling and income had the highest prevalence of tooth loss. The proportion of adolescents aged 18 years who had not lost any teeth was 81.2% (95%CI 75.1;86.1). Lack of functional dentition occurred in approximately one-quarter of adults, with a higher prevalence in women, those with black and brown skin and those with lower levels of schooling and income. The highest prevalence of lack of functional dentition in adults occurred among those who had fewer than four years of schooling (40.2%) and the lowest among those participants with household income above R$ 4,500.00 per month (7%). Edentulism was common in the elderly (53.7%); higher among women, those with lower levels of schooling and income and did not vary according to skin color. Almost 60% of the elderly with the lowest levels of income and schooling suffered from edentulism, whereas only 10% of the elderly with household income above R$ 4,500.00 per month suffered from it (Table 1).

Table 2 shows that mean tooth loss in adolescents was less than half a tooth for the country overall, varying form 0.1 in Curitiba and Vitória to 1.2 in the interior of the North. For adults, the mean for Brazil was 7.4 teeth lost, with the lowest mean in Vitória (4.2) and the highest in Rio Branco (13.6). The mean number of teeth lost in the elderly was almost 26.0, with the lowest mean being in Porto Alegre (18.7) and the highest in the interior of the Northeast (27.3).

Tooth loss affected 17.4% of Brazilian adolescents, with statistically higher proportions in Rio Branco, Recife, Boa Vista, Porto Velho and the interior of the North and lower in Vitória (Figure 1). Among adults, 22.4% had fewer than 21 natural teeth. Vitória, Porto Alegre, Florianópolis and Belo Horizonte had the lowest rates of prevalence, whereas the interior of

**Table 2.** Means (95%CI) and medians of the number of teeth lost for 15 to 19-year-olds, 35 to 44-year-olds and 65 to 74-year-olds according to domain (state capitals and the interior). SBBrasil 2010.

