Prevalence of Severe Periodontitis in a Colombian Adult Population

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Abstract

Objective: To determine the prevalence of severe chronic periodontitis in a cross-sectional national sample of Colombian adults held by the Colombian Health Ministry.

Methods: In 2014, a selected national sample, based on a multi-stage, stratified method, received an oral examination. Periodontal data was collected on 9,821 adults aged 18-79 years following a full-mouth examination. Pocket depth (PD) and clinical attachment loss (CAL) served for extent and severity of disease description. Two systems for detection of severe periodontitis cases were used. The first was the criteria for surveillance of periodontitis described by the Center for Disease Control and the American Academy of Periodontology (2014), the second was the periodontitis case definition described by the European Federation of Periodontology (EFP, 2005). Weighted prevalence was calculated and logistic models constructed to assess the association with demographic, socio-economic and oral hygiene factors.

Results: Based on the CDC-AAP criteria, the prevalence estimate of severe periodontitis was 10.6% (standard error (SE) 0.2), and for moderate periodontitis was 43.6% (SE 0.4). Adults aged after 65 had a high prevalence of severe periodontitis, 26.0% (SE 0.9), and a low mean number of teeth, 8.0 (SE 0.1). Increases in the presence of PD leveled after age 45, but CAL continued to increase in the age range 65-79, as approximately 23.7% of teeth, not previously affected, demonstrated CAL ≥ 1 mm at this age range. Factors associated with severe periodontitis were age, gender, income, smoking habits and presence of diabetes. For the EFP detection system, not-daily oral hygiene had an association.

Conclusions: Prevalence of severe periodontitis was 10.6%, a lower percentage than other epidemiological studies in Latin America; but still a high proportion of individuals, which would support the importance of preventive and treatment strategies for the country.

Key words: Chronic periodontitis, cross-sectional survey, epidemiology, prevalence, Latin America, population surveillance.

Introduction

Dental caries and periodontal disease constitute the two main causes of tooth loss in adult populations (Ong 1998; Klock and Haugejorden 1991; Susin *et al.*, 2005). Epidemiological studies of these diseases contribute to establishing the affected percentage of the population and understanding of associated factors, in order to design preventive and treatment strategies. A recent study by Kassebaum *et al.*, (2014), evaluated the global burden of 291 diseases, including severe periodontitis. Using three compatible diagnostic criteria for severe periodontitis based on pocket depth (PD) ≥ 6 mm, PD > 5 mm, and clinical attachment loss (CAL) ≥ 6 mm, its prevalence was estimated at 11.2% (95% Uncertainty Interval, (U.I.), 10.4% to 11.9%). Using the proposed criteria for surveillance of periodontitis by the CDC-AAP (Page *et al.,* 2012), the prevalence of severe, moderate and mild periodontitis in USA adults was estimated at 8.5%, 30.0% and 8.7% respectively (Eke *et al.,* 2012). An epidemiological study in Germany using the CDC-AAP criteria estimated the prevalence of severe periodontitis to be 15.7%, and moderate periodontitis 33.3%, according to the SHIP-Trend study (Schűtzhold *et al.,* 2015).

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Meanwhile, an Australian epidemiological study measured the prevalence of severe periodontitis as approximately 2.4%, and moderate periodontitis 20.5% (Slade *et al.,* 2007). These data show variability in the occurrence of severe periodontitis in different populations.

Using standardized criteria for periodontitis case reporting has enabled the evaluation of burden and described variability of disease estimates among geographic regions. A systematic review by Savage *et al.* (2009) on definitions for periodontitis found great variability for individual thresholds of PD and CAL in diagnosing periodontitis. For PD, thresholds varied between depths of ≥ 3 mm to ≥ 6 mm at single, two, four or the deepest PD sites of a tooth sextant. For CAL values, the authors found a range from a loss of ≥ 2 mm to ≥ 6 mm, at a variable number of sites. As mentioned by other authors, these inconsistencies in case definitions affect disease distribution estimates and restrict comparisons between studies (Borrell and Papapanou, 2005).

Different reviews on periodontal epidemiology have described a higher prevalence of periodontitis in Latin America where it has been reported that the prevalence of severe periodontitis at 20.6% (95% U.I. 12.4 - 31.5) for southern, and at 18.0% (95% U.I. 17.0 - 19.1) for tropical Latin America. (Kassebaum *et al.,* 2014). However, epidemiological studies in Latin America are few, mainly originating from Brazil and Chile (Susin *et al.,* 2004, Susin *et al.,* 2011, Gamonal *et al.,* 2010). Given the low number of epidemiological studies in Latin America, acquisition of data from other Latin American countries would be useful.

In Colombia, the Fourth National Oral Health Study was developed in an effort to obtain a detailed description of oral health conditions of the population (Peñaloza *et al.,* 2015). The aim of the present study was to perform an analysis of full-mouth data from the Colombian Oral Health Study to describe the prevalence of severe periodontitis using proposed case definitions for periodontitis, and its extent and severity according to categories for clinical attachment level (CAL) and pocket depth (PD).

