

# Tooth loss and associated factors in elders: results from a national survey in Uruguay

Patricia Nicola Laguzzi, DDS<sup>1</sup>; Helena Silveira Schuch, DDS, MS<sup>2</sup>; Lucy Derrégibus Medina, DDS<sup>1</sup>; Andrea Rodríguez de Amores, DDS<sup>1</sup>; Flavio Fernando Demarco, DDS, PhD<sup>3</sup>; Susana Lorenzo, DDS<sup>1</sup>

1 School of Dentistry, Universidad de la República, Montevideo, Uruguay

2 Australian Research Centre for Population Oral Health (ARCPOH), School of Dentistry, The University of Adelaide, Adelaide, SA, Australia

3 Social and Preventive Dentistry, Federal University of Pelotas, Pelotas, RS, Brazil

## Keywords

tooth loss; elderly; epidemiology; caries; socioeconomic.

## Correspondence

Prof./Dr. Flávio Fernando Demarco, Rua Gonçalves Chaves, 457, 5º andar, Centro. CEP 96015-560, Pelotas, RS, Brasil.

Tel: +55-53-3225-6741;

Fax: +55 53-3222-6690 R. 135;

e-mail: ffdemarco@gmail.com. Patricia Nicola Laguzzi, Lucy Derrégibus Medina, Andrea Rodríguez de Amores, Susana Lorenzo (PhD Student) are with the School of Dentistry, Universidad de la República. Helena Silveira Schuch (PhD Student) is with Australian Research Centre for Population Oral Health (ARCPOH), School of Dentistry, The University of Adelaide. Flavio Fernando Demarco is with the Social and Preventive Dentistry, Federal University of Pelotas.

Received: 10/20/2014; accepted: 8/28/2015.

doi: 10.1111/jphd.12123

Journal of Public Health Dentistry 76 (2016) 143–151

## Introduction

Several countries around the world have been experiencing an epidemiologic transition resulting from the reduction in birth rates and the increase in life expectancy, with populations presenting an increased percentage of elders (1). Uruguay shows a sharp increase in its aging population, with the percentage of individuals over 65 years old rising from 7.6% to 14.1% of the population in the period between 1963 and 2011 (2). Teeth present several functions throughout an individual's life, and the presence of a functional dentition is important for elderly individuals (3).

Tooth loss is a worldwide public health problem, especially in developing countries (4). It may affect systemic health conditions, such as obesity and increased blood pressure (5),

## Abstract

**Objectives:** This study evaluated the prevalence and severity of tooth loss in Uruguayan elders, assessing its association with demographic, socioeconomic, and behavioral factors; the use of health services; and self-reported dental treatment need.

**Methods:** A population-based cross-sectional study was done among Uruguayan individuals of ages 65-74 years. Data were collected through questionnaires and clinical examinations. The dependent variable, tooth loss, was classified into three distinct outcomes: functional dentition ( $\geq 20$  teeth), severe tooth loss ( $< 9$  teeth), and edentulism. The independent variables were: sex, socioeconomic status, use of health services, hypertension, diabetes mellitus, tobacco use, frequent consumption of alcohol, hygiene habits, and need for dental care.

**Results:** The sample comprised 341 individuals, and the mean number of teeth present was 9.73 (95% confidence interval, 8.77-10.69) for each individual. After multivariate analysis, lack of a functional dentition, severe tooth loss, and edentulism were found to be associated with lower socioeconomic level, frequent consumption of alcohol, and receiving treatment from the public health system ( $P < 0.05$ ). Individuals with self-reported dental treatment need had more severe tooth loss and presented a higher degree of edentulism ( $P < 0.05$ ).

**Conclusions:** There is a high and severe prevalence of tooth loss in elderly Uruguayans, especially among those from lower socioeconomic levels. Our findings highlight the importance of public health policies to prevent and treat tooth loss.

and negatively impact oral health-related quality of life (6), affecting chewing, swallowing (7), phonation, esthetics, and social life (6). Tooth loss is considered as a risk factor for malnutrition (7). Severe tooth loss (presence of less than nine teeth) is ranked as the 36th most prevalent condition in the Global Burden of Disease 2010 Study, with an estimated global prevalence of 2% (4). Edentulism, defined as the loss of all teeth, is related to obesity (8) and high blood pressure (5) and also increases the risk of death because of heart attack (9). A higher number of teeth has been related to better general health outcomes, and the presence of a shortened dental arch (premolar to premolar, superior and inferior) may provide acceptable oral function and could be considered as a cost-effective option (10), especially in countries of medium or lower income.

