Prevalence and Extent of Gingival Recession in a National Sample of Colombian Adults

Carlos Serrano[1], Elizabeth Suárez[2] and Alvaro Uzaheta[3]

[1]Department of Basic Science and Oral Medicine, [2]Department of Public Health, School of Dentistry, Universidad Nacional de Colombia, Bogotá, Colombia; [3]Universität Konstanz, Konstanz, Germany

Abstract

Objective: To perform an analysis of the Fourth Colombian Oral Health Study in order to describe the prevalence and extent of gingival recession in relation to different demographic, environmental and dental variables.

Methods: A national representative sample including 9255 adult individuals was randomly selected using probabilistic methods. Periodontal assessments were performed for all teeth, six sites per tooth. Clinical data collected were: number of teeth, pocket depth and position of the gingival margin. Presence of gingival recession was registered. Demographic, environmental and dental variables were collected. Prevalence and extent of gingival recession at different cut-off values, by tooth types, and factors associated with buccal recession ≥ 4 mm were described.

Results: Gingival recession was common in the examined population: 69.7% of subjects had ≥ 1 site with recession ≥ 1 mm, and 30.3% had ≥ 1 site with recession ≥ 3 mm. A total of 28.6% of teeth were affected by recession ≥ 1 mm, and 7.6% by recession ≥ 3 mm. The most frequently affected tooth types were first maxillary molars, first and second mandibular premolars, and the first maxillary premolar. Factors significantly associated with recession ≥ 4 mm were: older age, male gender, lower income, former smoker, diabetes, and less frequent toothbrushing.

Conclusions: Gingival recession is a common finding in the Colombian population. Factors associated with recession presence were the same as for periodontitis. Less frequent toothbrushing was associated with deep buccal recession.

Key words: Prevalence, gingival recession, attachment loss, toothbrushing, Latin America.

Introduction

The presence of gingival recession (GR) has been reported as highly prevalent in several representative population samples (Löe *et al.,* 1992; Albandar and Kingman, 1999; Susin *et al.,* 2004; Sarfati *et al.,* 2010; Rios *et al.,* 2014) and convenient samples (Sagnes and Gjermo, 1976; Vehkalahti, 1989; Källestål, 1992; Serino *et al.,* 1994; Toker and Ozdemir 2009; Chrysanthakopoulos, 2013). However, variation exists among study samples in different countries. The prevalence of GR ≥ 1 mm deep was 58% in a study sample in the United States (Albandar and Kingman 1999), but higher for samples in France and Brazil: 84.6% and 83.4%, respectively (Sarfati *et al.,* 2010; Susin *et al.,* 2004), and described as universal in a recent study in Brazil (99.7%; Rios *et al.,* 2014). For deeper GR in the range 4-5 mm, prevalence varies between 5.9% and 40.7% in different countries (Sarfati *et al.,* 2010; Rios *et al.,* 2014).

The presence of gingival recession has been reported to be higher on buccal surfaces compared to proximal surfaces, especially for young subjects (Löe *et al.,* 1992; Yoneyama *et al.,* 1988; Albandar and Kingman 1999; Murray-Thompson *et al.,* 2000). At the same time, several studies demonstrated that different tooth types are affected by gingival recession at varying levels. Maxillary first molars, maxillary first and second premolars, mandibular first and second premolars and mandibular incisors are referred to as the most frequently affected tooth types (Löe *et al.,* 1992; Källestål, 1992; Albandar and Kingman,

Correspondence to: Carlos Serrano, Department of Basic Science and Oral Medicine, School of Dentistry, Universidad Nacional de Colombia, Carrera 30 # 45-03, Building 210, Office 301, Bogotá, Colombia. Telephone number: +571-6352633, E-mail: caserranom@unal.edu.co

1999; Röthlisberger *et al.,* 2007; Rios *et al.,* 2014). On the contrary, others have not found any specific distribution pattern of gingival recession according to tooth types, the presence of gingival recession being evenly distributed among the dentition (Sarfati *et al.,* 2010).

Some reports have found that traditional risk indicators for severe periodontitis are associated with gingival recession occurrence. Two epidemiology studies have found an association between male gender, older age, smoking and gingival bleeding and the prevalence or extent of GR; other related factors have been level of education and serum glucose levels (Sarfati *et al.,* 2010; Rios *et al.,* 2014). Some have found a protective effect of higher frequency of toothbrushing, while others have observed no relation to oral hygiene practices, and some others have argued in favor of traumatic toothbrushing as contributing to the development of gingival recession (Vehkalahti 1989; Serino *et al.,* 1994).