Materials and Methods

Study design

A representative sample of the Colombian population was selected following a stratified, multistage, probability method, using information provided by the Colombian Department of Statistics (DANE, Bogotá DC, Colombia) of the projected population for Colombian municipalities 2005 - 2011. As a first stage, primary sampling units, consisting of Colombian municipalities, were selected according to a randomized simple sampling method (RSS). The municipalities were then divided as being mainly urban or rural communities. Thereafter, urban zones were divided into large cities and other towns, while rural areas were divided into small villages and rural sectors. For large cities, cartographic sectors were chosen using a probability method according to their surface area, and then blocks were selected, using a RSS method. For the other smaller urban municipalities, blocks were chosen directly by the RSS method. In rural municipalities, the RSS method was used to select blocks in small villages, and household groups located in proximity for the countryside. As a final stage, specific households in blocks in urban or rural areas were randomly selected by RSS. No replacement was applied when specific household inhabitants could not be examined. Households that could not be examined after up to three attempts were regarded as non-respondents. (*Figure 1*).

Exclusion criteria were the presence of uncontrolled infectious diseases, severe physical or mental disability, and health conditions that would require administration of antibiotic prophylaxis. 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 created for the study by the Colombian Health Ministry and the Universidad Javeriana (Bogotá, Colombia), agreement #55, 2014. All participants signed informed consent forms. All procedures were performed following the Helsinki Declaration.

Survey and Medical History

A survey with 75 questions was applied to all individuals. This had been validated in three municipalities, urban and rural; a total of 70 surveys served for validation. The first 15 questions of the survey were related to sociodemographic aspects; questions related to age, gender, monthly family income and health insurance membership were analyzed. Several types of health insurance systems exist in Colombia, the two most common being related to a higher income (contributory) or a lower income (subsidiary) than the national monthly minimum wage. The second section comprised 37 questions and was related to lifestyle and oral health. From this section, reasons for the last dental visit were further analyzed. The third section was related to oral hygiene behavior and habits and comprised 23 questions. Questions related to tooth brushing frequency; dental floss use and presence of smoking were analyzed. From the medical history questionnaire presence of diabetes was analyzed.

Periodontal Examination

The periodontal examination was performed by 24 teams composed of four people: head coordinator, examining dentist, surveyor and an assistant.

The clinical examination teams worked with portable dental chairs that included artificial light and chairs for