Several conditions have been associated with a higher prevalence of tooth loss, including low socioeconomic and educational levels (11). In addition, a higher prevalence of tooth loss has been reported in women (11); the city where the individuals live may also influence tooth loss (12). Some negative behaviors have also been associated with an increased risk of tooth loss, including smoking (13) and alcohol intake (14). The main cause of tooth loss in the young and adults is dental caries, whereas periodontal disease has been reported as an important cause of tooth loss at later ages (15). Poor oral health habits have been associated with caries prevalence and periodontal disease and, as a consequence, could be associated with increased risk of tooth loss. Also, the frequency of dental care and the type of dental service used during the life course may affect the number of teeth present in the mouth in later stages in life (15).

Despite the high percentage of elders in the Uruguayan population, thus far, no study has been done to investigate the prevalence of tooth loss among these individuals, impairing the establishment of public health policies to prevent or treat this disease. This study aimed to evaluate the prevalence and severity of tooth loss in the elderly population of Uruguay, investigating the association of such problem with demographic, socioeconomic, and behavioral factors; the use of health services; and self-reported dental treatment need.

## Methods

### Study design and sample selection

A population-based cross-sectional study was carried out in Uruguay from August 2010 to December 2011, with the support of the Ministry of Public Health of that country. The study protocol was approved by the Human Research Ethics Committee of the University of the Republic (Uruguay).

Multiple probabilistic sampling with cluster technique was used for subject recruitment, and three age groups were randomly selected in two geographic regions (capital and provinces) comprising 6 domain units. The age groups were 15-24, 35-44, and 65-74 years. The parameters ensured that the sample was nationally representative considering a prevalence of dental caries of 85%, selected based on the Brazilian National Oral Health Survey (2003), the 95% confidence interval (CI) and a design effect of 1.5, to which was added a nonresponse rate of 20%. A detailed description of the method of this survey can be found in Lorenzo *et al.* (16).

### Data collection

Data were collected through questionnaires and clinical oral examinations. The questionnaires gathered information on socioeconomic, demographic, general health, and behavioral characteristics, as well as the use of health services. Trained

and calibrated dentists (the lowest kappa index value obtained was 0.78) did the oral clinical examinations, collecting information related to dental caries, periodontal disease, tooth loss, oral mucosal lesions, and malocclusions, according to the criteria proposed by the World Health Organization (WHO) for the different outcomes (17). The clinical examinations were done at the participants' homes with the use of artificial light, a clinical mirror, and a Community Periodontal Index (CPI) periodontal probe (WHO).

The dependent variable in the present study was tooth loss, which was determined as code 4 (lost because of dental caries) or 5 (lost because of other reasons) in the Decayed, Missing and Filled teeth (DMFT) Index among individuals of ages 65-74 years. This variable was classified into three distinct outcomes: functional dentition, severe tooth loss, and edentulism. Severe tooth loss was defined as "having fewer than 9 remaining permanent teeth" (4), whereas functional dentition meant "having at least 20 teeth" (18,19).

The independent variables collected were: sex (female/male), socioeconomic status, use of health services (public/private), hypertension, diabetes mellitus, tobacco use, frequent consumption of alcohol, hygiene habits, and self-reported need for dental care. Socioeconomic status was divided into three categories: high, medium, and low; these were based on a short version of the Socioeconomic Level Index, which considers nine variables, including life features, home appliances, access to services, and ownership of assets (20).

The self-reported systemic conditions hypertension and diabetes were dichotomized into the categories "sick" and "healthy." Tobacco use was based on self-reported status as current smoker or nonsmoker, and alcohol consumption was dichotomized into frequent (daily/weekly intake) or infrequent (no/annual/monthly intake) consumption. Frequency of toothbrushing was used to evaluate oral hygiene (dichotomized into "two or more times daily" and "less than two times daily"). The self-reported type of health service used was recorded as either public or private service. The respondents also answered a question on their current need for dental treatment. All data on the variables were collected from the questionnaires, except those on tooth loss, which were obtained from the clinical examinations.

### Statistical analysis

The data were double-typed to avoid errors, and statistical analyses were done by using the Stata software package, version 12.0 (Stata Corporation, College Station, TX, USA). Descriptive analyses were initially carried out. Chi-squared test was used to evaluate differences in tooth loss according to the independent variables. To assess factors associated with tooth loss, the variables were treated dichotomously ["at least 20 teeth" (functional dentition) versus "less than 20 teeth"; "at

least 9 teeth” versus “less than 9 teeth” (severe tooth loss); and “at least 1 tooth” versus “edentulous”]. The associations between these dichotomous variables and the other variables investigated were evaluated separately by using Poisson regression models with robust variance. Unadjusted analyses provided summary statistics for assessing the association between the outcomes and the independent variables. This strategy allowed for the estimation of the prevalence ratio (PR) and 95% CI for evaluating predictors of tooth loss. In the adjusted analyses, all variables were included in the model fitting, and associations were considered significant at a *P* value of  $\leq 0.05$  after adjustment. All analyses were weighted allowing for the design effect and acknowledging the sample procedure using “svy” in STATA for data from complex samples.