In 2014, the Colombian Health Ministry developed the Fourth National Oral Health Study (Peñaloza *et al.,* 2015). A sample of 9255 subjects of age ≥ 18 years received a full-mouth periodontal examination at six sites per tooth. The aim of the present study was to perform a secondary analysis of this study in order to describe the prevalence and extent of GR in relation to different demographic, socio-economic, environmental, medical and dental variables.

Materials and methods

Sample population

A national oral epidemiology study representative of the Colombian population was performed on subjects 1 to 79 years of age. Periodontal examinations were performed on participants age ≥ 18 years. All geographic areas of the country were included.

Using projections for the Colombian population up to the year 2020, the reported population of Colombian municipalities 2005-2011, previous prevalence data of major oral disease conditions, and the political and administrative division of the country, a sample size of 23,283 community dweller individuals was selected. A total of 20,534 subjects were examined, giving a response rate of 88.2%; subjects not receiving an examination were absent from home after three attempts to contact them, or refused to have a clinical examination. A total of 9821 adult participants were selected, but 9255 had a periodontal examination, as the other 566 subjects were completely edentulous. Subjects were divided into five age groups: 18, 20 - 34, 35 - 44, 45 - 64 and 65 - 79 years old.

The study was approved and supervised by an ethical committee specifically created for the study by the Colombian Health Ministry in collaboration with the Universidad Javeriana (Bogotá, Colombia). All participants signed informed consent forms. All procedures were performed following the Helsinki Declaration about research methods on human beings.

Sampling procedures

The study used multi-stage, stratified, probability sampling procedures. As a first stage, Colombian municipalities were selected from each of the six regions of the country using randomized simple sampling and controlling for provision of public services and membership in different health insurance systems. As a second stage, municipalities were divided into mainly urban or rural communities; urban areas were classified into large cities and other towns, while rural areas were divided into small villages and other rural areas.

In large cities, cartographic maps were used to select sectors, adjusting the selection probability according to the size of each sector, and then block groups were randomly selected. In small cities, block groups were randomly selected directly from maps. In rural areas, block groups were randomly selected in small villages or houses in close proximity for dispersed rural areas. In each block, the houses to be visited by the examining teams were randomly selected. No replacement was used when the inhabitants of a house could not be located by the examining team (*Figure 1*).

Exclusion criteria were presence of severe physical or mental disabilities and other health conditions that required the use of prophylactic antibiotics.

Clinical team training and reproducibility

A total of 24 clinical teams participated in the study. Each team had four members: head coordinator, examining dentist, surveyor and an assistant. Each team had a portable dental chair that was moved to the different locations. All periodontal assessments were recorded using a pre-established computerized format and performed using the North Carolina periodontal probe (15 UNC, Hu-Friedy Mfg Co., Chicago, IL, USA).

Each of the examining dentists received a theoretical course of 52 hours. Subsequently, the clinical training course included examination of 285 people on all the clinical conditions assessed in the study; approximately 45 subjects were allocated for periodontal probing training. Agreement with a gold-standard periodontal specialist was measured. During the study, 1144 re-examinations were performed. Two-thirds of the re-examinations were used to calculate inter-examiner reproducibility and one-third intra-examiner reproducibility. Reproducibility was assessed by kappa values of 0.9 for intra-examiner measurements and 0.7 for inter-examiner measurements.

Survey and medical examination

A survey with 75 questions was answered by every participant. The first 15 questions were related to demographic and socio-economic aspects; information about age, gender, monthly income and membership in specific health insurance systems was considered for analysis.

