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Prevalence and predictors for clinical attachment loss in adolescents in Latin America: cross-sectional study

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Abstract

Aim: To describe the prevalence, severity and extension of clinical attachment loss (CAL) and to study the predictors in 15- to 19-year-old adolescents from high schools in the Latin America.

Materials and Methods: A cross-sectional, epidemiological study was performed. The sample included 1070 high school adolescents 15–19 years of age from Santiago de Chile (Chile), Buenos Aires, Córdoba, Mendoza (Argentina), Montevideo (Uruguay), Quito (Ecuador) and Medellín (Colombia). Calibrated examiners performed full mouth, six sites per tooth clinical examination.

Results: There was a response rate of 100%. The prevalence of CAL ≥3 mm in ≥1 site was 32.6%, probing pocket depth ≥4 mm was 59.3% and bleeding on probing (BoP) ≥25% was 28.6%. The logistic regression analysis adjusted for cities revealed that smoking (OR = 1.6), attending public school (OR = 2.3) and having a BoP ≥25% (OR = 4.2) were positively associated with CAL ≥3 mm in ≥ 1 site.

Conclusion: Clinical attachment loss was prevalent in Latin America adolescents and it is associated with smoking, attendance public school and BoP.

Key words: adolescent; clinical attachment loss; predictor; probing depth

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Periodontal disease is a heterogeneous group of conditions that affect gum health and tooth supporting structures. Some risk indicators, described for this disease, are socioeconomic level, age, gender, and plaque and bleeding indices. Smoking and diabetes mellitus are major risk factors for periodontal disease (Borrell & Crawford 2012, Genco & Borgnakke 2013).

Surveys in adults performed in Canada, USA and Australia showed 15–30% of clinical attachment loss (CAL) ≥6 mm (Gilbert & Heft 1992, Locker & Leake 1993, Slade et al. 1993). CAL is more prevalent in Latin America adults than in the USA and Europe (Oppermann et al. 2015). The overall prevalence of CAL ≥5 mm was 62.6% among adults in Porto Alegre, Brazil (Susin et al. 2004), and it was 58.3% and 81.4% among 35–44 and 55–74 year-old- subjects in Chile (Gamonal et al. 2010).

The prevalence of CAL ≥3 mm among adolescent population range between 0% and 10.1% (Hoover et al. 1981, Albandar et al. 1997).

Conflict of interest and source of funding statement

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Latin America adolescents presented a prevalence of CAL ≥3 mm of 4.5% in Santiago de Chile, Chile (Lopez et al. 2001), 4% in Santo Domingo, Dominican Republic (Collins et al. 2005), 22.3% in Porto Alegre, Brazil (Susin et al. 2011) and 100% in Cajaiba, Brazil (Corraini et al. 2008).

However, there is a considerable lack of methodological consistency in periodontal epidemiology. Some of methodological aspects consider the use of different periodontal protocols and periodontal probes, missing or insufficient examiner calibration, assessment of different clinical variables, and large variations in the definition of periodontitis (Savage et al. 2009, Holtfreter et al. 2014). Prevalence studies on periodontal disease in Latin America adolescents are marginal (Botero et al. 2015), difficult to compare (Mendoza et al. 2006), and they used partial recording protocol, which tended to underestimate the CAL prevalence (Peres et al. 2012). To overcome these limitations, some authors suggested some principles such as: definition of case as a person with CAL (Lopez & Baelum 2003), examiner calibration, full mouth assessment (Savage et al. 2009) and standardized principles for reporting prevalence and severity of periodontal diseases (Holtfreter et al. 2015).

Taking these factors into consideration, CAL was measured in 15- to 19-year-old secondary school adolescents from Santiago de Chile (Chile), Buenos Aires (Argentina), Córdoba (Argentina), Mendoza (Argentina), Montevideo (Uruguay), Quito (Ecuador) and Medellín (Colombia) to determine the prevalence, severity and extension CAL and to study the predictors.

Material and Methods

Study design

A cross-sectional, epidemiological study was conducted between 2010 and 2012. The target population for this cross-sectional screening study was defined as students the last four grades that cover adolescence in the high schools. The study included 15- to 19-year-old high school adolescents from Santiago de Chile (Chile), Buenos Aires, Córdoba, Mendoza (Argentina), Montevideo (Uruguay), Quito (Ecuador) and Medellín (Colombia), according to data obtained from the Statistics Institute of each country. This age group was selected based on recommendation from World Health Organization for oral health surveys (Petersen & Ogawa 2005). The five countries included in this study, were selected after accepting the invitation from the Federación Iberopanamericana de Periodoncia and then several Universities of these countries were invited to organize the present study.