| Domain | Teeth lost | | | | | |
|---|---|---|---|---|---|---|
| | 15-19 years old | | 35-44 years old | | 65-74 years old | |
| | Mean (95%CI) | Median | Mean (95%CI) | Median | Mean (95%CI) | Median |
| Porto Velho | 0.8 (0.6;1.0) | 0 | 10.7 (9.4;12.0) | 10 | 26.8 (25.3;28.2) | 32 |
| Rio Branco | 0.5 (0.4;0.7) | 0 | 13.6 (11.8;15.4) | 12 | 27.2 (25.5;29.0) | 32 |
| Manaus | 0.6 (0.2;1.1) | 0 | 11.0 (9.9;12.2) | 9 | 26.2 (25.0;27.3) | 28 |
| Boa Vista | 0.8 (0.5;1.0) | 0 | 9.7 (8.4;11.1) | 8 | 26.3 (24.6;27.9) | 32 |
| Belém | 0.6 (0.4;0.8) | 0 | 9.0 (8.0;10.1) | 7 | 25.5 (24.1;26.9) | 26 |
| Macapá | 0.6 (0.2;1.0) | 0 | 7.0 (5.6;8.4) | 6 | 24.2 (22.3;26.0) | 27 |
| Palmas | 0.5 (0.2;0.8) | 0 | 8.8 (7.8;9.8) | 7 | 26.5 (25.3;27.7) | 32 |
| São Luís | 0.2 (0.1;0.4) | 0 | 6.0 (4.4;7.7) | 3 | 24.1 (22.1;26.2) | 30 |
| Teresina | 0.3 (0.1;0.5) | 0 | 7.5 (6.7;8.6) | 5 | 25.8 (24.4;27.2) | 32 |
| Fortaleza | 0.2 (0.1;0.3) | 0 | 7.9 (6.6;9.1) | 6 | 24.9 (22.8;26.9) | 29 |
| Natal | 0.7 (0.0;1.5) | 0 | 9.4 (7.7;11.0) | 7 | 24.3 (22.7;25.9) | 27 |
| João Pessoa | 0.6 (0.2;1.0) | 0 | 8.5 (7.3;9.7) | 7 | 24.3 (22.3;26.4) | 29 |
| Recife | 0.7 (0.3;1.1) | 0 | 9.1 (7.2;10.9) | 6 | 22.9 (20.7;25.2) | 26 |
| Maceió | 0.3 (0.2;0.4) | 0 | 8.0 (6.8;9.2) | 7 | 22.2 (19.6;24.8) | 24 |
| Aracaju | 0.3 (0.1;0.4) | 0 | 9.0 (8.1;9.9) | 8 | 21.2 (19.3;23.2) | 23 |
| Salvador | 0.2 (0.1;0.3) | 0 | 6.4 (5.3;7.6) | 5 | 23.4 (22.0;24.7) | 26 |
| Belo Horizonte | 0.2 (0.1;0.3) | 0 | 5.0 (4.2;5.9) | 3 | 24.1 (21.9;26.2) | 30 |
| Vitória | 0.1 (0.0;0.2) | 0 | 4.2 (2.7;5.8) | 2 | 19.9 (17.1;22.8) | 23 |
| Rio de Janeiro | 0.3 (0.1;0.5) | 0 | 7.7 (6.5;8.9) | 5 | 26.0 (24.2;27.9) | 32 |
| São Paulo | 0.4 (0.2;0.6) | 0 | 7.0 (5.8;8.1) | 5 | 22.8 (21.4;24.3) | 26 |
| Curitiba | 0.1 (0.0;0.2) | 0 | 6.1 (4.9;7.4) | 4 | 23.0 (20.8;25.1) | 26 |
| Florianópolis | 0.2 (0.1;0.3) | 0 | 5.1 (3.6;6.6) | 2 | 22.2 (20.5;23.9) | 26 |
| Porto Alegre | 0.3 (0.2;0.4) | 0 | 4.3 (3.4;5.1) | 3 | 18.7 (16.1;21.3) | 20 |
| Campo Grande | 0.2 (0.1;0.3) | 0 | 7.4 (6.5;8.3) | 4 | 23.1 (21.2;25.0) | 27 |
| Cuiabá | 0.3 (0.1;0.5) | 0 | 7.5 (6.1;8.9) | 5 | 25.6 (23.6;27.6) | 32 |
| Goiânia | 0.2 (0.1;0.3) | 0 | 7.1 (5.8;8.4) | 5 | 26.6 (24.9;28.3) | 32 |
| Federal District | 0.2 (0.1;0.3) | 0 | 7.0 (5.7;8.3) | 5 | 23.2 (20.6;25.8) | 27 |
| Interior - North | 1.2 (0.9;1.4) | 0 | 11.3 (10.0;12.6) | 10 | 27.4 (26.5;28.3) | 32 |
| Interior - Northeast | 0.8 (0.4;1.2) | 0 | 11.3 (9.4;13.1) | 9 | 27.3 (26.3;28.3) | 32 |
| Interior - Southeast | 0.3 (0.1;0.5) | 0 | 6.5 (5.4;7.6) | 5 | 25.8 (24.2;27.4) | 32 |
| Interior - South | 0.2 (0.1;0.3) | 0 | 8.5 (6.9;10.1) | 5 | 25.7 (23.7;27.7) | 32 |
| Interior - Central-West | 0.4 (0.3;0.6) | 0 | 9.0 (7.1;10.8) | 6 | 26.2 (24.5;27.9) | 32 |
| Brasil | 0.4 (0.3;0.5) | 0 | 7.4 (6.9;8.0) | 6 | 25.4 (24.6;26.1) | 29 |

the Northeast, Manaus, Porto Velho, the interior of the North and Rio Branco had rates of prevalence above the national average (Figure 2). More than half of elderly individuals in Brazil (53.7%) were edentulous. Porto Alegre, Aracaju, Salvador, Vitória, Belém, Florianópolis and Macapá had rates below the national average, whereas in the interior of the Northeast and Rio Branco are where the highest rates were found (Figure 3).

Among adolescents, women, those with less schooling and the poorest had, respectively, a 59%, 124% and 184% higher chance of tooth loss than men, those with fewer than four years of schooling and those with a household income above R$ 4,500.00 (Table 3). In adults, sociodemographic factors associated with lack of functional dentition were the same as those for adolescents and were of similar magnitude, although the prevalence of lack of functional dentition among those with fewer than four years of schooling was almost five times higher than among those with 12 or more years of schooling (Table 4). Among the elderly, only income and schooling were associated

**Table 3.** Multivariate logistic regression of the association between tooth loss in adolescents (15 to 19 years old) and sociodemographic variables. SBBrasil 2010.

