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Inequalities in Oral Health among Older Brazilians: A Cross-Sectional Analysis of a National Survey

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Abstract

Objective: To investigate the association of tooth loss and periodontal disease with socioeconomic and demographic factors, the need for and use of health services, and the effect of oral health on the daily lives of older Brazilians. **Material and Methods:** We abstracted data from a nation-wide, representative, cross-sectional survey of 7619 Brazilians aged between 65 to 74 years. Poisson regression models were created to investigate associations between oral diseases and income, education level, gender, ethnicity, region of residence, and use of dental services; statistical significance was set at 5%. **Results:** The mean age of the 7619 subjects studied was 69 years (95% Confidence Interval, 68.9–69.1); 61.9% were women. Regarding ethnicity, 46.95% were White, 38.90% were Brown, 11.54% were Black and 2.53% belonged to other ethnic groups. Bleeding on probing or dental calculus was present in 26.67% of subjects, whereas LOA was present in 87.27%. The loss of at least one tooth was observed in 48.90% of subjects, while 47.03% were completely edentulous. Low educational status increased the prevalence ratio (PR) of all diseases (loss of attachment, PR=5.54; bleeding on probing, PR=3.93; tooth loss, PR=2.24; edentulousness, PR=3.34). The prevalence of tooth loss was 2.58 times higher in subjects who reported a monthly income of less than 301 USD. The effect on daily life was occasionally a protective factor and occasionally increased the likelihoods of diseases. **Conclusion:** These findings substantiate the association of socioeconomic conditions, demographic features, and use of dental services with bleeding on probing, presence of dental calculus, loss of periodontal attachment, tooth loss, and edentulousness among older Brazilian subjects.

Keywords: Oral Health; Health Status Disparities; Socioeconomic Factors; Tooth Loss.

Introduction

Population aging is a global phenomenon and its consequences have affected Brazil. The country is the largest and richest in Latin America, and its current population includes more than 20 million people above the age of 60 years [1]. Due to the ongoing demographic transition, changes in the epidemiological status of the country can also be observed; for instance, the number of people with chronic diseases is increasing [2].

Chronic periodontal disease, left untreated, can lead to tooth loss with an increase in risk for other health problems including cardiovascular and nutritional issues [3–5]. Systemic illnesses such as respiratory infections, poor glycemic control [6], kidney disease [7], and increased cardiovascular risk [4] have been reported to be associated with the periodontal status.

A study in Japan has found that tooth brushing, regular dental visits and use of dentures are inversely related to mortality among the elderly population with significant loss of teeth [8]. A Swedish study has reported a statistically significant association between the number of remaining teeth and risk of coronary artery disease [4].

In addition to risk factors including smoking, alcohol consumption and poor oral hygiene [9], social factors such as low income and poor educational status are important and have been associated with periodontal disease [10]. The role of social determinants and contextual variables as potential factors influencing oral health have been studied; however, there is no consensus in literature regarding these factors [11,12]. A recent study, including data from the European Union and Israel, showed that the tooth retention in older adults may be related to socioeconomic status in early life, living conditions in childhood, and experiences in oral health throughout life [13].

Despite its wealth, Brazil has a large socio-economic divide within its society; such countries exhibit declining health in the disadvantaged strata of the population both in terms of general and oral health [14]. We hypothesized that global trends in health inequality may be observed in oral health among older Brazilians, although universal access to public dental services could reduce disparities.

This study may be considered a starting point for future research on oral health equity in developing countries that focus on reducing disparities; it represents a period during which Brazil has invested in public policies on fair income distribution and reducing inequality [15]. Thus, the aim of this study was to investigate the association of tooth loss and periodontal disease with socioeconomic and demographic factors, the need for and use of health services, and the effect of oral health on the daily lives of older Brazilians.

Material and Methods

Study Design

This study was performed using secondary data from a national cross-sectional oral health survey among the Brazilian resident population (SBBrasil) conducted in 2010 by The Brazilian Health Ministry. The dataset is in the public domain, made available by the National Oral Health

Coordination on request by email [16]. This was the second largest oral epidemiological survey carried out in the country. The survey used a multi-stage cluster sampling and the units were census tracts and households. The data were collected from the five geographical regions of the country (North, Northeast, Midwest, Southeast and South) and from the capitals of all states including 177 municipalities. Informed consent was obtained from all subjects enrolled in the study [17]. According to the World Health Organization (WHO) guidelines for epidemiological surveys [18], data were obtained from subjects between the ages of 65- to 74-years (n = 7619). The SBBrasil survey was performed in accordance with the Helsinki declaration and has been approved by the national ethics committee (number: 15948/10).