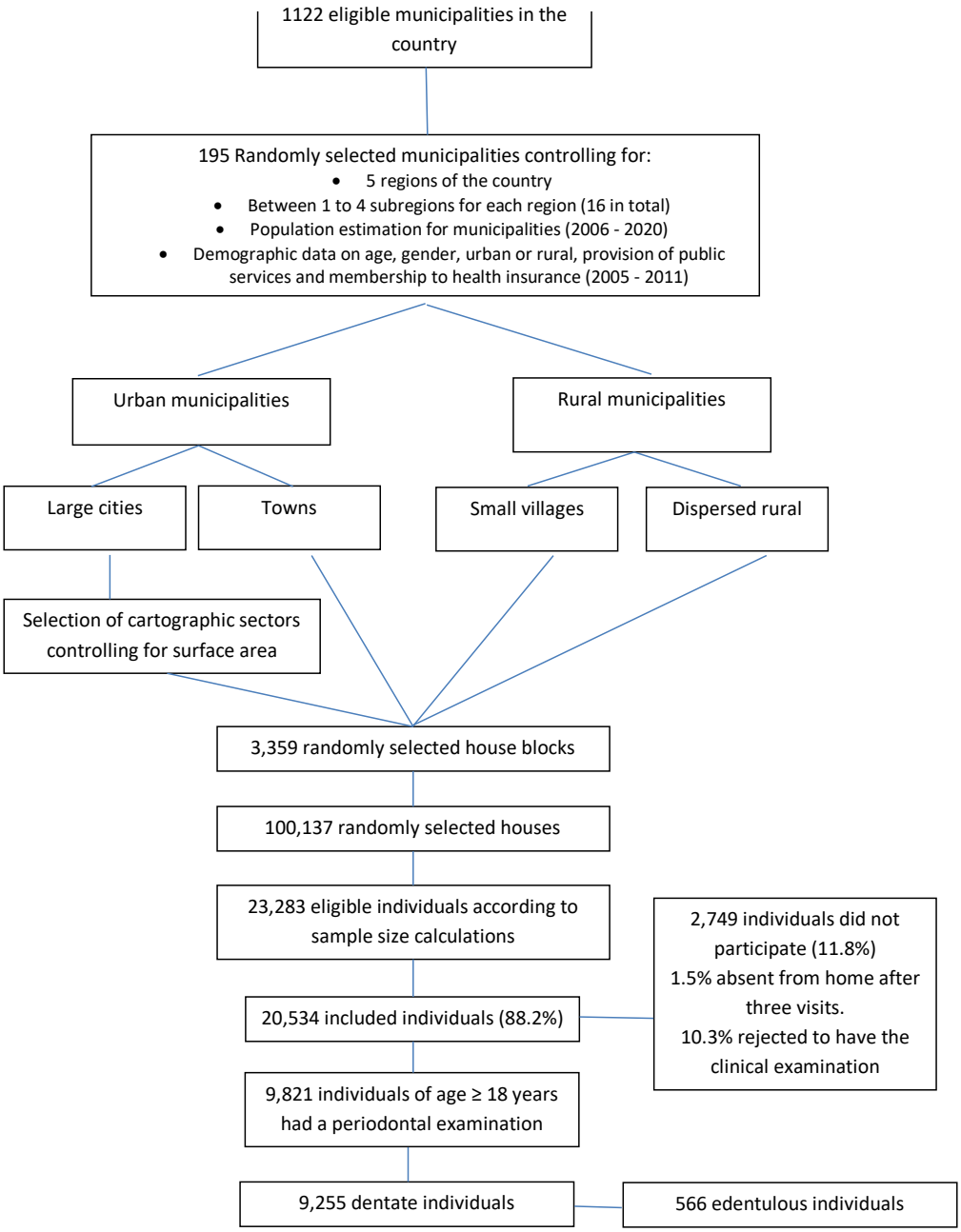

Figure 1. Flowchart of sampling strategy

dentists. Periodontal assessments were recorded in a computerized format and performed using the North Carolina periodontal probe (15 UNC, Hu-Friedy Mfg Co., Chicago, IL, USA). All permanent teeth, except third molars, were examined on six sites. The following clinical parameters were recorded: number of teeth, PD, and position of the gingival margin (GM). The GM was recorded as positive when located below the cement-enamel junction, and negative when located above the cement-enamel junction; thereafter CAL levels were calculated as CAL=PD±GM.

Measurement Training and Reproducibility

All 24 dentists received a theoretical course of 52 hours. Afterwards they were divided into three groups of eight dentists. They participated in a calibration exercise on 45 subjects divided into three groups of 15 patients. Each patient was examined by eight dentists and a calibrated experienced periodontist. Thereafter, during the course of the study 1144 re-examinations were performed. Two-thirds of these exams were used to calculate inter-examiner reproducibility and one-third intra-examiner reproducibility. Measurement reproducibility was assessed by κ analysis, calculated on the site-level for the six Ramfjord index teeth, employing complete coincidence of measurements. Values were 0.75 (range 0.48 - 0.98) for intra-examiner measurements, and 0.49 (range 0.29 - 0.63) for inter-examiner measurements.

Data Analysis

Weighted prevalence of periodontitis cases was described according to two classification systems. First, the case definition for the surveillance of periodontitis described by the AAP-CDC (Page, *et al.*, 2012). The three severity levels: mild, moderate and severe, were calculated. According to this system severe periodontitis cases are identified as having ≥ 2 interproximal sites with CAL ≥ 6 mm, and ≥ 1 site with PD ≥ 5 mm. The second classification system used was the periodontitis case definition proposed by the European Federation of Periodontology (Tonetti and Claffey, 2005). Although intended for the identification of risk factors for periodontitis, and as a consequence only including CAL parameters, it was used to identify possible periodontitis cases at two different severity levels, sensitive and specific. The more severe case definition considers having the presence of proximal attachment loss of ≥ 5 mm in ≥ 30% of teeth present (Tonetti and Claffey, 2005).

Prevalence of periodontitis was calculated measuring the presence of at least one site with CAL ≥ 3 mm or ≥ 5 mm, and PD ≥ 4 mm or ≥ 6 mm (Holtfreter *et al.,* 2015). Meanwhile, the extent was calculated by measuring the percentage of teeth affected, and individuals presenting ≥ 5% or ≥ 10% of teeth with the different CAL and PD categories.

Factors such as age, gender, living in rural or urban communities, income and health insurance system, were analyzed. Income was categorized on three levels according to the minimum monthly salary (COP 689,454, equivalent to USD 203): less than one salary, 1-2 salaries and > 2 salaries. Health insurance systems were placed in two categories: contributory and subsidiary.

Behavioral factors included oral hygiene practices and presence of a smoking habit. Toothbrushing frequency was categorized as not every day, 1, 2 or ≥ 3 times a day. Use of dental floss was categorized as not using floss, not daily use or daily use of floss. Subjects were categorized according to their reasons for dental visits.

Presence of smoking behavior was analyzed by a self-reported questionnaire, categorized as: current smokers, occasional smokers, former smokers or non-smokers. Presence of diabetes mellitus was self-reported by participants.

Weighted factors for measurements were calculated in four steps. First, using the multiplicative inverse of the probability of being included in the sample along the different stages of sampling: municipalities, sectors, blocks, houses and individuals. Second, considering non-response rates and inaccuracies in geostatistical information. Third, a correction according to the total population for Colombian as December 2013, and provision of public services. Lastly a correction was made according to geographic regions and age groups sizes.