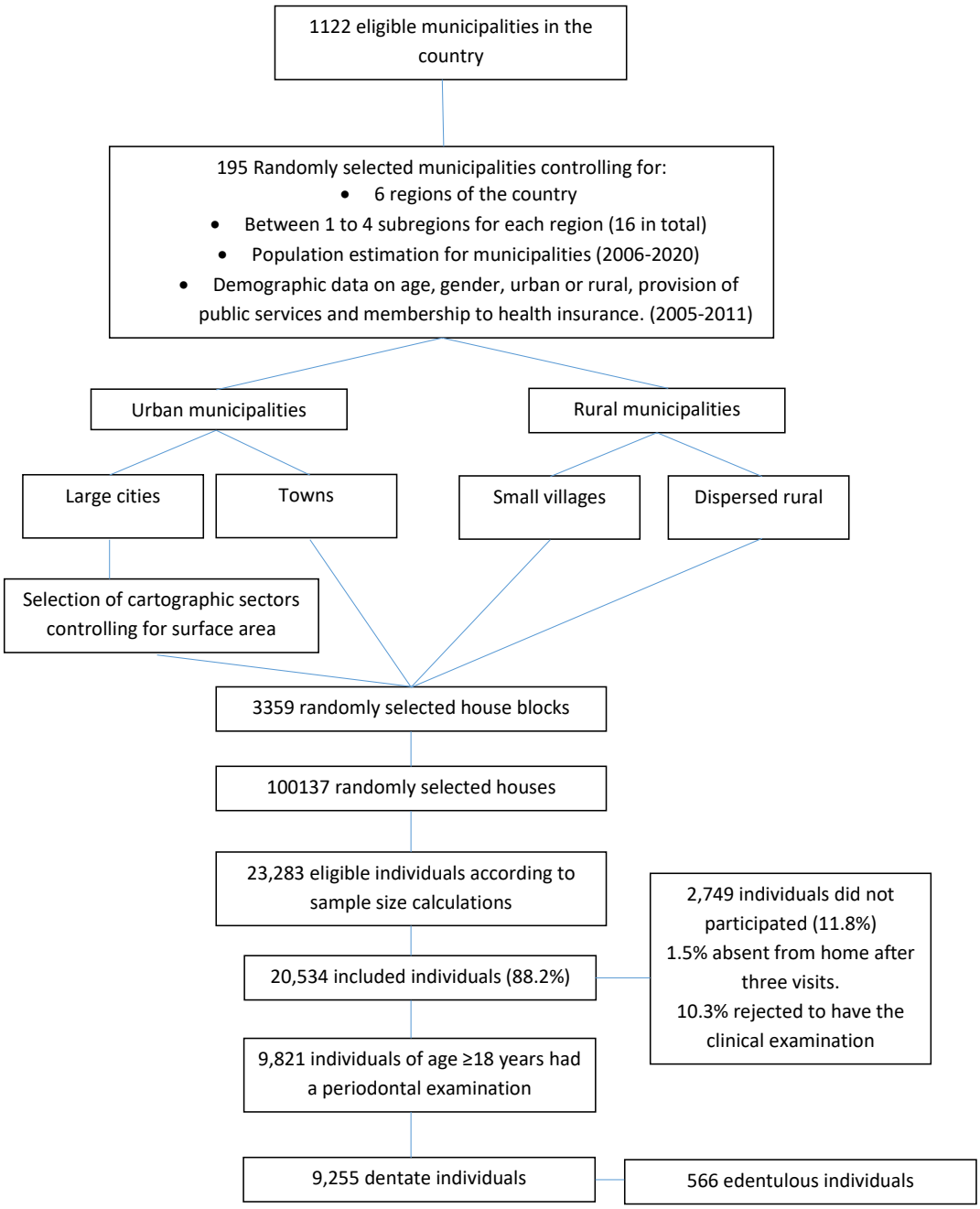

Figure 1. Flowchart of sampling strategy.

The monthly income was classified in three categories: less than the minimum monthly salary, from 1 to 2 minimum monthly salaries and > 2 minimum monthly salaries. The two main types of health insurance systems in Colombia are the contributory and the subsidiary systems, which are related to a higher or lower income. The second 37 questions were related to lifestyle and oral health aspects. The third section had 23 questions that were related to oral hygiene and smoking. Tooth-brushing frequency was classified as not every day or once, twice, or three or more times daily. Use of dental floss could be never, not every day or everyday use. A smoking habit was classified as: current smoker, former smoker, occasional smoker and non-smoker. Presence of diabetes was dichotomously reported.

Clinical examination

All permanent teeth, except third molars, were clinically examined at six sites per tooth. The following clinical parameters were recorded: number of teeth, pocket depth and level of the gingival margin. When the gingival margin was apical to the cemento-enamel junction, a negative score was given, and presence of gingival recession was registered.

Data analysis

Analysis was performed for all sites and buccal sites separately, reporting presence of GR severity as ≥ 1 mm, ≥ 3 mm and ≥ 4 mm. Prevalence of GR was defined as percentage of the population presenting with ≥ 1 site with the different GR depth thresholds. Extent was defined as the percentage of teeth presenting with the GR thresholds.

Finally, severity was the mean depth in millimeters for GR thresholds. An additional analysis of the presence of buccal GR for each specific tooth type in both jaws was performed.