Oral Examination

Oral examination was performed to evaluate primary oral diseases in accordance with the WHO guidelines [18]. Caries status was assessed visually and the DMFT-index (decayed, missing and filled teeth) was recorded. In order to evaluate periodontal status, the Community Periodontal Index (CPI) was determined. The examination was performed with a blunt probe and a sextant, and the presence of gingival bleeding, calculus, and periodontal pockets were noted. The Loss of Periodontal Attachment (LOA) was also noted during the probing [17].

Examinations were carried out at individual households by 10 mobile teams. The survey team included a qualified dentist and an interviewer. Ten mobile teams carried out the survey in the capital cities; 2–6 teams were involved in other cities. There were conducted eight examination sessions of 4 hours each, totaling 32 hours. A consensus policy was adopted, based on the coefficients of correlation between each examiner. The minimum acceptable value of the kappa coefficient was 0.65.

Two outcome variables, tooth loss and edentulousness, were obtained from the DMFT-index, and both were dichotomized for analysis. Tooth loss was defined as loss of at least one tooth; edentulousness was defined as loss of all teeth.

The outcome variables related to periodontal disease were based on CPI and LOA. These variables were also dichotomized; LOA was defined loss of periodontal attachment greater than 3 mm in at least one of the examined teeth, and the CPI was dichotomized based on the presence of a dental calculus or bleeding upon probing in at least of the one examined teeth.

Covariates

Socioeconomic variables including gender, ethnicity (White, Black, Brown, and others), school education (≤8; 9–11 and 12–15 years), reported monthly income in US dollars (USD) (≤ 301; 302–903; 904–2710 and ≥2710) were retrieved from questionnaires. There were also collected data on the geographic region of residence, whether living in a capital city or not, number of people living in the same house, number of bedrooms, and number of declared possessions (defined as the number of television sets, sound systems, microwaves, refrigerators, telephones, washing machines,

dishwashers, computers and cars). In addition, we collected data on the time of the last dental visit (≤1 year or ≥ 1 year), the type of dental service used (public, private or other) and the perceived need for dentures. We determined the influence of the dentition status on daily activities; the nine variables included were the influence on chewing and brushing; inconvenience due to oral health problems; influence on leisure activities, sports, speech, social relations, study/work, and sleep.

Statistical Analysis

Poisson regression models were applied in the analysis. We performed chi-square tests to verify the relationship between outcomes and covariates. An explanatory variable was included in the model after univariate analysis at a significance level of 25%[19]. We disregarded variables below this level of significance. This analysis also estimated the crude PR with CI of 95%.

Socioeconomic and demographic conditions were considered distal determinants that influenced proximal determinants, including behaviors related to health, and were adapted to the study variables.

We carried out the analysis based on a hierarchical model of social determination of diseases [20]. A conceptual framework was designed where socioeconomic and demographic conditions were considered as distal determinants of oral health that influenced other determinants, including living conditions, dental requirements, access to dental services, and health perception (Figure 1).
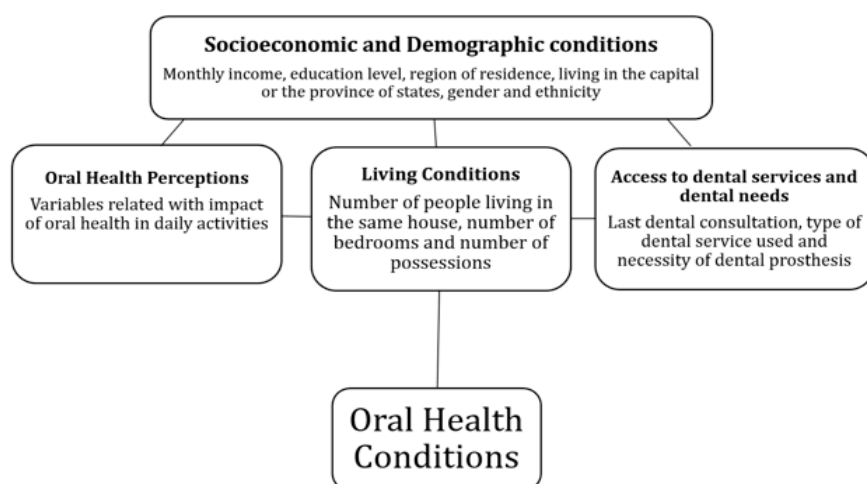
Figure 1. Determinants of health. Framework used in data analyses.