Data analysis was performed on SAS (version 9.1, SAS Institute, Cary, NC, USA), and R statistical software (R 2.9.2, R Foundation for Statistical Computing, Vienna, Austria). Variables were analyzed for their relation to the two definitions of severe periodontitis; significant variables were those with $p < 0.05$. Weighted odds ratios and 95% confidence intervals (C.I.) were reported.

Results

Study sample

A target sample size of 23,283 individuals was selected based on previous national studies and Colombian demographic data. A total of 20,534 people were examined, presenting a response rate of 88.2%. From the 11.8% non-response rate, 1.5% of the subjects were absent when the examination teams visited their homes, and the other 10.3% rejected having a clinical examination.

As the periodontal examination was performed only in subjects aged ≥ 18 years to ≤ 79 years, the total of included individuals were 9821. From these individuals, 566 subjects (5.8%) were completely edentulous, resulting in 9255 examined subjects (*Table 1*).

Number of Teeth

A significant proportion of individuals were completely edentulous (5.76%). There were no fully edentulous individuals before age 45, but at later ages the number of edentulous persons increased, up to 32.9% in the age range 65-79 years.

The mean number of teeth was 21.7 (SE 0.07). This mean number decreased from values above 23 teeth until the age of 45 years, to 8.0 teeth after age 65 (*Table 1*). Former smokers had approximately four less teeth than non-smokers. A difference was present in the mean number of teeth between participants with diabetes or without.

Prevalence of Periodontitis Cases

When using the CDC-AAP criteria, the total prevalence of periodontitis was 61.5%, being mild for 7.3%, moderate for 43.6% and severe for 10.6% of the individuals. The percentage of the population with no periodontitis decreased steadily, from 79.0% at age 18 to 11.9% in the age range 65-79 years. Severe periodontitis increased from negligible levels up to age 35, to 8.4% at the age range 35-44, and then to levels above 20% at later ages. In particular, the presence of severe periodontitis cases was nearly double in men (13.9%), compared to women (7.5%). Individuals affiliated with the lower income insurance system had a higher prevalence of severe periodontitis (13.6%), compared to the higher income system (6.8%). Inhabitants of rural areas had a higher prevalence of periodontitis cases compared to individuals living in urban areas. Differences in the prevalence of different periodontitis categories were observed related to smoking habit and the presence of diabetes. For smoking subjects the prevalence of severe periodontitis cases was 18.7%, while it was 8.6% for non-smokers. The prevalence of severe cases was 22.0% for subjects with diabetes compared to 10.2% for subjects without diabetes.

Table 1. Demographic characteristics of Fourth National Oral Health Study participants.

Characteristic	*Periodontally- examined individuals*		*Edentulous individuals*
	n (%)	*Mean number of teeth*	*n (%)*
Age (yrs)			
0-17			
18	1809 (100.0)	27.5	0 (0)
20 - 34	2855 (100.0)	26.7	0 (0)
35 - 44	1678 (99.5)	23.8	8 (0.5)
45 - 64	2121 (92.6)	17.7	170 (7.4)
65 - 79	792 (67.1)	8.0	388 (32.9)
Gender			
Male	3408 (95.3)	22.5	169 (4.7)
Female	5847 (93.7)	21.0	397 (6.3)
Health Insurance System			
Contributory (Higher-income)	3197 (95.2)	22.4	160 (4.8)
Subsidiary (Lower-income)	5009 (93.4)	20.7	353 (6.6)
Living Area			
Urban	7268 (94.7)	22.1	408 (5.3)
Rural	1987 (92.6)	20.2	158 (7.4)
Smoking Habit			
Non-smoker	6468 (95.7)	22.7	289 (4.3)
Smoker	672 (93.0)	21.1	51 (7.0)
Occasional smoker	503 (94.2)	22.8	31 (5.8)
Former smoker	1611 (88.6)	18.8	195 (11.4)
Diabetes Mellitus			
Yes	336 (87.3)	15.6	49 (12.7)
No	8919 (94.5)	22.0	517 (5.5)
Total	9255	21.7	566

For the EFP criteria, total prevalence of periodontitis cases was 67.9%. The sensitive-case definition was present in 53.2% of individuals, and the specific-case definition in 14.7%. The percentage of the population that was not categorized as a periodontitis case fell from 76.9% at age 18, to 6.7% in the age range 65 - 79 years. Meanwhile, the percentage of the population in the greater severity specific-case definition increased from null levels up to age 35 to 59.7% at the age range 65 - 79 years. Presence of the more severe case definition was greater in men than in women, 17.7% compared to 11.9%. This presence was similarly greater with individuals in the lower income health insurance system and rural areas, compared to those in higher income and urban areas. The presence of the specific-case definition was more frequent in smokers (22.6%), than in the non-smokers (11.0%). A difference was present between patients with diabetes (39.3%), compared to the participants without diabetes (13.5%) (*Table 2*).