A multivariate logistic regression analysis was designed to assess factors related to the presence of buccal GR ≥ 4 mm. Included variables were age, gender, living area, income, smoking, presence of diabetes, toothbrushing frequency and use of dental floss. Data analysis was performed using R software, (R 2.9.2, R Foundation for Statistical Computing, Vienna, Austria). Significant variables were those with $p < 0.05$. Risk ratios were calculated with 95% confidence intervals.

Results

Number of teeth

A total of 5.76% of the selected sample were completely edentulous, mainly in the age range of 65 - 79 years. The mean number of teeth was 21.7 (0.07), which decreased from 27.5 teeth at age 18 to 8.0 teeth in the age range 65 - 79 years (*Table 1*).

Table 1. Number of participants and mean number of teeth.

Characteristic	Participants n (%)	Mean number of teeth
Age (yrs)		
18	1809 (18.4)	27.5
20 - 34	2855 (29.1)	26.7
35 - 44	1686 (17.2)	23.8
45 - 64	2291 (23.3)	17.7
65 - 79	1180 (12.0)	8.0
Gender		
Male	3581 (36.5)	22.5
Female	6240 (63.5)	21.0
Health insurance system		
Contributory (higher-income)	3357 (34.2)	22.4
Subsidiary (lower-income)	5362 (54.6)	20.7
Living area		
Urban	7674 (78.1)	22.1
Rural	2147 (21.9)	20.2
Smoking habit		
Non-smoker	6755 (68.8)	22.7
Smoker	723 (7.4)	21.1
Occasional smoker	533 (5.4)	22.8
Former smoker	1810 (18.4)	18.8
Diabetes mellitus		
Yes	383 (3.9)	15.6
No	9438 (96.1)	22.0
Total	9821	21.7

Prevalence, extent and severity of GR

Presence of GR was common in the studied population; 69.7% of subjects had ≥ 1 site with GR ≥ 1 mm, and 30.3% had ≥ 1 site with GR ≥ 3 mm. The prevalence of GR increased with aging: at age 18, prevalence of GR ≥ 1 mm was 15.6%; in the age range 20 - 34 it was 46.1%; after age 45 prevalence reached above 90% (*Table 2*).

Regarding extent, a total of 28.6% of teeth were affected by GR ≥ 1 mm, and 7.6% by GR ≥ 3 mm. Extent of GR increased among older age groups; GR ≥ 1 mm affected only 1.2% of teeth at age 18, increasing to affect 76.0% of teeth in the age range 65 - 79 years. A total of 20.4% of teeth had their buccal surfaces affected by GR ≥ 1 mm, 3.8% of teeth had buccal surfaces affected by GR ≥ 3 mm, and 1.9% of teeth had their buccal surfaces affected by GR ≥ 4 mm. Mean severity (SE) of all GR was 2.03 mm (0.008); for buccal surfaces only it was 1.95 mm (0.009; *Table 3*).

A clear tendency was seen for men, people affiliated with the lower income health insurance, those living in rural areas, smokers and former smokers, and diabetic patients to have a greater prevalence and extent of GR. Prevalence of deep GR ≥ 3 mm was 34.2% for men compared to 26.6% for women, 33.2% for the low income insurance compared to 29.2% for the higher income, and 33.0% for people living in rural areas compared to 29.6% in urban areas. These differences were observed for smoking and diabetic categories also: prevalence of GR ≥ 3 mm was 36.6% for smokers compared to 25.6% for non-smoking individuals, and 50.3% for diabetic patients compared to 29.6% for non-diabetic patients. For deep GR, ≥ 3 mm and ≥ 4 mm, the extent values were frequently double for people affiliated with the low income insurance system, smokers, former smokers and diabetic subjects compared with their counterparts. These differences could be seen for all surfaces and buccal surfaces (*Table 2*).

Presence of buccal GR by tooth type

The presence of buccal GR demonstrated significant differences among tooth types. For the maxilla, the most frequently affected teeth were first molars, followed by first premolars, second premolars, second molars and canines. In the maxilla, the least affected teeth were the incisors. While 26 - 29% of first molars had GR ≥ 1 mm, only 3 - 4% of incisors had GR of this severity. For the mandible, the most frequently affected teeth were the first and second premolars, followed by the canines, central incisors and first molars, with a similar magnitude, then lateral incisors; finally, the least frequently affected teeth in the mandible were second molars. In the mandible, 25 - 26% of premolars were affected by GR ≥ 1 mm, while 10 - 12% of second molars were affected; differences were smaller than in the maxilla (*Table 4*).