## Results

This national survey evaluated a total of 1,485 individuals, with a response rate of 74.8% for the capital area

(Montevideo) and 61.3% for the countryside. Of the total respondents, 341 belonged to the elderly group (65–74 years old); 37% of them were women, 68% were from the countryside (provinces), and 41.4% were from lower socioeconomic levels. Regarding the use of health services, 38.5% had access to public health care. Regarding tooth loss, only 2.05% of the total sample had between 28 and 32 teeth, and the mean number of teeth present was 9.73 (95% CI, 8.77–10.69) for each individual.

Table 1 shows the results of the bivariate analysis in relation to the three outcomes used to categorize tooth loss severity and the independent variables. Socioeconomic level was found to be significantly associated with having less than 20 teeth ( $P = 0.01$ ), severe tooth loss ( $P = 0.01$ ), and edentulism ( $P = 0.05$ ), with those living in poorer conditions showing higher degrees of tooth loss. Sex had only a borderline association with severe tooth loss ( $P = 0.05$ ), with women presenting worse conditions, and this association was not observed in the other outcomes. General health conditions, i.e., hypertension and diabetes, were not found to be

**Table 1** Distribution of the Studied Variables according to Number of Teeth Present Teeth Lost

	Less 20 (%)	<i>P</i> value	Less 9 (%)	<i>P</i> value	Edentulism (%)	<i>P</i> value
Sex						
Male	76.5	0.350	44.7	0.055	25.4	0.686
Female	81.8		57.9		27.8	
Family income						
High/medium	74.4	0.014	45.4	0.012	20.4	0.005
Low	87.7		62.4		37.4	
Residence						
Capital	77.8	0.606	48.9	0.422	23.8	0.346
Countryside	80.7		54.4		29.4	
Health service						
Private	72.8	0.003	42.4	$P < 0.001$	18.2	$< 0.001$
Public	90.4		67.6		40.6	
Alcohol						
Infrequent consumer	75.5	0.121	42.4	0.001	19.3	0.0034
Frequent consumer	84.9		64.7		36.9	
Tobacco use						
Nonsmoker	94.2	0.009	61.8	0.306	31.6	0.559
Smoker	78.3		50.9		26.2	
Toothbrushing						
Two or more times/day	78.1	0.485	52.6	0.639	26.6	0.969
Less than two times/day	82.3		49.1		26.8	
Self-reported need for treatment						
Need	79.6	0.960	41.2	$< 0.001$	17.5	$< 0.001$
No need	79.3		64.0		37.1	
Diabetes						
Healthy	80.0	0.580	53.1	0.586	27.2	0.756
Sick	77.5		44.9		24.9	
Hypertension						
Healthy	79.1	0.974	47.9	0.349	26.8	0.950
Sick	79.3		54.3		26.5	

Uruguay, 2010 ( $N = 341$ ).

Chi-squared analysis.

associated with tooth loss in the present study. Regarding behavioral variables (smoking habit, alcohol consumption, and toothbrushing frequency), toothbrushing was not associated with any of the outcomes, whereas smoking habit was associated with having less than 20 teeth ( $P < 0.01$ ), and frequent alcohol consumption with severe tooth loss and edentulism ( $P < 0.01$ ). Regarding the use of health services, those attending public services presented unfavorable conditions ( $P < 0.001$ ). Also, the self-reported need for dental treatment was associated with more severe tooth loss and edentulism ( $P < 0.01$ ).

Table 2 shows the results of the multivariate analysis in relation to the outcome “less than a functional dentition.” After adjustments, the variables that were found to be associated with this outcome were family income, tobacco use,

alcohol consumption, and type of health services used, with a lower number of teeth among individuals with a lower family income [1.18 (1.03-1.34)], frequent consumers of alcohol [1.17 (1.03-1.33)], and those who use public health services [1.19 (1.06-1.33)]. Absence of smoking habit was a protective factor against an unfavorable condition [0.82 (0.73-0.92)].