| Variable | Unadjusted | | Adjusted | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Model 1 | | Model 2 | | Model 3 | |
| | OR (95%CI) | p | OR (95%CI) | p | OR (95%CI) | p | OR (95%CI) | p |
| Sex | | 0.018 | | 0.018 | | 0.055 | | 0.037 |
| Male | 1 | | 1 | | 1 | | 1 | |
| Female | 1.63 (1.09;2.45) | | 1.63 (1.08;2.44) | | 1.51 (0.99;2.30) | | 1.59 (1.03;2.43) | |
| Skin color | | 0.103 | | 0.125 | | | | |
| White | 1 | | 1 | | | | | |
| Brown skinned | 1.50 (1.07;2.12) | | 1.49 (1.07;2.07) | | | | | |
| Black | 1.48 (0.94;2.33) | | 1.47 (0.94;2.31) | | | | | |
| Yellow | 0.63 (0.25;1.58) | | 0.60 (0.23;1.57) | | | | | |
| Indigenous | 1.29 (0.27;6.22) | | 1.21 (0.23;6.40) | | | | | |
| Household income | | 0.004 | | | | 0.007 | | 0.033 |
| Over R$ 4,500.00 | 1 | | | | 1 | | 1 | |
| R$ 4,500.00-R$ 1,501.00 | 1.53 (0.44;5.35) | | | | 1.48 (0.43;5.07) | | 1.61 (0.45;5.76) | |
| R$ 1,500.00-R$ 501.00 | 2.63 (0.76;9.11) | | | | 2.42 (0.72;8.19) | | 2.42 (0.68;8.56) | |
| Below R$ 500.00 | 3.62 (1.01;13.01) | | | | 3.33 (0.94;11.79) | | 2.84 (0.78;10.41) | |
| Years of schooling | | < 0.001 | | | | | | < 0.001 |
| 12 or more | 1 | | | | | | 1 | |
| 9 to 11 | 1.04 (0.58;1.86) | | | | | | 1.00 (0.53;1.86) | |
| 5 to 8 | 2.03 (1.15;3.57) | | | | | | 1.84 (1.01;3.34) | |
| 4 or fewer | 2.74 (1.33;5.64) | | | | | | 2.24 (1.05;4.80) | |

Model 1: Sex and skin color; Model 2: Household income adjusted for sex (skin color excluded from the model – $p > 0.20$); Model 3: Years of schooling adjusted for income and sex. OR: Odds Ratio.

with edentulism. As income decreased, the prevalence of edentulism increased, creating a gradient. Among the elderly on the lowest level of income, edentulism was almost four times more prevalent than among those on the highest level of income, whereas edentulism is twice as prevalent among those with the least amount of schooling compared to those with the most (Table 5).

## DISCUSSION

When comparing the 2010 and 2003 nationwide studies carried out by the Ministério da Saúde, significant decreases in rates of tooth loss were recorded in adolescents and adults, while edentulism in the elderly remained stable. This is the first nationwide study which shows decreases in tooth loss among adults. In adolescents, the mean number of teeth lost fell by more than half, from 0.96 to 0.40; the prevalence of having lost at least one tooth dropped from 38.9% to 17.4% and the proportion of 18-year-olds who had not lost any teeth was above 80%, approaching the 85% proposed by the WHO as a goal for the year 2000.[12] The mean number of teeth lost for adults fell from 13.5 to 7.4. Edentulism in the elderly remained around 54% in both studies.[b,c]

Despite advances, regional and social inequalities remain. In adolescents, the magnitude of the association between tooth loss in females compared with males and between the highest and lowest income groups increased between 2003 and 2010 (prevalence ration from 1.15 to 1.59 and from 1.37 to 3.62, respectively). This was similar for adults, suggesting that the decrease in tooth loss has been accompanied by an increase in inequality. Antunes et al[2] identified a similar pattern for dental caries in school children in the state of São Paulo, using the Gini index as a measure of inequality. Peres et al[22,23] identified unequal distribution of fluoridation of tap water in municipalities in Santa Catarina and in Brazil, highlighting the "inverse law of equality"[28] as a hypothesis to explain these findings. According to this "law", populations with better social conditions, living in municipalities in more affluent regions tend to be the first to benefit from preventative programs and activities in health care, including those carried