Table 2. Prevalence of different gingival recession (GR) cut-off values for all sites and buccal sites, % (SE).

	GR ≥ 1 mm		GR ≥ 3 mm		GR ≥ 4 mm	
	All	**Buccal**	**All**	**Buccal**	**All**	**Buccal**
Age range						
18	15.6 (2.0)	10.5 (1.7)	0.2 (0.1)	0.2 (0.1)	0.08 (0.09)	0.04 (0.02)
20 - 34	46.1 (0.8)	34.8 (0.7)	7.2 (0.4)	5.2 (0.4)	3.7 (0.4)	2.5 (0.4)
35 - 44	81.0 (0.4)	70.6 (0.5)	25.1 (0.6)	17.2 (0.3)	9.6 (0.3)	6.3 (0.2)
45 - 64	94.0 (0.1)	88.5 (0.2)	59.0 (0.5)	42.1 (0.5)	40.5 (0.6)	22.1 (0.4)
65 - 79	98.4 (0.05)	95.5 (0.1)	79.6 (0.5)	57.5 (0.9)	60.9 (0.9)	37.1 (1.0)
Gender						
Male	74.4 (0.3)	65.3 (0.4)	34.2 (0.5)	25.7 (0.4)	21.6 (0.5)	13.4 (0.4)
Female	65.2 (0.6)	56.7 (0.6)	26.6 (0.5)	17.5 (0.3)	16.6 (0.4)	8.8(0.2)
Health insurance system						
Contributory (higher-income)	69.5 (0.4)	61.9 (0.4)	29.2 (0.3)	21.2 (0.3)	16.4 (0.3)	9.3(0.2)
Subsidiary (lower-income)	72.0 (0.6)	61.8 (0.8)	33.2 (0.7)	22.9 (0.5)	22.0 (0.6)	13.4 (0.4)
Living area						
Urban	68.8 (0.3)	61.2 (0.4)	29.6 (0.3)	21.6 (0.3)	17.6 (0.3)	10.8 (0.2)
Rural	73.0 (1.4)	60.0 (1.7)	33.0 (1.5)	21.4 (1.1)	24.3 (1.3)	11.9 (0.9)
Smoking habit						
Non-smoker	66.0 (0.6)	55.9 (0.6)	25.6 (0.5)	17.0 (0.3)	15.1 (0.4)	8.5 (0.3)
Smoker	69.0 (0.6)	62.1 (0.7)	36.6 (0.5)	30.6 (0.5)	26.5 (0.5)	15.3 (0.5)
Former smoker	83.1 (0.3)	78.1 (0.3)	45.2 (0.6)	34.4 (0.6)	29.1 (0.6)	18.4 (0.4)
Diabetes mellitus						
Yes	93.4 (0.2)	77.2 (0.6)	50.3 (1.0)	35.6 (1.0)	37.8 (1.0)	21.2 (0.8)
No	68.8 (0.5)	60.3 (0.5)	29.6 (0.4)	21.0 (0.3)	18.4 (0.4)	10.7 (0.2)
Total	69.7 (0.4)	60.9 (0.5)	30.3 (0.4)	21.5 (0.3)	19.1 (0.4)	11.1 (0.2)

SE, standard error

Table 3. Extent of teeth with different gingival recession (GR) cut-off values for all sites and buccal sites, % (SE). Mean severity of different cut-off values of GR in mm (SE).