Table 3 presents the results of the multivariate analysis in relation to severe tooth loss. After adjustments, having less than nine teeth was found to be associated with type of health service used ( $P < 0.01$ ), family income ( $P = 0.02$ ), and alcohol consumption ( $P < 0.01$ ), with individuals attending public health services [1.44 (1.12-1.86)], from lower socioeconomic levels [1.45 (1.12-1.87)], and with frequent alcohol consumption [1.63 (1.27-2.08)] presenting severe tooth loss. The

**Table 2** Crude and Adjusted Analysis of Having at Least 20 Teeth in Mouth in the Elderly

Independent variables	PR (95% CI) <sup>†</sup>	P value	PR (95% CI) <sup>*</sup>	P value
Socioeconomic and demographic variables				
Sex		0.378	–	–
Male	1			
Female	1.07 (0.92-1.24)			
Family income		0.014		0.014
High/medium	1		1	
Low	1.18 (1.03-1.34)		1.18 (1.03-1.34)	
Residence		0.616	–	–
Capital	1			
Countryside	1.04 (0.90-1.20)			
Systemic diseases				
Hypertension		0.974	–	–
Healthy	1			
Sick	1.00 (0.87-1.15)			
Diabetes		0.971	–	–
Healthy	1			
Sick	1.00 (0.81-1.24)			
Behavioral characteristics				
Alcohol		0.107		0.013
Infrequent consumer	1		1	
Frequent consumer	1.12 (0.97-1.30)		1.17 (1.03-1.33)	
Tobacco use		< 0.001		0.001
Smoker	1		1	
Nonsmoker	0.83 (0.75-0.92)		0.82 (0.73-0.92)	
Toothbrushing		0.472		–
Two or more times/day	1			
Less than two times/day	1.05 (0.91-1.21)			
Health service		0.001		0.003
Private	1		1	
Public	1.26 (1.10-1.44)		1.19 (1.06-1.33)	
Self-reported need for treatment		0.960	–	–
Need	1			
No need	0.99 (0.86-1.15)			

\* PR: adjusted prevalence ratio.

† PR: crude prevalence ratio.

Uruguay, 2010 (n = 341).

Poisson regression analysis.

CI, confidence interval.

**Table 3** Crude and Adjusted Analysis of Every Tooth Loss in Elderly

Independent variables	PR (95% CI) <sup>†</sup>	P value	PR (95% CI) <sup>*</sup>	P value
Socioeconomic and demographic variables				
Sex		0.069		0.116
Male	1		1	
Female	1.29 (0.98-1.71)		1.25 (0.95-1.64)	
Family income		0.012		0.021
High/medium	1		1	
Low	1.37 (1.07-1.76)		1.33 (1.04-1.70)	
Residence		0.432	–	–
Capital	1			
Countryside	1.11 (0.85-1.45)			
Systemic diseases				
Hypertension		0.354	–	–
Healthy	1			
Sick	1.13 (0.87-1.48)			
Diabetes		0.472	–	–
Healthy	1			
Sick	0.88 (0.63-1.24)			
Behavioral characteristics				
Alcohol		0.001		0.001
Infrequent consumer	1		1	
Frequent consumer	1.53 (1.18-1.98)		1.54 (1.20-1.56)	
Tobacco use		0.261		0.137
Smoker	1		1	
Nonsmoker	0.82 (0.58-1.16)		0.77 (0.54-1.09)	
Toothbrushing		0.644	–	–
Two or more times/day	1			
Less than two times/day	0.93 (0.70-1.25)			
Health service		<0.001		0.001
Private	1		1	
Public	1.65 (1.30-2.10)		1.52 (1.19-1.92)	
Self-reported need for treatment		0.001		< 0.001
Need	1		1	
No need	1.55 (1.19-2.01)		1.63 (1.27-2.08)	

\* PR: adjusted prevalence ratio.

† PR: crude prevalence ratio.

Uruguay, 2010 (n = 341).

Poisson regression analysis.

CI, confidence interval.

self-reported need for dental treatment was also associated with severe tooth loss ( $P < 0.01$ ), with those who reported having no need for treatment presenting worse oral health conditions [1.63 (1.27-2.08)].

Table 4 shows the results of the multivariate analysis in relation to edentulism. After controlling for confounders, the absence of teeth was found to be associated with family income ( $P < 0.01$ ), alcohol consumption ( $P < 0.01$ ), type of health service used ( $P < 0.01$ ), and self-reported need for dental treatment ( $P < 0.001$ ). Individuals with a lower family income [1.83 (1.19-2.79)], frequent consumers of alcohol [1.82 (1.17-2.84)], and those who reported a need for dental treatment [2.07 (1.35-3.18)] had a higher chance of being edentulous. Also, those who reported receiving public health care services had a 90% higher prevalence of edentulism [2.04 (1.31-3.17)].