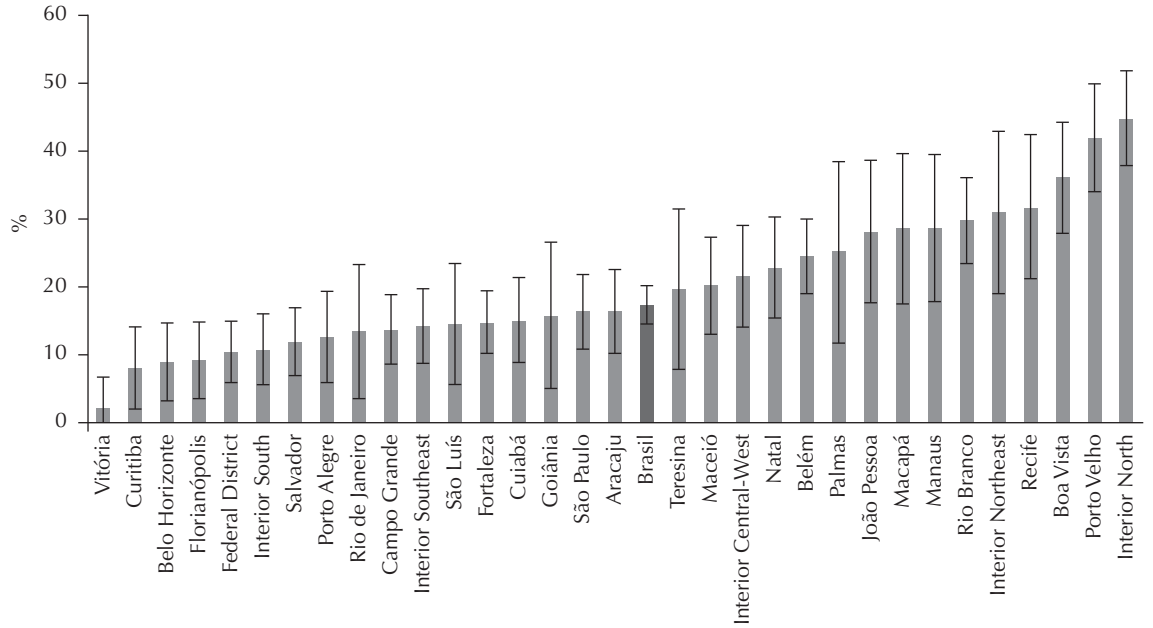


**Figure 1**. Prevalence of teeth lost in individuals aged 15 to 19, according to domain (state capitals and interior). SBBrasil 2010.

out almost exclusively by the state, such as the national immunization program or the national program to fluoridate water supplies.

The decreased tooth loss in adolescents and adults observed over the last ten years indicates, possibly, a combination of the cohort effect, improvements in socioeconomic conditions, especially in education,[16] and in the health care system with the fluoridation of tap water and widespread use of fluoridated toothpastes. In the 1980s and 90s these two measures achieved broad coverage of the population and largely explain the reduction in the prevalence of dental caries, the principal cause of tooth loss, in Brazil. During the 1980s and 90s, the adolescents and adults examined in 2010 were exposed to these measures; the elderly examined in 2010 did not benefit from these effects during their own childhood and