	GR ≥ 1 mm		GR ≥ 3 mm		GR ≥ 4 mm	
	All	**Buccal**	**All**	**Buccal**	**All**	**Buccal**
Age range						
18	1.2 (0.1)	0.7 (0.1)	0.01 (0.01)	0.01 (0.01)	0.01 (0)	0
20 - 34	7.5 (0.2)	4.8 (0.2)	0.7 (0.06)	0.4 (0.06)	0.3 (0.03)	0.2 (0.03)
35 - 44	25.7 (0.3)	17.5 (0.2)	2.7 (0.1)	1.5 (0.05)	0.8 (0.05)	0.4 (0.02)
45 - 64	52.9 (0.4)	38.0 (0.3)	15.6 (0.3)	7.8 (0.2)	7.9 (0.3)	3.8 (0.1)
65 - 79	76.0 (0.6)	60.8 (0.7)	37.4 (0.8)	18.1 (0.5)	22.3 (0.6)	9.4 (0.3)
Gender						
Male	31.0 (0.4)	22.8 (0.3)	8.4 (0.2)	4.7 (0.1)	4.4 (0.1)	2.2 (0.06)
Female	26.2 (0.4)	18.1 (0.3)	6.9 (0.2)	3.0 (0.1)	3.5 (0.1)	1.5 (0.08)
Health insurance system						
Contributory (higher-income)	27.0 (0.3)	19.6 (0.2)	5.9 (0.1)	2.8 (0.1)	2.7 (0.1)	1.1 (0.03)
Subsidiary (lower-income)	31.4 (0.4)	22.0 (0.3)	9.7 (0.3)	5.1 (0.1)	5.3 (0.2)	2.7 (0.1)
Living area						
Urban	27.5 (0.2)	20.0 (0.2)	6.7 (0.1)	3.6 (0.1)	3.4 (0.07)	1.7 (0.03)
Rural	32.4 (1.1)	22.1 (0.7)	6.9 (0.2)	4.7 (0.3)	5.9 (0.5)	2.5 (0.2)
Smoking habit						
Non-smoker	24.2 (0.4)	16.9 (0.3)	5.8 (0.2)	2.6 (0.1)	2.9 (0.1)	1.3 (0.09)
Smoker	34.7 (0.6)	26.2 (0.5)	11.2 (0.4)	6.7 (0.2)	6.1 (0.2)	3.2 (0.1)
Former smoker	42.5 (0.5)	31.1 (0.4)	13.0 (0.3)	7.0 (0.2)	6.7 (0.2)	3.4 (0.1)
Diabetes mellitus						
Yes	56.2 (1.3)	38.5 (0.7)	20.9 (0.5)	9.7 (0.3)	11.5 (0.4)	6.0 (0.3)
No	27.6 (0.3)	19.8 (0.2)	7.2 (0.2)	3.6 (0.1)	3.7 (0.1)	1.7 (0.06)
Total	28.6 (0.3)	20.4 (0.2)	7.6 (0.2)	3.8 (0.1)	4.0 (0.1)	1.9 (0.05)
Severity of GR	2.2 (0.01)	1.9 (0.009)	3.5 (0.008)	3.4 (0.006)	4.3 (0.007)	4.2 (0.004)

SE, standard error

Table 4. Prevalence of buccal gingival recession (GR) by tooth type, % (SE).

GR depth	Tooth type													
Maxilla	17	16	15	14	13	12	11	21	22	23	24	25	26	27
≥ 1 mm	16.9	29.0	18.7	22.2	12.3	4.6	4.3	3.5	4.3	12.6	19.0	15.8	26.6	18.1
	(0.3)	(0.5)	(0.3)	(0.3)	(0.3)	(0.1)	(0.1)	(0.1)	(0.2)	(0.3)	(0.5)	(0.3)	(0.4)	(0.3)
≥ 3 mm	1.9	4.1	1.9	2.9	2.3	0.3	0.4	0.1	0.7	1.1	3.3	2.0	4.3	2.3
	(0.06)	(0.1)	(0.06)	(0.07)	(0.2)	(0.04)	(0.02)	(0.01)	(0.2)	(0.04)	(0.1)	(0.1)	(0.1)	(0.1)
Mandible	47	46	45	44	43	42	41	31	32	33	34	35	36	37
≥ 1 mm	12.2	14.4	26.2	26.6	12.7	11.0	15.1	14.9	10.4	13.9	25.8	25.9	14.3	10.4
	(0.3)	(0.4)	(0.4)	(0.4)	(0.3)	(0.2)	(0.3)	(0.3)	(0.2)	(0.3)	(0.4)	(0.4)	(0.4)	(0.3)
≥ 3 mm	0.4	1.5	4.7	5.0	2.5	1.0	1.8	1.9	1.1	2.4	4.2	4.6	1.0	0.8
	(0.04)	(0.05)	(0.1)	(0.1)	(0.09)	(0.04)	(0.07)	(0.2)	(0.08)	(0.08)	(0.1)	(0.2)	(0.06)	(0.04)

SE, standard error

Factors associated with buccal GR ≥ 4 mm

In the multivariate regression analysis, older age, male gender, being affiliated with the low income health insurance system, being a former smoker or a diabetic patient were significantly associated with the presence of buccal GR ≥ 4 mm. In addition, lower frequency of daily toothbrushing (≤ 1 a day) was associated with higher prevalence of deep buccal GR. Performance of interdental cleaning was not associated with the presence of these deep GR lesions (*Table 5*).