## Discussion

This is the first study to use nationally representative data from Uruguay to evaluate oral health in the young, adults, and elders. Specifically, the present study investigated tooth loss among elders. Almost 75% of the surveyed population were found to have at least one tooth lost, and the mean number of teeth present was lower than 10. Several studies have shown that a higher number of teeth in the mouth is beneficial to general and oral health (3). Thus, in the present study, we categorized tooth loss into three degrees of severity: functional dentition (at least 20 teeth), severe tooth loss (less than 9 teeth), and edentulism. Other studies have also used this approach to investigate the severity of tooth loss and its associated factors (21). The overall results of our study showed that the prevalence and severity of tooth loss

**Table 4** Crude and Adjusted Analysis Edentulism in Elderly

Independent variables	PR (95% CI) <sup>†</sup>	P value	PR (95% CI) <sup>*</sup>	P value
Socioeconomic and demographic variables				
Sex		0.688	–	–
Male	1			
Female	1.09 (0.70-1.70)			
Family income		0.005		0.005
High/medium	1		1	
Low	1.83 (1.19-2.79)		1.83 (1.19-2.79)	
Residence		0.355	–	–
Capital	1			
Countryside	1.24 (0.79-1.95)			
Systemic diseases				
Hypertension		0.950	–	–
Healthy	1			
Sick	0.99 (0.64-1.51)			
Diabetes		0.925	–	–
Healthy	1			
Sick	0.98 (0.60-1.59)			
Behavioral characteristics				
Alcohol		0.004		0.008
Infrequent consumer	1		1	
Frequent consumer	1.91 (1.23-2.97)		1.82 (1.17-2.84)	
Tobacco use		0.548	–	–
Smoker	1			
Nonsmoker	0.83 (0.45-1.53)			
Toothbrushing		0.969	–	–
Two or more times/day	1			
Less than two times/day	1.01 (0.63-1.61)			
Health service		<0.001		0.002
Private	1		1	
Public	2.29 (1.52-3.45)		2.04 (1.31-3.17)	
Self-reported need for treatment		0.001		0.001
Need	1		1	
No need	2.13 (1.35-3.34)		2.07 (1.35-3.18)	

\* PR, adjusted prevalence ratio.

† PR, crude prevalence ratio.

Uruguay, 2010 (n = 341).

Poisson regression analysis.

CI, confidence interval.

were positively associated with poorer socioeconomic condition, use of public health services, frequent alcohol consumption, and self-reported absence of need for dental treatment.

In the present study, the prevalence of a functional dentition (at least 20 teeth) was 18.8%, whereas severe tooth loss was found in 54% and edentulism in 28.2% of the studied population. These data show a high prevalence and severity of tooth loss in this population, which could compromise the oral health-related quality of life of these individuals. Uruguay presents a higher Human Development Index than most Latin American countries, which could have an impact on the general and oral health status of its population. The prevalence of edentulism in Uruguayan elderly was lower than that observed in a National Oral Health Survey in Brazil

(54.8%) (21). In a study among the elderly in southern Brazil, which shares common socioeconomic and cultural aspects with Uruguay, prevalence rates of 51.1%, 34%, and 14.8% were observed for edentulism, severe tooth loss, and presence of 10 or more teeth, respectively (22). In comparison, more than one third of US elderly are edentulous (23), whereas in Canada, Portugal, and Turkey, the percentage is more than 50% (24). A lower prevalence (11%) of edentulism was observed in the UK (25), whereas a similar prevalence (32%) was found in a study in Norway (12). Thomson (1) pointed out that edentulism has decreased in developed countries in the last decades and that incremental tooth loss is currently more common among adults of all ages.

Regarding gender, some studies have found higher chances of tooth loss in women than in men (11). Women have been

shown to seek health (and dental) treatment more than men do, which could contribute to the higher prevalence of tooth loss in women, especially because, in developing countries, the majority of treatments provided by public services is mutilative (extraction) (15,22). In contrast, another study found a higher prevalence of tooth loss in men (26). In the present study, gender was not found to be significantly associated with the outcomes investigated.

Uruguay is a country with 3 million inhabitants, almost half of whom live in the capital (Montevideo). In Norway, geographic disparities were observed in relation to dental status and use of dentures, which were attributed to differences in socioeconomic factors and dental services offered (12). Despite the socioeconomic and cultural differences between the capital and the provinces of Uruguay, location had no influence on the prevalence or severity of tooth loss in this study.

Socioeconomic status was found to be related to tooth loss in the three stages of severity adopted in the present study, confirming the findings in other countries (11,27). In fact, extensive social inequalities were observed, with tooth loss being more prevalent among older individuals with poorer education or low income (28). This association could be linked to economic constraints, which determine the selection of radical, rather than conservative, dental treatment. Furthermore, people who live in poverty conditions or with socioeconomic limitations are well known to present worse health conditions (4), which could be reflected in greater tooth loss. However, contrary to the expectation, a study done in Italy did not find an association between socioeconomic factors and tooth loss (7).