Four blocks of analysis were designed to perform the Poisson regression. The first block consisted of the effect of socioeconomic and demographic factors. The second block included characteristics of the households and possessions. The third block included factors related to the need for oral health and the use of dental health services. The fourth block included variables that accounted for the effects of oral health on daily life. The order of entry into the model was determined according the values of likelihood ratio followed by the PR observed on univariate analysis.

All analyses were performed using Stata, version 11.2 (Stata Corporation, College Station, Texas, USA). We used a "stepwise" procedure for the best fit of the model in which successive addition of variables was carried out with identification of variables that best explained the outcome variable [19]. We used a significance level of p <0.05, and the final fit of the models was examined using the Wald test.

Results

The mean age of the studied population (n=7619) was 69 years (95% CI 68.9-69.1), with 61.9% female subjects. Regarding ethnicity, 46.95% were White, 38.90% were Brown, 11.54% were Black and 2.53% belonged to other ethnic groups. In regard to educational status, 76.30% had up to 8 years of schooling (elementary school level), 11.42% had between 9 and 11 years (high school level) and 9.69% had between 12 and 15 years of education (college level). The most frequently reported income was between 302 and 903 USD (52.88%), followed by 904–2710 USD (26.24%), less than 301 USD (11.11%), and greater than 2710 USD per month (6.05%) (Table 1).

Table 1. Prevalence of bleeding on probing/ dental calculus, loss of periodontal attachment, tooth loss and edentulousness of Brazilian elders according socioeconomic and demographic features.

Variables	Total (n=7619)[*]		Bleeding on probing/calculus (n=2032)[**]		Loss of Attachment (n=6649)[**]		Tooth Loss (n=3726)[**]		Edentulousness (n=3583)[**]	
	n	%	n	%	n	%	n	%	n	%
Gender										
Male	2903	38.10	863	42.47	2501	37.61	1552	41.65	1206	33.66
Female	4716	61.90	1169	57.53	4148	62.39	2174	58.35	2377	66.34
Ethnicity										
White	3577	46.95	950	46.75	3042	45.75	1783	47.85	1624	45.33
Black	879	11.54	246	12.11	779	11.72	426	11.43	426	11.89
Brown	2970	38.90	784	38.58	2659	39.99	1428	38.33	1435	40.05
Other	193	2.53	52	2.56	169	2.54	89	2.39	98	2.74
Monthly Income@										
Up to 301 USD	849	11.14	178	8.76	747	11.23	333	8.94	488	13.62
302-903 USD	4029	52.88	991	48.77	3631	54.61	1811	48.60	2089	58.30
904-2710 USD	1999	26.24	608	29.92	1724	25.93	1116	29.95	793	22.13
Over than 2710 USD	461	6.05	172	8.46	328	4.93	322	8.64	91	2.54
Did not answer	281	3.69	83	4.08	219	3.29	144	3.86	122	3.40
Educational attainment										
Up to 8 years	5813	76.30	1415	69.64	5245	78.88	2586	69.40	3048	85.07
Between 9-11 years	870	11.42	301	14.81	720	10.83	530	14.22	291	8.12
Between 12-15 years	738	9.69	278	13.68	535	8.05	528	14.17	138	3.85
Did not answer	198	2.60	38	1.87	149	2.24	82	2.20	106	2.96
Region of Residence										
Southeast	1287	16.89	344	16.93	1062	15.97	611	16.40	623	17.39
South	1163	15.26	326	16.04	1033	15.54	636	17.07	475	13.26
Midwest	1117	14.66	245	12.06	1030	15.49	479	12.86	589	16.44
Northeast	2294	30.11	664	32.68	1993	29.97	1192	31.99	1020	28.47
North	1758	23.07	453	22.29	1531	23.03	808	21.69	876	24.45
Residence in the capital or the province of the state										
Capital	6003	78.79	1721	84.69	5157	77.56	3103	83.28	2651	73.99
Province	1616	21.21	311	15.31	1492	22.44	623	16.72	932	26.01

[*]Total of participants on the study, with and without disease; [**]Number of participants with disease; @Up to 301 USD = Up to 500 Brazilian reais; 302-903 USD = 501-1500 Brazilian reais; 904-2710 USD = 1501-4500 Brazilian reais; Over than 2710 USD = Over than 4500 Brazilian reais.