Probing Depth

Mean PD was 4.43 mm (SE 0.007). When considering the cut-off value of ≥ 4 mm, the presence of pocketing was a common finding in the population. After age 20, over 30% of the population had at least one site with PD ≥ 4 mm. When analyzing cut-off values for deep pockets ≥ 6 mm, presence of at least one deep pocket was lower. The largest prevalence of PD ≥ 6 mm was for the age range 45 - 64 years with an occurrence of 9.8%. A decrease in the proportion of individuals presenting deep pockets was seen at the older age range. The percentage of the population having at least one site with PD ≥ 6 mm was double for men (9.3%), compared to women (4.5%). It was greater for people living in rural areas (8.7%) and having lower-income insurance (7.6%), than people living in urban areas (6.4%) and enrolled in the higher-income insurance system (5.7%). Greater values were seen for current smokers (9.2%), than for non-smokers, (6.9%), but only slightly more prevalent in individuals with diabetes (7.2%), compared to individuals without diabetes (6.9%).

The extent categories had very different proportions depending on the use of several cut-off values. The presence of ≥ 5% and ≥ 10% of teeth with PD ≥ 4 mm increased from very low levels at young ages to around 21-33% in senior adults. For the cut-off value PD ≥ 6 mm, the extent category ≥ 5% of teeth reached 4%; the extent category ≥ 10% reached near 3%. A large increase was seen in the 45 - 64 age group, and a smaller decrease at a later age. (*Table 3*).

Table 2. Weighted percentage of individuals on different categories of periodontitis cases according the CDC-AAP (Page *et al.,* 2012) and EFP (Tonetti and Claffey, 2005) classification systems. Percentage (SE)

	CDC-AAP classification				*EFP definition*		
	No	*Mild*	*Moderate*	*Severe*	*No*	*Sensitive-case*	*Specific-case*
Age							
18	79.0 (5.4)	10.9 (2.3)	9.9 (3.3)	0.2 (0.1)	76.88 (2.3)	23.1 (2.7)	0.02 (0.0)
20 - 34	59.2 (0.4)	11.2 (0.1)	27.0 (0.3)	2.6 (0.1)	52.9 (0.7)	46.3 (0.3)	0.8 (0.04)
35 - 44	33.7 (0.3)	8.2 (0.2)	49.7 (0.3)	8.4 (0.2)	25.0 (0.8)	69.3 (0.4)	5.7 (0.1)
45 - 64	14.8 (0.2)	2.6 (0.1)	61.6 (0.4)	21.0 (0.3)	9.5 (0.3)	58.5 (0.3)	32.0 (0.3)
65 - 79	12.0 (0.5)	0.1 (0.0)	61.9 (1.3)	26.0 (1.1)	6.7 (0.4)	33.6 (1.1)	59.7 (1.6)
Gender							
Male	34.0 (0.63)	6.8 (0.2)	45.3 (0.7)	13.9 (0.3)	28.9 (0.5)	53.4 (1.0)	17.7 (0.3)
Female	42.7 (0.7)	7.8 (0.2)	42.0 (0.7)	7.5 (0.2)	35.1 (0.7)	53.0 (0.7)	11.9 (0.2)
Health Insurance System							
Contributory	42.4 (0.7)	5.5 (0.1)	45.3 (0.6)	6.8 (0.2)	33.9 (0.4)	56.6 (0.8)	9.5 (0.2)
Subsidiary	32.9 (0.6)	8.6 (0.3)	44.9 (0.8)	13.6 (0.3)	28.2 (0.9)	52.0 (0.8)	19.8 (0.4)
Living area							
Rural	31.1 (0.8)	8.4 (0.8)	45.1 (1.4)	15.4 (0.8)	25.6 (0.4)	55.0 (1.4)	19.4 (1.0)
Urban	40.2 (0.4)	7.5 (0.2)	43.0 (0.3)	9.3 (0.1)	33.8 (1.9)	53.2 (0.3)	13.0 (0.2)
Smoking Habit							
Current Smoker	32.8 (1.3)	6.2 (0.3)	42.3 (1.0)	18.7 (0.6)	30.2 (1.3)	47.2 (1.0)	22.6 (0.7)
Occasional smoker	55.6 (1.0)	5.7 (0.4)	30.5 (0.9)	8.2 (0.6)	45.0 (1.0)	46.9 (0.9)	8.1 (0.7)
Former smoker	27.9 (0.7)	3.9 (0.2)	53.8 (0.7)	14.4 (0.5)	21.1 (0.5)	55.0 (0.8)	23.8 (0.7)
Non-smoker	40.6 (0.6)	9.3 (0.3)	41.5 (0.5)	8.6 (0.3)	34.4 (0.6)	54.6 (0.5)	11.0 (0.3)
Diabetes mellitus							
Yes	27.0 (1.3)	0.8 (0.9)	50.2 (1.5)	22.0 (1.1)	12.1 (0.7)	48.6 (1.3)	39.3 (1.2)
No	38.6 (0.5)	8.0 (0.2)	43.2 (0.4)	10.2 (0.2)	32.7 (0.5)	53.8 (0.4)	13.5 (0.3)

SE: Standard error
CDC: Center for Disease Control
AAP: American Academy of Periodontology
EFP: European Federation of Periodontology

Table 3. Prevalence and extent of different pocket depth cut-off values (SE).