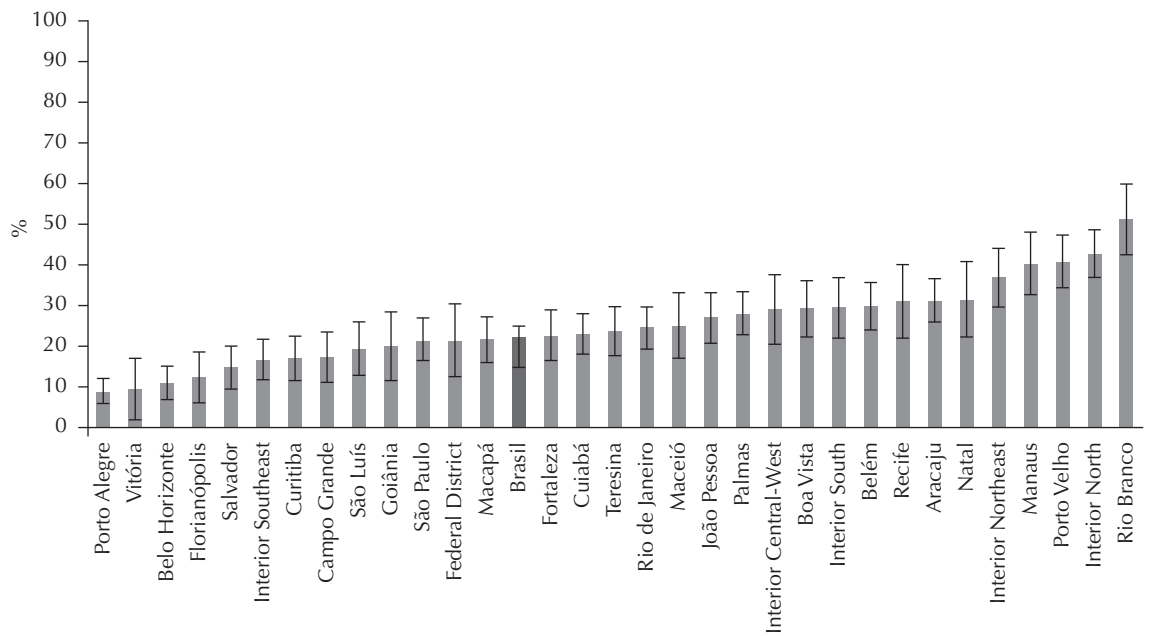


**Figure 2.** Prevalence of individuals with no functional dentition (< 21 natural teeth) in individuals aged 35 to 44 according to domain (state capitals and interior). SBBrasil 2010.

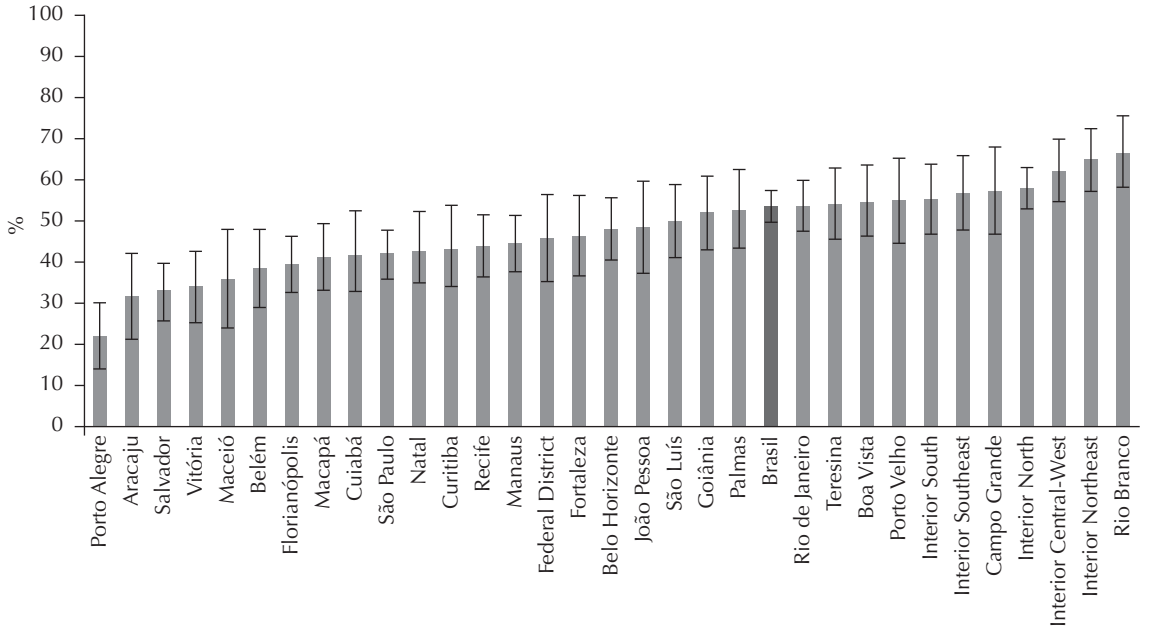


**Figure 3.** Proportion of individuals aged 65 to 74 with edentulism, according to domain (state capitals and interior). SBBrasil 2010.