Discussion

The prevalence of GR in the studied population was high: 69.7% of the population had ≥ 1 site with GR ≥ 1 mm, and 30.3% had ≥ 1 site with GR ≥ 3 mm. The extent of GR was considerable: 28.6% of teeth were affected by GR ≥ 1 mm, and 7.6% by GR ≥ 3 mm. Other sectional studies have observed high prevalence of GR, describing how it could represent the majority of attachment loss that is observable when aging (Yoneyama *et al.,* 1988).

There exist few reports on the prevalence of GR based on national representative samples. Another Latin American study by Rios *et al.* (2014) described the prevalence of GR in a sample of 1023 individuals from Porto Alegre, Brazil: the presence of GR ≥ 1 mm in one tooth was found in 99.7% of individuals, and of GR ≥ 3 mm in 75.4%. A previous similar study by Susin *et al.* (2004) evaluated 1460 individuals from the same city: the prevalence of GR ≥ 1 mm was 83.4%, and of GR ≥ 3 mm was 51.6%. In France, Sarfati *et al.* (2010) used data from 2074 subjects included in the National Periodontal and Systemic Examination Survey to perform risk assessment for GR: these authors found GR 1 to 3 mm deep in 76.9% of individuals, and GR 4 to 5 mm in 5.9%. Finally, in the USA, Albandar and Kingman (1999) used data from the National Health and Nutrition Examination Survey (NHANES III) that included 9689 subjects; the prevalence of GR ≥1 mm was 57.9%, and GR ≥ 3 mm was 22.4%. Data from the present study showed lower prevalence of GR than studies in Brazil, a fairly similar prevalence to the study in France, but larger than the USA study.

Table 5. Multivariate regression models of factors associated with the presence of buccal gingival recession (GR) ≥ 4 mm.

Associated factors	OR	95% CI
Age		
18 (ref)	1	
20 - 34	61.06*	3.56 - 1048.65
35 - 44	264.75*	15.93 - 4400.97
45 - 64	1044.90*	74.42 - 14670.95
65 - 79	1996.32*	121.52 - 32794.66
Gender		
Female (ref)	1	
Male	1.24*	1.15 - 1.34
Living area		
Urban (ref)	1	
Rural	1.28	0.86 - 1.90
Income		
> 2 salaries (ref)	1	
1 - 2 salaries	1.09	0.87 - 1.37
< 1 salary	1.10	0.79 - 1.52
Health insurance		
Contributory (higher income, ref)	1	
Subsidiary (lower income)	1.76*	1.61 - 1.93
Smoking habit		
Non-smoker (ref)	1	
Smoker	1.15	0.78 - 1.70
Former smoker	1.46*	1.30 - 1.64
Diabetes mellitus		
Non-diabetic individual (ref)	1	
Diabetic individual	1.48*	1.12 - 1.95
Toothbrushing frequency		
≥ 3 day (ref)	1	
2 day	0.82*	0.75 - 0.90
≤ 1 day	1.51*	1.12 - 1.93
Dental floss use		
Daily (ref)	1	
Occasional	1.06	0.95 - 1.18
Never	1.00	0.83 - 1.20

*$p < 0.05$; OR,odds ratio; CI, confidence interval; ref, reference

When extent values for GR were compared among studies, a similar trend of results was observed. The two studies performed in Brazil demonstrated larger extent of GR; for example Rios *et al.* (2014) described the extent of GR ≥ 1 mm as affecting 67.6% of teeth, and for GR ≥ 3 mm as 27.8%. Data from the study by Susin *et al.* (2004), performed 10 years earlier, showed lower values; extent of GR ≥ 1 mm was 43.5% of teeth, and for GR ≥ 3 mm, it was 17.0%. In contrast, in the USA the report by Albandar and Kingman (1999) described the extent of GR ≥ 1 mm as 22.3%, and for GR ≥ 3 mm as approximately 6.4%. Large differences in the extent of GR when comparing two different populations were reported by the classical study of the natural history of periodontal disease in man by Löe *et al.* (1992). Although prevalence of GR was high in both populations, at age 40 years 90.2% of a Norwegian group of individuals and 100% of a Sri Lankan group were affected by GR, but the extent values were different: 26.2% of buccal sites in the Norwegian group compared to 50.0% of the Sri Lankan group were affected by GR.