Among the subjects studied, 78.79% lived in state capitals, and 21.21% lived in provinces of the states. Dental calculus or bleeding upon probing was present in 26.67% (n=2032) and LOA was present in 87.27% (n=6649) of subjects. Loss of at least one tooth was found in 48.90% (n=3726) of subjects while 47.03% (n=3583) were edentulous (Table 1).

A need for prostheses was reported by 55.6% (4237) of subjects. Regarding the time of the last visit to the dentist, 52.6% (4010) of participants reported having consulted a dentist more than a year ago, and 26.8% (2041) stated that they had consulted a dentist within the previous year. The types of dental services used were as follows: 45.6% had used private practices, 27.3% had used public services, and 9.8% reported having used other types of services.

Final Poisson Regression models for each of the outcome variables are presented in tables 2, 3, 4 and 5. Overall, income and educational level were associated with all outcomes. Living in the North or Northeast regions increased the risk for bleeding and dental calculus, LOA and tooth loss (Tables 2, 3, 4). Time since the last dental consultation was identified as a risk factor for the three studied conditions (Tables 2, 3, 5). Statistical significance was seen in all except the loss of tooth model. A low educational status increased the prevalence of LOA by 5.54 times (Table 3).

Table 2. Final Poisson Regression model of bleeding on probing and/or dental calculus among Brazilian elders.

Variables	PR$_c$	PR$_a$	CI 95% (PR$_a$)	p†	p‡
SOCIOECONOMIC AND DEMOGRAPHIC FEATURES					
Monthly Income@					
Up to 301 USD	8.15	2.23	0.94-5.23	0.067	
302-903 USD	10.08	3.14	1.83-5.38	<0.001	
904-2710 USD	4.54	2.45	1.56-3.84	<0.001	
Over than 2710 USD	1	1			
Educational Attainment					
Up to 8 years	8.35	3.93	2.44-6.32	<0.001	
Between 9-11 years	3.06	1.84	1.12-3.01	0.016	
Between 12-15 years	1	1			
Ethnicity					<0.001
White	1	1			
Black	3.88	2.46	1.08-5.58	0.031	
Brown	3.00	1.63	1.03-2.58	0.036	
Others	6.57	3.28	0.43-24.80	0.251	
Region					
Southeast	1	1			
South	0.87	1.23	0.71-2.12	0.452	
Midwest	1.20	1.06	0.55-2.01	0.866	
Northeast	0.94	0.90	0.55-1.46	0.668	
North	4.21	2.72	1.23-6.01	0.013	
HOUSING FEATURES AND POSSESSIONS*					
Number of Bedrooms					
Up 2 bedrooms	2.02	2.21	1.31-3.72	0.003	
3 bedrooms	1.00	1.14	0.71-1.84	0.587	<0.001
4 bedrooms	1.14	1.38	0.76-2.50	0.285	
5 or + bedrooms	1	1			
USE OF DENTAL SERVICES AND DENTAL NEEDS**					
Last Dental Consultation					
Less than one year	1	1			<0.001
More than one year	3.72	2.05	1.34-3.11	0.001	
Necessity of dental prosthesis					

	PR_c	PR_a	CI 95% (PR_a)	p†	p‡
No	1	1			
Yes	3.40	2.08	1.36-3.19	0.001	
HEALTH PERCEPTION***					
Impact on speech					
No	1	1			<0.001
Yes	7.02	3.79	1.17-12.32	0.026	

PRc – Crude prevalence ratio/ PRa – Adjusted prevalence ratio / p† - category p-value p‡- variable p-value *Adjusted for income, schooling, ethnicity, region **Adjusted for income, educational Attainment, ethnicity, region, number of bedrooms ***Adjusted for income, schooling, ethnicity, region, number of bedrooms, last dental consultation and need for dental prostheses @1 American dollar = 1.66 Brazilian reais at the time of survey. Up to 301 USD = Up to 500 Brazilian reais; 302-903 USD = 501-1500 Brazilian reais; 904-2710 USD = 1501-4500 Brazilian reais; Over than 2710 USD = Over than 4500 Brazilian reais.