	PD ≥ 4 mm				PD ≥ 6 mm			
	≥ 1 site	% of teeth	≥ 5 % teeth	≥ 10 % teeth	≥ 1 site	% of teeth	≥ 5 % teeth	≥ 10 % teeth
Age range								
18	16.6 (2.0)	1.5 (0.4)	9.1 (1.5)	4.7 (1.2)	1.4 (0.4)	0.08 (0.04)	0.16 (0.06)	0.06 (0.06)
20 - 34	30.0 (0.7)	3.9 (0.2)	18.7 (0.7)	11.3 (0.6)	5.9 (0.4)	0.6 (0.1)	1.9 (0.4)	1.4 (0.4)
35 - 44	30.8 (0.6)	4.1 (0.1)	19.3 (0.4)	11.9 (0.4)	5.0 (0.2)	0.5 (0.05)	2.3 (0.2)	1.3 (0.1)
45 - 64	32.0 (0.5)	6.7 (0.1)	26.4 (0.5)	18.3 (0.7)	9.8 (0.3)	1.7 (0.04)	7.6 (0.2)	5.3 (0.2)
65 - 79	35.8 (0.8)	8.6 (0.4)	33.1 (0.8)	21.6 (0.8)	7.8 (0.6)	1.3 (0.1)	6.9 (0.6)	5.1 (0.5)
Gender								
Male	37.7 (0.5)	6.8 (0.2)	27.3 (0.5)	20.8 (0.5)	9.3 (0.3)	1.3 (0.1)	5.3 (0.3)	3.9 (0.3)
Female	24.4 (0.6)	3.2 (0.1)	18.1 (0.4)	16.3 (0.3)	4.5 (0.2)	0.5 (0.02)	2.6 (0.1)	1.5 (0.1)
Total	30.7 (0.5)	5.0 (0.1)	21.6 (0.4)	13.9 (0.3)	6.9 (0.2)	0.9 (0.05)	3.9 (0.2)	2.7 (0.2)

%: Percentage
SE: Standard error

Clinical Attachment Level

Mean CAL was 1.47 mm (SE 0.01). Presence of a single site with the different cut-off values for CAL increased with age. For 18-year-old individuals, 16.9% had one site with CAL ≥ 3 mm, and 1.9% had a site with CAL ≥ 5 mm. For the age range 45 - 64, a total of 93.5% of subjects had a least one site with CAL ≥ 3 mm, and 60.6% had a site with CAL ≥ 5 mm. The presence of CAL ≥ 5 mm was greater in men (39.1%) than in women (28.1%). It was also larger in people with the low-income insurance and living in rural areas than in their counterparts. A difference was present between subjects with or without diabetes. Presence of a site with CAL ≥ 5 mm was 55.7% for participants with diabetes compared to 32.7% for participants without diabetes. Similarly, the values were higher for smokers (43.8%), compared to non-smokers (28.7%).

The extent categories had increases among age groups, for example CAL ≥ 5 mm in at least 5% of teeth was present in 5.6% of subjects aged 20 - 34, but increased to 74.1% in the age range 65 - 79 years. As with other clinical parameters, differences with gender, living area, health insurance system, diabetes and smoking status were seen. The percentage of subjects presenting CAL ≥ 5 mm in at least 5% of the teeth was 50.8% for subjects with diabetes, compared to 25.0% for subjects without diabetes; and 32.3% for smokers, compared to 20.9% for non-smokers (*Table 4*).

Factors Associated with Severe Periodontitis

Older age groups, having a lower income and being a participant with diabetes were significantly associated with severe periodontitis for both classifications ($p < 0.001$). Being male, a former smoker and enrolled in the lower-income health insurance were associated when using the AAP-CDC classification ($p < 0.001$). Being a smoker ($p < 0.001$), lack of routine toothbrushing ($p < 0.01$) or not-daily use of dental floss ($p < 0.001$) had an association when using the EFP classification (*Table 5*).

Discussion

The prevalence of severe periodontitis cases according to the CDC-AAP criteria was 10.6%, and based on the EFP criteria 14.7%, the value for the CDC-AAP criteria was similar to the calculated value of reviews on periodontal epidemiology. A review by Kassebaum *et al.* (2014) calculated the global prevalence of severe periodontitis as 11.2% (95% C.I. 10.4%-11.9%). This review described an increasing prevalence of severe periodontitis for older age groups but having a peak at age 40, no differences between men and women, and Latin American countries having higher prevalence figures. In contrast, the present study found increasing values for severe periodontitis after age 44 and a larger prevalence in men. In the cited review, prevalence for Latin American countries was calculated based on six studies, originating from Brazil and Chile. The prevalence values had a variation between 15.1% and 20.4%, larger values than those found in the Colombian study. In the city of Porto Alegre, southern Brazil, two studies evaluated the prevalence of CAL in 974 individuals older than 30 years, and 584 individuals in the age range 14 - 29 years (Susin *et al.,* 2004, Susin *et al.,* 2011). The older age group showed a high prevalence for CAL; over 90% of the individuals in the age range 50-59 and 60-69 years-old had at least one tooth with CAL ≥ 5 mm. The values in a similar age group, 45-64 years, were lower in the present sample, 60.6%. The young individuals in the Brazilian study had also larger prevalence of CAL; the prevalence of CAL ≥ 5 mm was 17.4%, compared to a prevalence of 11.7% for the 20-34-year-old age group in the Colombian sample. A national study in Chile analyzed a total of 1561 subjects in the age range 35 - 44 and 65 - 74 years by a full-mouth examination (Gamonal *et al.,* 2010).