**Table 4.** Multivariate Poisson regression analyses of the association between functional dentition in adults (35 to 44) and sociodemographic variables. SBBrasil 2010.

| Variable | Unadjusted | | Adjusted | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Model 1 | | Model 2 | | Model 3 | |
| | PR (95%CI) | p | PR (95%CI) | 95%CI | PR (95%CI) | p | PR (95%CI) | p |
| Sex | | < 0.001 | | < 0.001 | | < 0.001 | | < 0.001 |
| Male | 1 | | 1 | | 1 | | 1 | |
| Female | 1.38 (1.17;1.62) | | 1.39 (1.18;1.63) | | 1.38 (1.16;1.63) | | 1.53 (1.30;1.80) | |
| Skin color | | 0.023 | | 0.018 | | 0.487 | | |
| White | 1 | | 1 | | 1 | | | |
| Brown skinned | 1.22 (1.01;1.46) | | 1.22 (1.02;1.46) | | 1.07 (0.90;1.27) | | | |
| Black | 1.37 (1.07;1.76) | | 1.38 (1.08;1.78) | | 1.16 (0.90;1.50) | | | |
| Yellow | 0.69 (0.41;1.14) | | 0.68 (0.42;1.11) | | 0.61 (0.35;1.06) | | | |
| Indigenous | 1.00 (0.50;2.01) | | 1.02 (0.50;2.08) | | 0.86 (0.42;1.78) | | | |
| Household income | | < 0.001 | | | | < 0.001 | | 0.016 |
| Over R$ 4,500.00 | 1 | | | | 1 | | 1 | |
| R$ 4,500.00-R$ 1,501.00 | 2.17 (1.04;4.52) | | | | 2.12 (1.03;4.35) | | 1.53 (0.80;2.97) | |
| R$ 1,500.00-R$ 501.00 | 3.63 (1.69;7.80) | | | | 3.52 (1.67;7.40) | | 1.83 (0.93;3.62) | |
| Below R$ 500.00 | 4.74 (2.20;10.17) | | | | 4.50 (2.14;9.49) | | 1.99 (1.01;3.93) | |
| Years of schooling | | < 0.001 | | | | | | < 0.001 |
| 12 or more | 1 | | | | | | 1 | |
| 9 to 11 | 2.20 (1.40;3.45) | | | | | | 2.00 (1.25;3.20) | |
| 5 to 8 | 3.40 (2.33;4.95) | | | | | | 3.17 (2.12;4.73) | |
| 4 or fewer | 5.23 (3.66; 7.47) | | | | | | 4.71 (3.17;7.00) | |

Model 1: Sex and skin color; Model 2: Household income adjusted for sex and skin color; Model 3: Years of schooling adjusted for income and sex (skin color excluded from the model – p > 0.20). PR: Prevalence ratio.

**Table 5.** Multivariate Poisson regression analyses of the association between edentulism in the elderly (65 to 74) and sociodemographic variables. SBBrasil 2010.

| Variable | Unadjusted | | Adjusted | | | |
|---|---|---|---|---|---|---|
| | | | Model 1 | | Model 2 | |
| | RP (IC95%) | p | PR(95%CI) | p | PR(95%CI) | p |
| Sex | | 0.041 | | 0.067 | | |
| Male | 1 | | 1 | | | |
| Female | 1.13 (1.00;1.27) | | 1.10 (0.97;1.25) | | | |
| Skin color | | 0.273 | | | | |
| White | 1 | | | | | |
| Brown skinned | 1.03 (0.90;1.18) | | | | | |
| Black | 1.06 (0.88;1.29) | | | | | |
| Yellow | 1.17 (0.88;1.55) | | | | | |
| Indigenous | 1.38 (0.91;2.08) | | | | | |
| Household income | | < 0.001 | | < 0.001 | | 0.036 |
| Over R$ 4,500.00 | 1 | | 1 | | 1 | |
| R$ 4,500.00-R$ 1,501.00 | 4.86 (2.72;8.68) | | 4.76 (2.66;8.52) | | 3.66 (1.99;6.76) | |
| R$ 1,500.00-R$ 501.00 | 5.60 (3.13;10.02) | | 5.50 (3.07;9.85) | | 3.90 (2.09;7.27) | |
| Below R$ 500.00 | 5.67 (3.10;10.39) | | 5.60 (3.06;10.24) | | 3.92 (2.05;7.51) | |
| Years of schooling | | < 0.001 | | | | < 0.001 |
| 12 or more | 1 | | | | 1 | |
| 9 to 11 | 1.70 (0.99;2.91) | | | | 1.35 (0.79;2.29) | |
| 5 to 8 | 2.48 (1.53;4.02) | | | | 1.85 (1.15;2.98) | |
| 4 or fewer | 2.73 (1.65;4.50) | | | | 2.02 (1.24;3.29) | |

Model 1: Sex and skin color; Model 2: Household income and schooling adjusted for sex (skin color excluded from the model – p > 0.20). PR: Prevalence ratio.

adolescence. It is expected that decreased edentulism in those aged 65-74 as a cohort effect will only be identified in epidemiological studies in the 2050s.