Tooth loss affects systemic health in several ways (5), impairs oral health-related quality of life, and is considered as one of the current major public health problems (4). In contrast to other studies, the present survey did not find any association between the outcomes and some systemic diseases (diabetes and hypertension). This result could have been affected by the data collection method, which relied on self-reports of those diseases. Although the use of self-reports is not the most appropriate way to diagnose and evaluate chronic systemic diseases, such method has been used in other epidemiologic studies (22). Tooth loss was also not found to be associated with oral hygiene habits (frequency of toothbrushing), which might be due to the established social pattern, in which toothbrushing at least twice daily is the convention; thus, even those who do not brush their teeth twice daily could have reported such frequency. Therefore, the question regarding toothbrushing habits should not be considered as a good indicator of oral health quality.

Behavioral characteristics, such as tobacco use and alcohol consumption, were also found to be associated with tooth loss. In spite of the well-known association between smoking and severe periodontal diseases, and consequently with tooth

loss (13), smoking habit was associated only with having less than 20 teeth. In a national survey done in Japan, the prevalence of total tooth loss was found to be higher in current smokers, and a significant relationship was evident in men (29). It should be highlighted that a significant relationship between alcohol consumption and tooth loss was observed in all the stages of tooth loss adopted in the present study. This result could be explained in two different ways: a) biologically, considering the biological plausibility that alcohol may affect periodontal tissues (30); and b) behaviorally, adopting an understanding that both frequent alcohol consumption and poor health condition are results of self-neglecting behavior (13).

In agreement with other studies (27), users of public health systems presented a higher prevalence of tooth loss. This could indicate that in public health services, dental care is more mutilative, with more extractions done than in the private sector, because of the inability to provide alternative conservative treatment to extraction. In fact, in the Uruguay public health system, older people are offered only extractions, besides emergency care. As suggested by Thomson (1), total tooth loss is mostly regarded by dental public health observers as an inevitable end point, reflecting the failure of both self-care and the dental care system to ensure the retention of a functional dentition in the person involved. In addition, considering that water fluoridation was introduced in this country only in the early 1990s, it can be assumed that the Uruguayan elderly in this study did not experience such intervention, which could have resulted in their having more decayed teeth, leading to the increased prevalence of tooth loss.

It should be highlighted that the present study found a negative association between the self-reported need for dental treatment and the presence of edentulism and severe tooth loss, with people having these conditions presenting a lower self-reported need for dental treatment. This relation was not observed in the group of individuals with more than 20 teeth in the mouth. These data are similar to those found in Brazil (21); the association could be explained by a lower degree of oral health care, which leads to both tooth loss and a lower perception of oral health problems. The negative self-perceived need for dental care could be related to higher resilience among elders (31), considering that in low- and medium-income countries, tooth loss is culturally accepted, especially among older adults. In addition, the fact that dental pain is the main reason for seeking dental treatment and that people who present severe tooth loss or edentulism do not suffer from pain could explain the association between tooth loss and self-reported need for dental treatment.

The results of the present study should be interpreted with caution, taking into consideration some limitations. First, the cross-sectional design of the study, in which the exposure variables and outcomes are assessed at the same time, limits the attainment of causal inferences and the elucidation of a

pathway linking each covariate to the outcome. Some of the covariates included in this study could be considered as both a potential cause and a consequence of tooth loss (e.g., diabetes). In this case, although it is possible to assume a bidirectional relationship between the conditions, because the majority of studies address diabetes as a risk factor for tooth loss (32), the authors decided to consider this covariate as a cause of tooth loss. This impossibility of identifying the cause and the effect is a well-known limitation of cross-sectional studies.

Also, the response rate in the present study was low (61% in the countryside and 74.8% in the capital), but it was similar to those in other countries with similar characteristics (27). Differences in response rate were also observed in a study investigating tooth loss in Norway, which achieved a mean of 53% (42.9-83.9%) (12), lower than that in our study. Statistical adjustments on sex and age were done to keep the sample representative of the entire country, but this resulted in loss of precision, as expressed by a larger CI. Data from these refuses and losses are unknown and could have influenced the results. Another study limitation was that the use of and the need for dental prostheses were not considered. It could be speculated that, among those who presented tooth loss, some did not report a need for dental treatment because they had received prosthetic rehabilitation treatment, which may, in turn, lead to a higher self-rating of oral health.

Nevertheless, the present study has its strengths. For the survey, an extensive training and calibration process was undertaken with a kappa value of 0.78 in the DMFT index. The data analyzed in this study came from the First National Oral Health Survey of Uruguay and are representative of the population. This study is particularly relevant because it is the first of its kind in Uruguay and in the elderly population, and the data gathered could be useful in the planning of public health policies.