Table 4. Prevalence and extent of different clinical attachment loss cut-off values (SE).

	CAL ≥ 3 mm				*CAL ≥ 5 mm*			
	≥ 1 site	*% of teeth*	*≥ 5 % teeth*	*≥ 10 % teeth*	*≥ 1 site*	*% of teeth*	*≥ 5 % teeth*	*≥ 10 % teeth*
Age range								
18	16.9 (1.9)	1.4 (0.2)	8.7 (1.3)	4.5 (1.3)	1.9 (0.5)	0.1(0.04)	0.3 (0.2)	0.08 (0.2)
20 - 34	49.0 (0.7)	7.9 (0.3)	32.4 (0.7)	24.4 (0.8)	11.7 (0.4)	1.4 (0.2)	5.6 (0.4)	3.5 (0.4)
35 - 44	78.0 (0.5)	21.9 (0.3)	66.1 (0.6)	58.3 (0.3)	30.1 (0.6)	3.9 (0.2)	18.7 (0.5)	11.3 (0.4)
45 - 64	93.5 (0.1)	47.5 (0.4)	89.8 (0.2)	85.2 (0.3)	60.6 (0.5)	17.9 (0.3)	50.2 (0.6)	40.3 (0.7)
65 - 79	97.3 (0.1)	71.2 (0.7)	95.1 (0.1)	92.1 (0.2)	76.1 (0.6)	36.9 (0.9)	74.1 (0.6)	67.7 (0.8)
Gender								
Male	74.1 (0.3)	29.0 (0.4)	57.5 (0.5)	56.1 (0.4)	39.1 (0.5)	10.5 (0.2)	22.8 (0.5)	25.8 (0.5)
Female	66.2 (0.6)	22.7 (0.3)	48.3 (0.7)	45.4 (0.6)	28.1 (0.5)	7.3 (0.2)	16.8 (0.4)	18.3 (0.4)
Total	70.0 (0.4)	25.8 (0.3)	52.8 (0.5)	50.6 (0.5)	33.5 (0.5)	8.9 (0.2)	25.4 (0.4)	19.7 (0.4)

%: Percentage
SE: Standard error

Table 5. Odd ratio with 95% confidence intervals for factors associated to severe periodontitis according to the AAP (Page *et al.,* 2012) and EFP classification systems (Tonetti and Claffey, 2005). OR (95% CI)

Associated Factor	*Categories*	*CDC-AAP*	*EFP*
Age	18	0.34 (0.23, 0.41)***	0.17 (0.06, 0.42)***
	20 - 34 (ref.)	1	1
	35 - 44	3.74 (3.2, 4.1) ***	15.83 (6.7, 45.7)***
	45 - 64	11.09 (7.8, 13.1) ***	58.76 (18.9, 192.4)***
	65 - 74	14.86 (9.5, 21.6)***	234.90 (88.7, 950.6)***
Gender	Female (ref.)	1	1
	Male	1.72 (1.6, 2.0) ***	0.97 (0.9, 1.1)
Living area	Urban (ref.)	1	1
	Rural	1.29 (0.8, 2.0)	1.21 (0.9, 1.8)
Health insurance system	Contributory (ref.)	1	1
	Subsidiary	1.39 (1.3, 1.6) ***	2.36 (2.1, 2.4)***
Income	> 2 monthly salaries (ref.)	1	1
	1-2 monthly salaries	0.88 (0.8, 0.9)**	1.75 (1.5, 2.0)***
	< 1 monthly salary	1.94 (1.5, 3.0)***	2.69 (2.4, 3.9)***
Toothbrushing	1 day (ref.)	1	1
	< 1 day	1.26 (0.8, 2.1)	2.27 (1.4, 3.3)**
	2 day	1.17 (0.8,1.8)	1.21 (0.8, 2.0)
	≥ 3 day	0.75 (0.4, 1.3)	1.25 (0.9, 1.6)
Dental floss use	Every day (ref.)	1	1
	Never	0.82 (0.7, 1.0)	1.94 (15, 2.2)***
	Occasional	0.91 (0.8, 1.1)	1.42 (1.3, 1.4)***
Reason for dental visits	Certificate (ref.)	1	1
	Treatment	1.74 (0.3, 4.0)	0.54 (0.1, 1.4)
	Emergency	1.50 (0.82, 3.0)	0.39 (0.1, 1.1)
	Prevention/control	0.88 (0.4, 1.9)	0.38 (0.1, 1.0)
Smoking	Non-smoker (ref.)	1	1
	Current smoker	1.09 (0.9, 1.3)	1.57 (1.2, 1.7)***
	Former smoker	1.28 (1.2, 1.4) ***	1.14 (1.0, 1.2)
Diabetes status	Non-diabetic individual (ref.)	1	1
	Diabetic individual	1.97 (1.5, 3.0) ***	3.19 (2.6, 3.3)***