Table 3. Final Poisson Regression model of the Loss of Attachment in Brazilian elders.

Variables	PR_c	PR_a	CI 95% (PR_a)	p†	p‡
SOCIOECONOMIC AND DEMOGRAPHIC FEATURES					
Monthly Income@					
Up to 301 USD	4.13	2.20	1.58-3.07		
302-903 USD	9.19	3.02	2.08-4.36	<0.001	
904-2710 USD	9.54	3.11	1.79-5.40		
Over than 2710 USD	1	1			
Educational Attainment					
Up to 8 years	9.10	5.54	4.03-7.60	<0.001	
Between 9-11 years	2.69	1.92	1.37-2.70		<0.001
Between 12-15 years	1	1			
Region					
Southeast	1	1			
South	1	1.36	0.94-1.98	0.103	
Midwest	1.51	1.43	0.95-2.15	0.088	
Northeast	1.09	1.33	0.96-1.84	0.085	
North	2.80	2.58	1.67-3.99	<0.001	
USE OF DENTAL SERVICES AND DENTAL NEEDS*					
Necessity of dental prosthesis					
No	1	1			
Yes	2.85	2.04	1.56-2.68	<0.001	
Last Dental Consultation					<0.001
Less than one year	1	1			
More than one year	3.91	2.30	1.76-3.01	<0.001	
HEALTH PERCEPTION **					
Impact on speech					
No	1	1			<0.001
Yes	3.36	2.11	1.25-3.58	0.005	

PRc – Crude prevalence ratio/ PRa – Adjusted prevalence ratio / p† - category p-value p‡- variable p-value *Adjusted for income, schooling and region of residence ** Adjusted for income, educational Attainment and region of residence, use of and need for dental prostheses. *The category "Housing Features and Possessions" was not associated with the Loss of Periodontal Attachment.* @1 American dollar = 1.66 Brazilian reais at the time of survey. Up to 301 USD = Up to 500 Brazilian reais; 302-903 USD = 501-1500 Brazilian reais; 904-2710 USD = 1501-4500 Brazilian reais; Over than 2710 USD = Over than 4500 Brazilian reais.

In addition to income and education, an important risk factor for tooth loss was race. Subjects in the "Brown" category had 2.07 times increased risk for tooth loss (Table 4).

Table 4. Final Poisson Regression model of Tooth loss among Brazilian elders.

Variables	PR_c	PR_a	CI 95% (PR_a)	p†	p‡
SOCIOECONOMIC AND DEMOGRAPHIC FEATURES					
Monthly Income@					
Up to 301 USD	3.93	1.74	0.78-3.99	0.175	
302-903 USD	3.82	1.90	1.22-3.26	0.019	<0.001
904-2710 USD	3.14	2.16	1.31-3.56	0.002	
Over than 2710 USD	1	1			

	PRc	PRa	CI 95% (PRa)	p†	p‡
Educational Attainment					
Up to 8 years	3.13	2.24	1.37-3.63	0.001	
Between 9-11 years	1.85	1.39	0.81-2.36	0.227	
Between 12-15 years	1	1			
Ethnicity					
White	1	1			
Black	1.51	1.16	0.64-2.11	0.617	
Brown	2.70	2.07	1.29-3.33	0.003	
Others	0.84	0.61	0.23-1.58	0.313	
Region					
Southeast	1	1			
South	1.04	1.27	0.77-2.08	0.354	
Midwest	1.41	1.33	0.74-2.38	0.354	
Northeast	1.80	1.84	1.12-3.09	0.016	
North	2.16	1.71	0.94-3.09	0.074	
HOUSING FEATURES AND POSSESSIONS*					
Number of people who live in the same house					
Up to 2 people	1	1			
3 people	1.87	1.83	1.08-3.09	0.023	<0.001
4 people	1.05	0.99	0.61-1.59	0.969	
5 or + people	1.63	1.38	0.84-2.24	0.198	
HEALTH PERCEPTION**					
Anger about oral/dental problems					
No	1	1			<0.001
Yes	0.60	0.48	2.56-7.16	<0.001	