In conclusion, tooth loss has a high prevalence and severity in Uruguayan elderly, especially those living in deprived conditions. The WHO estimated for the year 2000 that 50% of the elderly population should have at least 20 teeth (33); our results reveal how far Uruguay is from meeting this objective, reinforcing the need for public health policies that would help prevent tooth loss. Tooth loss affects oral function and nutrition. In addition, severe tooth loss and edentulism can cause serious health hazards and may pose an independent and significant risk factor for mortality (31), resulting in a heavy economic burden for the population and the country (4). Continuous tooth loss and its end point (edentulism) represents the failure of both self-care and the dental care system to maintain a functional dentition in an individual (1). Thus, it is also important to implement rehabilitation treatments (prosthetic appliances) for affected individuals, which could improve their oral functions and esthetics, and consequently, their quality of life (22).

## Acknowledgments

The authors are grateful to the Sectorial Commission of Scientific Research (CSIC) and the School of Dentistry of the Universidad de la República (UDELAR) for the research funding grant.

## References

1. Murray Thomson W. Epidemiology of oral health conditions in older people. *Gerodontology*. 2014;**31**(Suppl. 1):9-16.
2. INE INDEI. Resultados del Censo de Población 2011: población, crecimiento y estructura por sexo y edad. 2011 ed. Montevideo, Uruguay. 2011. p. 19.
3. Fejerskov O, Escobar G, Jøssing M, Baelum V. A functional natural dentition for all – and for life? The oral healthcare system needs revision. *J Oral Rehabil*. 2013;**40**(9):707-22.
4. Marcenes W, Kassebaum NJ, Bernabé E, Flaxman A, Naghavi M, Lopez A, Murray CJ. Global burden of oral conditions in 1990-2010: a systematic analysis. *J Dent Res*. 2013 Jul;**92**(7):592-7.
5. Peres MA, Tsakos G, Barbato PR, Silva DA, Peres KG. Tooth loss is associated with increased blood pressure in adults – A multidisciplinary population-based study. *J Clin Periodontol*. 2012;**39**(9):824-33.
6. Gerritsen AE, Allen PF, Witter DJ, Bronkhorst EM, Creugers NH. Tooth loss and oral health-related quality of life: A systematic review and meta-analysis. *Health Qual Life Outcomes*. 2010;**8**:126.
7. Musacchio E, Perissinotto E, Binotto P, Sartori L, Silva-Netto F, Zambon S, et al. Tooth loss in the elderly and its association with nutritional status, socio-economic and lifestyle factors. *Acta Odontol Scand*. 2007;**65**(2):78-86.
8. Österberg T, Dey DK, Sundh V, Carlsson GE, Jansson JO, Mellström D. Edentulism associated with obesity: A study of four national surveys of 16 416 Swedes aged 55-84 years. *Acta Odontol Scand*. 2010;**68**(6):360-7.
9. Watt RG, Tsakos G, de Oliveira C, Hamer M. Tooth loss and cardiovascular disease mortality risk – Results from the Scottish Health Survey. *PLoS ONE*. 2012;**7**(2):e30797.
10. Walter MH, Hannak W, Kern M, Mundt T, Gernet W, Weber A, et al. The randomized shortened dental arch study: Tooth loss over five years. *Clin Oral Invest*. 2013;**17**(3):877-86.
11. Gaio EJ, Haas AN, Carrard VC, Oppermann RV, Albandar J, Susin C. Oral health status in elders from South Brazil: A population-based study. *Gerodontology*. 2012;**29**(3):214-23.
12. Henriksen BM, Axell T, Laake K. Geographic differences in tooth loss and denture-wearing among the elderly in Norway. *Community Dent Oral Epidemiol*. 2003;**31**(6):403-11.
13. Sakki TK, Knuutila ML, Vimpari SS, Hartikainen MS. Association of lifestyle with periodontal health. *Community Dent Oral Epidemiol*. 1995;**23**(3):155-8.