Among the elderly aged over 65 in Brazil, the prevalence of edentulism is still among the highest in the world, behind Turkey where the rate is 67% (2007) and Portugal, 70% (2000). At the other end of the scale, the USA, with 24% (1999 - 2002) and Australia, 20% (2004-06), Norway (2008) and France (2000), both with 16%, have the lowest prevalence of tooth loss, when nationwide studies carried out after the year 2000 are considered.[5]

Regional inequalities in tooth loss are striking, especially among youths and adults. In general, those living in the state capitals and the interior of the North and Northeast have a higher prevalence of tooth loss than those living in the South and Southeast. This situation reflects different coverage of population measures recognized to prevent tooth loss, such as fluoridated water supplies, concentrated in the South and Southeast of the country.[22] Moreover, use of and access to oral health care services are lower in the poorer areas. According to data from the *Sistema de Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico* (Telephone Monitoring System for Risk and Protection Factors for Chronic Diseases - VIGITEL) 2009, the prevalence of lack of access to orthodontic services (needing but not receiving care) varied considerably between state capitals. In Manaus, Macapá, Belém and Rio Branco approximately one in four did not receive treatment when they needed it. This value is around five times higher than that reported by residents in Curitiba.[24] Data from the SBBrasil 2010 show that more than 80% of the population in all age groups had visited a dentist, with the use of private services predominantly in the Southeast and South among adults and the elderly.[c]

Social, economic and demographic characteristics are consistently associated with tooth loss. The higher prevalence in women, both for adolescents and for adults, had already been observed in studies before the 2000s. However, results from 2010 show higher prevalence ratios of tooth loss between sexes, indicating increased inequality between men and women. This finding, although consistent with other investigations,[3,4,21] is not easy to interpret. Higher use of orthodontic services by women may, depending on the type of practice, result in over-treatment. Types of orthodontic services based on pay-per-procedure, normally invasive, may result in loss

of dental tissue in each consultation which, cumulatively, may accelerate tooth loss.[10] Data from VIGITEL 2009 show that more than 60% of the population in the state capitals had visited a private dentist where the type of payment encouraged intervention.[24] A study by Caldas Jr et al[8] reinforced this hypothesis, showing a strong association between the number of teeth extracted due to dental caries and the frequency with which they were filled. As there are still restrictions to access and use of specialist orthodontic services within the *Sistema Único de Saúde* (Brazilian public health system), especially when it comes to carrying out endodontic treatment, it is very probable that extraction becomes the unavoidable treatment option in cases of advanced dental caries, especially for those on lower incomes.

Income and schooling, but not skin color, proved to be associated with tooth loss in adolescents, adults and the elderly, after adjusting for socioeconomic and demographic variables. There is a social gradient to tooth loss: the lower the income and schooling the higher the tooth loss. Less well-off individuals and those with less schooling live in areas with lower coverage of fluoridated tap water[22] and of orthodontic services,[13] consume more sugar[17] and brush their teeth less frequently.[1] All of these factors contribute to the increased prevalence and extent of dental caries and, consequently, to tooth loss. In this study, skin color ceased to be associated with tooth loss after adjusting for social and economic variables, indicating, in this case, that social and economic conditions have higher weighting than race.

This study originates from the third Brazilian epidemiological survey into oral health conditions carried out with adolescents, adults and the elderly. The first, in 1986, took place in 16 state capitals and the elderly were those aged between 50 and 59.[b] The second, in 2003, took place in 250 municipalities in all states.[b] The methodology of the 2010 study showed some improvements compared to the previous studies, including 32 domains (26 state capitals, the Federal Disctrict and the interior of the five macro-regions) and the database provided sampling weights so as to avoid the limitations of the previous studies.[22] As these three studies adopted different methodologies, caution is recommended when comparing their results. However, the difference in tooth loss between the two most recent studies (2003 and 2010) are significant; therefore, it is not probable that they are merely reflective of differences in the methodological procedures.

A significant decrease in tooth loss among adolescents and adults was recorded compared with the first decade of the 2000s. Among the elderly, the situation of almost half of individuals suffering from edentulism remained the same. In spite of advances, social and regional inequalities remain, suggesting that, in conjunction with universal population measures, the most vulnerable should also receive prioritized health care (proportionate universalism).

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