PRc – Crude prevalence ratio/ PRa – Adjusted prevalence ratio / p† - category p-value p‡- variable p-value *Adjusted for income, schooling, ethnicity, region **Adjusted for income, educational Attainment, ethnicity, region, number of people who live in the same house. The category "Use of Dental Services and Dental Needs" was not associated with Tooth Loss. @1 American dollar = 1.66 Brazilian reais at the time of survey. Up to 301 USD = Up to 500 Brazilian reais; 302-903 USD = 501-1500 Brazilian reais; 904-2710 USD = 1501-4500 Brazilian reais; Over than 2710 USD = Over than 4500 Brazilian reais.

The poorest and least educated subjects were more likely to be edentulous. However, we identified a protective effect related to oral health assistance at public dental services compared to private services (PR=0.62) (Table 5).

Table 5. Final Poisson Regression model of Edentulousness Among Brazilian elders.

Variables	PRc	PRa	CI 95% (PRa)	p†	p‡
SOCIOECONOMIC AND DEMOGRAPHIC FEATURES					
Monthly Income@					
Up to 301 USD	5.55	2.58	1.93-3.46	<0.001	
302-903 USD	4.37	2.14	1.64-2.77	<0.001	
904-2710 USD	2.70	1.67	1.29-2.18	<0.001	
Over than 2710 USD	1	1			
Educational Attainment					<0.001
Up to 8 years	4.71	3.34	2.69-4.15	<0.001	
Between 9-11 years	2.18	1.89	1.47-2.43		
Between 12-15 years	1	1			
Gender					
Male	1	1			
Female	1.42	1.43	1.29-1.58	<0.001	
Residence in the capital or the province of the state					
Province	1.73	1.52	1.34-1.71	<0.001	
Capital	1	1			
Region					
Southeast	1	1			
South	0.74	0.81	0.68-0.96	0.018	
Midwest	1.23	1.15	0.97-1.37	0.111	
Northeast	0.86	0.96	0.83-1.11	0.580	
North	1.09	1.05	0.90-1.23	0.506	

	PRc	PRa	95% CI	p+	p‡
HOUSING FEATURES AND POSSESSIONS*					
Number of Bedrooms					
Up 2 bedrooms	0.88	0.80	0.70-0.91	0.001	
3 bedrooms	0.70	0.75	0.65-0.86	<0.001	<0.001
4 bedrooms	0.87	0.92	0.77-1.10	0.361	
5 or + bedrooms	1	1			
USE OF DENTAL SERVICES AND DENTAL NEEDS**					
Last Dental Consultation					
Less than one year	1	1			
More than one year	4.14	3.54	3.11-4.06	<0.001	
Type of Dental Service used					
Private	1	1			
Public	0.86	0.62	0.54-0.71	<0.001	
Others	0.46	0.60	0.49-0.73	<0.001	
HEALTH PERCEPTION**					
Impact on social relations					
No	1	1			<0.001
Yes	0.64	0.53	0.44-0.64	<0.001	
Impact on brushing					
No	1	1			
Yes	0.32	0.29	0.23-0.35	<0.001	
Impact on speech					
No	1	1			
Yes	1.08	1.96	1.61-2.37	<0.001	

PRc – Crude prevalence ratio/ PRa – Adjusted prevalence ratio / p+ - category p-value p‡- variable p-value *Adjusted for income, schooling, gender, Residence in the capital or the province of the state, region **Adjusted for income, educational Attainment, gender, Residence in the capital or the province of the state, region, number of bedrooms ***Adjusted for income, schooling, gender, Residence in the capital or the province of the state, region, number of bedrooms, last dental consultation, type of dental service used. @1 American dollar = 1.66 Brazilian reais at the time of survey. Up to 301 USD = Up to 500 Brazilian reais; 302-903 USD = 501-1500 Brazilian reais; 904-2710 USD = 1501-4500 Brazilian reais; Over than 2710 USD = Over than 4500 Brazilian reais.