14. Tezal M, Grossi SG, Ho AW, Genco RJ. Alcohol consumption and periodontal disease. The third national health and nutrition examination survey. *J Clin Periodontol*. 2004;**31**(7): 484-8. [Epub 2004/06/12].
15. Moreira Rda S, Nico LS, Tomita NE. [Spatial risk and factors associated with edentulism among elderly persons in Southeast Brazil]. *Cad Saude Publica*. 2011;**27**(10):2041-54, O risco espacial e fatores associados ao edentulismo em idosos em municipio do Sudeste do Brasil-O risco espacial e fatores associados ao edentulismo em idosos em municipio do Sudeste do Brasil.
16. Lorenzo S, Álvarez R, Blanco S, Peres MA. Primer Relevamiento Nacional de Salud Bucal en población joven y adulta uruguaya. Aspectos metodológicos. *Odontostomatología*. 2013;**XV**:8-25.
17. World Health Organization. *Oral health surveys: Basic methods*. Vol. vii, 4th ed. Geneva: World Health Organization; 1997. p. 66. p.
18. WHO. *Recent advances in oral health*. Geneva: World Health Organization; 1992.
19. Chalub LL, Borges CM, Ferreira RC, Haddad JP, Ferreira e Ferreira E, Vargas AM. Association between social determinants of health and functional dentition in 35-year-old to 44-year-old Brazilian adults: A population-based analytical study. *Community Dent Oral Epidemiol*. 2014;**42**(6):503-16.
20. Universidad de la República, Facultad de Ciencias Sociales, Departamento de Sociología. Montevideo 2006 [cited 2014 January 30]. Available from: [http://www.audap.com.uy/documentos/publicacion\\_inse\\_nacional.pdf](http://www.audap.com.uy/documentos/publicacion_inse_nacional.pdf).
21. Hugo FN, Hilgert JB, de Sousa Mda L, da Silva DD, Pucca GA. Correlates of partial tooth loss and edentulism in the Brazilian elderly. *Community Dent Oral Epidemiol*. 2007;**35**(3):224-32.
22. Silva AE, Demarco FF, Feldens CA. Oral health-related quality of life and associated factors in Southern Brazilian elderly. *Gerodontology*. 2015;**32**(1):35-45.
23. U.S. Department of Health and Human Services. *Healthy People 2010. 2nd ed. With Understanding and Improving Health and Objectives for Improving Health*. 2 vols. Washington, D.C.: U.S. Government Printing Office; 2000.
24. Beaglehole R, Benzian H, Crail J, Mackay J. *The Oral Health Atlas. Mapping a neglected global health issue*. Cointrin Switzerland: FDI World Dental Federation; 2009.
25. Pau A, Allen CD. Self-reported oral health status of adults resident in Medway, Kent in 2009. *Prim Dent Care*. 2011;**18**(4):173-9.
26. Morales-Suarez-Varela M, Ibanez-Cabanell P, Gimeno-Clemente N, Roig-Garcia JM, Nieto-Garcia MA, Llopis-Gonzalez A. Oral and dental health of non-institutionalized elderly people in Spain. *Arch Gerontol Geriatr*. 2011;**52**(2):159-63.
27. Barbato PR, Muller Nagano HC, Zanchet FN, Boing AF, Peres MA. [Tooth loss and associated socioeconomic, demographic, and dental-care factors in Brazilian adults: An analysis of the Brazilian Oral Health Survey, 2002-2003]. *Cad Saude Publica*. 2007;**23**(8):1803-14, Perdas dentarias e fatores sociais, demograficos e de servicos associados em adultos brasileiros: uma analise dos dados do Estudo Epidemiologico Nacional (Projeto SB Brasil 2002-2003)-Perdas dentarias e fatores sociais, demograficos e de servicos associados em adultos brasileiros: uma analise dos dados do Estudo Epidemiologico Nacional (Projeto SB Brasil 2002-2003).
28. Petersen PE, Kandelman D, Arpin S, Ogawa H. Global oral health of older people – Call for public health action. *Community Dent Health*. 2010;**27**(4 Suppl. 2):257-67.
29. Hanioka T, Ojima M, Tanaka K, Aoyama H. Association of total tooth loss with smoking, drinking alcohol and nutrition in elderly Japanese: Analysis of national database. *Gerodontology*. 2007;**24**(2):87-92.
30. Tezal M, Grossi SG, Ho AW, Genco RJ. The effect of alcohol consumption on periodontal disease. *J Periodontol*. 2001;**72**(2):183-9.
31. Padilha DM, Hilgert JB, Hugo FN, Bos AJ, Ferrucci L. Number of teeth and mortality risk in the Baltimore longitudinal study of aging. *J Gerontol A Biol Sci Med Sci*. 2008;**63**(7):739-44.
32. Petersen PE. The World Oral Health Report 2003: Continuous improvement of oral health in the 21st century – The approach of the WHO Global Oral Health Programme. *Community Dent Oral Epidemiol*. 2003;**31** (Suppl. 1):3-23.
33. Petersen PE. The World Oral Health Report 2003: continuous improvement of oral health in the 21st century – the approach of the WHO Global Oral Health Programme. *Community Dent Oral Epidemiol*. 2003;**31** (Suppl. 1):3-23.

Copyright of Journal of Public Health Dentistry is the property of Wiley-Blackwell and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.