Ref.: Reference, OR: Odd ratio, CI: 95% confidence interval
*: $p < 0.05$
**: $p < 0.01$
***: $p < .001$

Results showed that 58.3% of the younger group and 81.4% of the older had CAL ≥ 5 mm, the values in the present study for the same age groups were 30.1% and 76.1%. However, the mean number of missing teeth for individuals 65 - 74 years in this Chilean study was 15.8, a lower figure than the Colombian sample. As teeth are lost prevalence of periodontitis could diminish, what could partly explain the differences.

A recent report from Eke *et al.,* (2015) calculated severe periodontitis to be 8.9% of the sampled population of 7,066 participants in the NHANES 2009 - 2012 study. In Germany, the Study of Health in Pomerania (SHIP-Trend 2011), calculated the presence of severe periodontitis as 15.7%, using a sample of 3,620 individuals aged 25-81 years, with a half-mouth examination method (Schűtzhold *et al.,* 2015). Another European study performed in the city of Turin, Italy, performed a full-mouth examination on 736 subjects in the age range 20 - 75 years old in which the prevalence of severe periodontitis was 34.9% (95% C.I. 31.2-38.7; Aimetti *et al.,* 2015). In Australia, a national representative sample of 5,505 people of age ≥ 15 years had a full-mouth periodontal examination on 4 sites per tooth; they showed a prevalence of moderate-severe periodontitis of 22.9% and severe periodontitis of 2.4% (Slade *et al.,* 2007). The prevalence of severe periodontitis in the present study was higher than the values reported for the national samples of Australia and the USA, but lower than the

estimates from a German region and a large Italian city. Considering that the study sample by Schűtzhold *et al.* (2015) performed a half-mouth examination, it is possible that prevalence of periodontitis could have been underestimated (Kingman and Albandar, 2002). A French study, though not using the AAP-CDC criteria, has reported lower prevalence of severe CAL. This national representative study analyzed 2,144 individuals in the age range 35 - 64 years with ≥ 6 teeth; the prevalence of CAL ≥ 5 mm was 19.7% (Bourgeois *et al.,* 2007). The prevalence of CAL ≥ 5 mm in the present study was higher, 33.5%.

A review by Sommer *et al.* (2013) on the prevalence of chronic diseases in different countries found that living in a low-middle income country increases the risk for disease development. Since 19.4% is the average index of social disparities for countries with high human development, and 23.7% the average for Latin America, the value for Colombia is higher at 24.1%. In Colombia, access to oral health care services is different in urban and rural areas, and type of dental treatment could differ according to affiliation to different health insurance systems, which is based in income. The great social disparities could be reflected in a significant association between severe periodontitis, demographic and socio-economic factors.

A percentage of 7.4% of study participants described themselves as smokers. The percentage of smoking adults has decreased in Colombia, from 21.4% in 1993 to 12.8% in 2007 (Arenas *et al.,* 2007). Some authors suggest that as the percentage of smokers decreases, the prevalence of periodontitis could also decrease (Bergstrom, 2014). Data from this study shows that the prevalence of severe periodontitis was higher for smokers and former smokers. No differences were found between current and former smokers for periodontitis case definitions and CAL, however PD in former smokers showed more similarities to those in non-smokers, a similar finding to other studies (Bergstrom *et al.,* 2000).

The prevalence of severe periodontitis in participants with diabetes was higher. Interestingly, there were no differences in PD values for the two groups, but there were for CAL, what would imply larger gingival recession..

The present study had some limitations. A non-response analysis was not performed, so it is not possible to know the demographic characteristics of non-respondents. As the majority of these individuals refused to undertake clinical examination, consequently sampling bias cannot be estimated. Other limitations included the presence of 24 examination teams, which could explain low κ values for inter-examiner agreement. Many variables were self-reported. For diabetes status no laboratory tests were performed and therefore the possibility existed of asymptomatic diabetic subjects not aware of abnormal glucose levels.

In conclusion, the results of this national study showed a prevalence of severe periodontitis of 10.6%, according to CDC-AAP criteria, and of 14.7%, according to EFP criteria. These values are lower than the reported prevalence of severe periodontitis in Latin American countries described in other studies. Prevalence of severe periodontitis was significantly associated with age, gender, income, smoking behavior, diabetic status and not routine oral hygiene. A further study on the relationships between specific demographic and socio-economic factors, and the presence of severe periodontitis is warranted.

Acknowledgements and Conflict of interests

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The authors declare that they do not have conflicts of interest.

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