Sampling and sample size

The sample size was calculated considering the rate of 4.5% of CAL ≥3 mm in ≥1 sites in adolescents described by Lopez et al. (2001), with 95% confidence interval and 1.6% range of error. Thus, the study required a sample of 1032 subjects, plus an oversampling to allow better precision in estimates. According to the Statistics Institute of each country, this study included adolescents from cities mentioned above, representing the total adolescents population in the five countries. The sampling units were schools and unit of analysis was the adolescent.

Sampling – stage 1

The number of subjects in each city is derived by proportionate stratification, according to data from the Statistics Institute of each country. In this study, only urban adolescents were sampled.

Sampling – stage 2

A stratified, random sample was generated using information on the governmental support to high schools to form two strata, one of the high schools receiving partial or total support from the government ($n = 57$), and the other high schools not receiving support ($n = 47$). Within each stratum, schools were selected using a randomization table. All schools were contacted to obtain information of the number of students in the last four grades. However, 16 schools do not respond and four schools declined to participate, leaving 84 schools available for the study.

Sampling – stage 3

The subjects were selected according to gender and age, using a randomization table. The number of individuals to be included in each stratum is derived by proportionate stratification. Subjects undergoing fixed orthodontic treatments at the time of clinical examination or with any condition that required antibiotic premedication prior to the periodontal examination were excluded from the study.

Data collection techniques

Clinical evaluation was carried out in schools, under room light. The examiner was properly sitting down and the subject was lying down on a clinical stretcher. Periodontal clinical parameters were evaluated at six sites in all teeth, excluding third molars. These parameters included probing pocket depth (PPD), dichotomous mesio-buccal, mid-buccal, disto-buccal, disto-lingual, mid-lingual and mesio-lingual measurements of supragingival plaque accumulation (plaque index [PI]), and bleeding on probing (BoP) at the base of the crevice. Clinical attachment loss was determined using the distance from the cement-enamel junction (CEJ) to the free gingival margin (FGM) and the distance from the FGM to the bottom of the pocket/sulcus. From these two measurements, the clinical attachment level (distance from the CEJ to the bottom of pocket/sulcus) was calculated. The assessment of the periodontal supporting tissue status was made with a first generation manual periodontal probe (UNC-15; Hu Friedy Mfg. Co. Inc., Chicago, IL USA). At the time of recording depths, if necessary, measurements were approximated to the nearest whole millimetre. The interdentally measures were probed parallel in relation to the tooth axis. Finally, the subjects were asked to fill a short questionnaire giving details about their demographic information (name, gender, age) and smoking habits.

Reproducibility of the measurements

All examiners in the survey group received theoretical classes, clinical training and calibration in CAL,

which were administered by a senior member of the Periodontal Department of the Faculty of Dentistry, University of Chile (Jorge Gamonal). CAL was used to record the periodontal condition of the individuals. Nine dentists performed the clinical evaluations. Calibration training was performed within successive days. All examinations were repeated until acceptable consistency was achieved. A > 93% of intra-examiner agreement was obtained for CAL ≥1 mm, with an average maximum difference for each subject of 0.3 mm, corresponding to kappa value of 0.88. A > 91% of inter-examiner agreement was obtained for the site with CAL ≥1 mm, with an average maximum difference for each subject of 0.8 mm, corresponding to kappa value of 0.95. The reliability of the examiners was in a range considered good to excellent.

Validity and reliability examinations were performed during the field period at the beginning of the study (Mendoza, Argentina) and then when 50% of the subjects had been examined (Santiago de Chile) (Landis & Koch 1977).

Variable definitions

Clinical attachment loss and PPD were presented as mean (±standard error). According to standards for reporting chronic periodontitis prevalence and severity in epidemiological studies (Holtfreter et al. 2015), the prevalence of CAL was defined as the percentage of subjects who had ≥1 site with CAL ≥1 mm, ≥3 mm and ≥5 mm. The extent of CAL was defined as the percentage of sites/teeth, which had CAL ≥1 mm, ≥3 mm and ≥5 mm. The prevalence of PPD was defined as the percentage of subjects who had ≥1 site with PPD ≥4 mm. The extent of PPD was defined as the percentage of sites/teeth, which had PPD ≥4 mm.

Bleeding on probing and PI were presented as mean (±standard deviation). Also, PI was divided into <30% and ≥30%, the BoP into <25% and ≥25%. Those thresholds were selected because patients with mean PI ≥30% and BoP ≥25% should be considered to be at high risk for periodontal breakdown (Lang & Tonetti 2003, Leininger et al. 2010).

The type of school as public or private was considered (public school received governmental support, and private school did not). This variable was used as a proxy for socioeconomic position (Lopez & Baelum 2007). Subjects were defined by their smoking habits as either never- smokers or smokers (current or former smokers).