Discussion

In this study of a national sample of elderly Brazilian subjects, income and educational status were significant predictors of oral health in all the models studied, after adjusting for other covariates, suggesting the role of the socioeconomic gradients in oral health [21]. The low level of education among older subjects was striking, with over 76% having less than 8 years of formal education. We found LOA and bleeding on probing to be significantly associated with educational status, monthly income, demographic characteristics, dental visits and dental care requirements. Similarly, in a 5-year follow-up study, the progression of periodontal disease was associated with socioeconomic factors such as income and level of education [22]. Low education levels, low income, and lack of public dental services have been identified as barriers faced by elderly subjects seeking access to dental services [23]. A study including data from European countries and Israel showed that the number of teeth in older adulthood was related to the socioeconomic background in childhood [13].

Throughout the history of Brazilian colonization, the North and Northeast regions are known to have suffered economic and social inequalities and continue to do so, while most of the population and the national gross domestic product are concentrated in the South and Southeast regions [24].

This situation was reaffirmed in our study. Despite the advances Brazil has made in health care in recent years, inequalities based on geographical location remain [25]. The Northern and

Northeastern regions had the worst oral health status (Tables 2, 3 and 4) and also showed a 2.5 times higher risk of impaired oral health compared to other regions. Thus, residing in the Southern region acted as a protective factor, which decreased the prevalence of edentulousness by 19% compared to people living in the Southeastern region (Table 5).

These findings demonstrate the vulnerability of the poorest and most disadvantaged strata of the population. Throughout four-fifths of its historical legacy, Brazil has employed slaves, including Indians and Blacks, and subjected them to deprivation and poverty [26]. It is only for approximately 20 years that Governmental efforts have been focused in many areas, including the health sector, to offer the entire population equitable care without discrimination; these efforts have been operationalized through the Unified Health System (SUS). Specifically, in oral health, the SUS has been expanded by a proposal known as "Brasil Sorridente" (Smiling Brazil), which is also run by the Government and funded by specific taxes and social contributions. "Brasil Sorridente" comes under the universal health system and is focused on primary care [25].

The implementation of a health system certainly increases the availability of services while stimulating demand. In this study, we found that seeking dental care served as a predictor of oral health in three of the four proposed models; subjects who reported not having visited the dentist within the previous year were at a 3.54 higher risk of edentulousness (Table 5). We must also note the fact that seeking dental care in the Brazilian public health service acted as a protective factor against edentulousness, decreasing the risk by 38% compared to the private sector (Table 5). To address the high demand for specialized services in dental care, beginning in 2004, the national oral health policy was extended beyond primary care to establish specialized centers in dentistry that offers more complex, free treatment in prostheses, endodontics, periodontology, care of patients with special needs and oral surgery.

In contrast, only 27.3% of subjects utilized public health services for dental care which may be indicate the relative lack of specialized services such as dentures, because nearly 50% of subjects were edentulous. This corroborates with the findings of another Brazilian study [10], which suggests that years of social inequity are responsible for the health of the population in addition to the difficulty that the SUS had in responding to the demand for specialized treatment among the older population.

The maintenance of teeth throughout life also contributes to adequate nutrition, self-esteem, and social life. Results from a study carried out in the Southeast region of Brazil suggested that social participation reduces the prevalence of edentulousness among the elderly population [27]. Additionally, among older Japanese subjects, an active social life is associated with improved oral health [28].

The association between edentulousness and social inequality is reported in the literature and reinforces the relationship between social gradient and the loss of teeth [21].

The current study has the advantages of using data from a large national sample of the older Brazilian population; the present data will serve as an impetus for the structuring of social and health

policies of this country and challenge the past history of inequities. However, considering the cross-sectional design of the study, we can propose hypotheses, but no causal inferences can be made. Additionally, the dataset lacked important information about individual behaviors and general health characteristics or habits, including alcoholism and smoking. These factors may have influenced disease severity; however, a previous study has shown that these individual behaviors are not sufficient on their own right to eliminate the social inequalities in health [29].

This study includes important considerations for public health. First, public health policies should focus not only on the quality of oral health care but should also seek to overcome social gradients. This process requires coordinated actions based on the social determinants of health [30].

Conclusion

These findings substantiate the association of socioeconomic conditions, demographic features, and use of dental services with bleeding on probing, presence of dental calculus, loss of periodontal attachment, tooth loss, and edentulousness among older Brazilian subjects. Our results also demonstrated the impact of the social gradient on oral health problems of older subjects and provides additional evidence of inequality. Our findings will facilitate the design of policies to overcome fragmentation of health services, known to be essential to overcome inequalities and achieve an equitable society.

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