The prevalence of buccal GR demonstrated great differences according to tooth type. The most affected tooth types were the first maxillary molars, first and second mandibular premolars, and the first maxillary premolar, while the least affected tooth types were the central and lateral maxillary incisors, the lower second molars, the lower lateral incisors and the maxillary canines. Others studies have described GR by tooth type. For example, Albandar and Kingman (1999) described maxillary first molars and mandibular central incisors as the most affected tooth types when considering buccal and mesial sites. These authors found much greater prevalence and severity of GR in buccal sites. Sarfati *et al.* (2010) did not find any specific distribution pattern for GR according to tooth types when analyzing mid-buccal sites; nevertheless, incisors and canines in both jaws were the most affected teeth. Susin *et al.* (2004) found that mandibular central incisors, second mandibular premolars, first maxillary premolars and molars were the most affected teeth when measuring six sites per tooth. Serino *et al.* (1994) described a larger prevalence of buccal GR in incisors and canines for young subjects, and for maxillary molars, maxillary premolars and mandibular premolars for older subjects in a group of 225 subjects. Daprile *et al.* (2007) referred to mandibular premolars, first maxillary molars and maxillary premolars as the most affected teeth for buccal GR in a small sample of Italian dental students followed for 5 years. The majority of the reported studies described results for buccal GR as in the present study. Compared to the results of these studies there were coincidences in maxillary first molars, mandibular premolars and first maxillary premolar as tooth types frequently affected by buccal GR. However, differences from other populations could be related to jaw or tooth anatomy that could predispose teeth for GR.

Several factors were significantly related to the occurrence of buccal GR ≥ 4 mm: older age, male gender, being affiliated with the lower income health insurance, being a former smoker, diabetes and less frequent toothbrushing. Others have found a significant association between GR and age, when analyzing tooth-level data (Susin *et al.,* 2004), buccal sites only (Sarfati *et al.,* 2010), or tooth-level and buccal sites (Rios *et al.,* 2014). Similarly, an association with male gender has been found (Albandar and Kingman, 1999; Sarfati *et al.,* 2010; Rios *et al.,* 2014); based on buccal-only, buccal-mesial or tooth-level analysis. However, the study by Susin *et al.* (2004) did not find an association between GR and gender. Higher probability of presenting with deep GR with older age has been related to the cumulative periodontal attachment loss with aging, while the association with male gender and lower income are commonly explained as a consequence of difficulties in dental care access, or lower dental self-care related to lower education level (Borrel and Papapanou, 2005). Similarly, other national studies on GR have found that smoking presence is related to GR prevalence and extent. In the present study former smokers, but not current smokers, showed association with deep GR. Smoking was identified as a significantly related factor by Susin *et al.,* (2004), Sarfati *et al.,* (2010) and Rios *et al.,* (2014) based on buccal-only and tooth-level assessments. In the study by Rios *et al.* (2014) smoking was associated with GR ≥ 3 mm, but not with GR ≥ 5 mm. Diabetes was not associated with GR in other studies. The majority of these indicated factors have been implicated as risk factors for periodontitis (Borrell and Papapanou, 2005), which would indicate that GR could be a related phenomenon to severe periodontitis. However, a periodontitis-associated parameter, such as pocket depth, was not included in the analysis.

Interestingly, less frequent toothbrushing, ≤ 1 a day in contrast to 2 or ≥ 3 times a day, was significantly associated with the presence of buccal GR ≥ 4 mm. Proximal tooth cleaning with dental floss was not related to deep buccal GR. The study by Rios *et al.* (2014) reported a similar finding when considering GR ≥ 5 mm in all sites, but not when only considering buccal GR ≥ 5 mm sites. Other studies have concluded that people performing more frequent toothbrushing show a larger number of sites with GR (Vehkalahti, 1989; Tozer and Ozdemir, 2009), or have found an association between traumatic toothbrushing and occurrence of GR (Litonjua *et al.,* 2003; Tozer and Ozdemir, 2009). Although information regarding toothbrushing techniques or type of toothbrush was not collected in the present study, it could be stated that toothbrushing is inversely correlated with deep buccal GR presence, probably as an effort for plaque control and improved periodontal status.

The present study, although including a large national representative sample of individuals, had several limitations. A group of individuals 19 years old was not included, and plaque indices were not collected, as the clinical examination was performed using portable dental chairs and the exam conditions were not the same as in dental office assessments. Finally, some of the variables, for example smoking behavior and diabetes, were self-reported by participants.

It could be concluded that GR is a common periodontal finding in the Colombian population. For GR ≥ 1mm prevalence was 69.7%, and extent was 28.6% of teeth. Factors traditionally associated with periodontitis were also associated with buccal GR occurrence, namely older age, male gender, lower income, being a former smoker, diabetes presence and less frequent toothbrushing.

Conflict of interests and source of funding statement

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