Ethical considerations

The Ethics Committee of each centre revised and approved the protocol for this study. An informed consent document was handed to every subject who had agreed to participate for their guardians to revise and sign. All subjects were informed of their oral health status via written communication if so required. Subjects with oral pathologies were duly informed, and a written derivation to a specialist was provided.

Statistical analysis

Univariable and multivariable analyses were used to compare CAL, PPD, BoP and PI measures and tooth count between males and females. Also, mean CAL, PPD, BoP, PI and prevalence of CAL ≥3 mm in ≥1 site were compared between females- males, adolescents attending private- public school, smokers and no smokers, subjects who had BoP <25% and ≥25% or PI <30% or ≥30%.

Logistic regression analyses were used to assess the influence of the predictors age, gender, attending public or private school, smoking status (smoker or no smoker), BoP (<25% or ≥25%), PI (<30% or ≥30%) and cities on the occurrence of at least one site with CAL ≥3 mm. First, an analysis using univariate models was performed. Later, a multivariate analysis model was constructed and only exposures showing in the univariable analyses associations with $p \leq 0.25$ were included (Hosmer & Lemeshow 2000).

A 95% level of confidence was considered as representing statistical significance ($p < 0.05$). The statistical analysis was performed using Microsoft Excel® 2011 and the Stata® 11 statistical package for Mac (StataCorp, College Station, TX, USA).

Results

A total of 1234 subjects were invited and examined, and 1070 of those 15- to 19-year-old adolescents complied with the criteria (Table 1). The reasons for non-eligibility were: undergoing orthodontic treatment (76), requirement for antibiotics (19) and being under the age of 15 (35). Non-participation due to refusal to be examined (34). The final sample included 555 (51.87%) female and 515 (48.13%) male. The mean age was 16.4 ± 1.5 years. 27.5% of subjects were smokers and 52.2% of them attended a public school (Table 1). The distribution according to centre in Table 1.

Overall in each subject, in total 164.9 ± 6.6 sites were examined in 27.5 ± 1.1 teeth. The mean CAL was 0.5 ± 0.6 mm, the mean PPD was 1.9 ± 0.5 mm, the mean BoP was 19.9 ± 24.1%, and the mean PI was 48.1 ± 30.1%. Females had a significantly higher means PPD (1.9 mm *versus* 1.8 mm), BoP (50.0% *versus* 46.1%) and PI (22.9% *versus* 16.8%) (Table 2 and 3). Subjects attended public school presented significantly higher mean CAL (0.5 mm *versus* 0.4 mm), PPD (2.0 mm *versus* 1.8 mm), BoP (25.3% *versus* 14.1%) and PI (52.9% *versus* 43.0%). Smokers had a significantly higher mean CAL (0.6 mm *versus* 0.5 mm) and PPD (1.9 mm *versus* 1.8 mm), and they had significantly lower mean BoP (18.4% *versus* 20.5%). Subjects with a BoP ≥25% presented significantly higher mean CAL (0.8 mm *versus* 0.4 mm), PPD (2.3 mm *versus* 1.7 mm) and PI (75.7% *versus* 37.1%). Adolescents with PI ≥30% had significantly higher mean CAL (0.6 mm *versus* 0.3 mm), PPD (2.0 mm *versus* 1.6 mm) and BoP (64.5% *versus* 14.1%) (Table 3).

Overall, 88.5% of the students examined had at least one site with CAL ≥1 mm. CAL ≥3 mm was seen in 32.6% and CAL ≥5 mm was found in 4.5%. 34.3% of sites and 57.7% of teeth were affected by CAL ≥1 mm. The percentage of sites that had CAL ≥3 mm was 3.1% and the percentage of teeth was 9.1%. The extent of CAL ≥5 mm was

Table 1. Characteristics of study subjects with periodontal examination

	City, Country							Total
	Buenos Aires, Argentina	Córdoba, Argentina	Mendoza, Argentina	Montevideo, Uruguay	Santiago, Chile	Medellín, Colombia	Quito, Ecuador	
Sample size	128 (12.4%)	169 (16.4%)	113 (10.9%)	42 (4.1%)	294 (28.5%)	142 (13.8%)	144 (14.0%)	1032 (100%)
Number of subjects invited to participate	139	173	117	42	430	189	144	1234
Net sample size	128 (12.0%)	169 (15.8%)	113 (10.6%)	42 (4%)	332 (31.0%)	142 (13.3%)	144 (13.5%)	1070 (100%)
Age, years	16.3 ± 1.1	15.6 ± 1.6	16.2 ± 1.5	16.3 ± 0.9	16.9 ± 1.4	16.1 ± 1.1	16.5 ± 1.6	16.4 ± 1.5
Male gender	57 (44.5%)	75 (44.4%)	63 (55.8%)	19 (45.2%)	167 (50.3%)	84 (59.1%)	50 (34.7%)	515 (48.1%)
Current smokers	26 (20.3%)	25 (14.8%)	24 (21.2%)	5 (11.9%)	159 (47.9%)	17 (12.0%)	38 (26.4%)	294 (27.5%)
Subjects attend public school	73 (57.0%)	97 (57.4%)	99 (87.6%)	10 (23.8%)	78 (23.5%)	127 (89.4%)	75 (52.1%)	559 (52.2%)
Tooth count*	27.4 ± 1.2	27.9 ± 0.7	27.6 ± 1.0	27.1 ± 1.4	27.3 ± 1.2	27.6 ± 1.1	27.5 ± 1.2	27.5 ± 1.1

Data are presented as numbers (percentages) or means ± standard deviations (SD).
*Excluding third molars.

0.08% of sites and 0.4% of teeth. Females had a significantly higher prevalence of CAL ≥3 mm (35.8% *versus* 29.1%) and ≥5 mm (5.7% *versus* 3.1%), extent of CAL ≥3 mm (4.0% *versus* 2.0% sites; 11.3% *versus* 6.8% teeth affected) and ≥5 mm (0.1% *versus* 0.03% sites; 0.5% *versus* 0.2% teeth affected) (Table 2).

The prevalence of PPD ≥4 mm was 59.3%. Four point one percent of sites and 11.0% of teeth were affected by PPD ≥4 mm (Table 2). The prevalence of BoP ≥25% was 28.6%, and it was higher in females (34.1% *versus* 22.7%) (Table 2). The prevalence of PI ≥30% was 67.6%, and it was higher in females (69.2% *versus* 65.8%) (Table 2).

Clinical attachment loss ≥3 mm in ≥1 sites was significantly more prevalent in women (35.8% *versus* 29.1%), in public high school students (35.9% *versus* 28.9%), in smokers (40% *versus* 29.8%), in those with a BoP ≥25% (57.8% *versus* 22.5%), a PI ≥30% (39.4% *versus* 18.4%) (Table 4).

The adjusted logistic regression analysis revealed that smoking (OR = 1.6), attending public school (OR = 2.3), having a BoP ≥25% (OR = 4.2) and living in Santiago de Chile, Chile (OR = 9.5), Buenos Aires, Argentina (OR = 3.3) and in Quito, Ecuador (OR = 520.2) were statistically significantly positively associated with having at least one site with CAL ≥3 mm (Table 5). The validity of final model was 0.000 and the goodness was 0.3489.

Discussion

The prevalence of CAL in 15- to 19-year-old high school from Latin America is consistent with other studies. In this study, the prevalence of CAL ≥1 mm was 88.5%, CAL ≥3 mm was 32.6% and CAL ≥5 mm was 4.5%. The prevalence of CAL ≥1 mm was 69.2% in Santiago de Chile, Chile and 49.5% in Santo Domingo, Dominican Republic. The prevalence of CAL ≥3 mm was 4.5% in adolescents in Santiago de Chile, Chile, 4% in Santo Domingo, Dominican Republic, 22.3% in Porto Alegre, Brazil and 100% in Cajaiba, Brazil. The prevalence of CAL ≥5 mm was 7.4% in Porto Alegre, Brazil and 7.7% in Cajaiba,

Table 2. Prevalence of at least one affected site and extent (proportion) of affected sites and teeth per mouth by degree of CAL (cut-offs ≥1, ≥3 and ≥5 mm), PPD (cut-off ≥4 mm), BoP (cut-off ≥25%), PI (cut-off ≥30%) and mean in total, gingival biotype and tooth count according to gender

	Age groups (15–19 years)		
	Female (n = 555)	Male (n = 515)	Total (n = 1070)
CAL measures			
Prevalence CAL ≥ 1 mm	87.2 (0.01)	89.9 (0.01)	88.5 (0.009)
Prevalence CAL ≥ 3 mm	35.8 (0.02)*	29.1 (0.02)*	32.6 (0.01)
Prevalence CAL ≥ 5 mm	5.7 (0.009)†	3.1 (0.007)†	4.5 (0.006)
Proportion of sites/mouth CAL ≥ 1 mm (%)	36.5 (1.4)	31.9 (1.4)	34.3 (1.0)
Proportion of sites/mouth CAL ≥ 3 mm (%)	4.0 (0.5)†	2.0 (0.3)†	3.1 (0.3)
Proportion of sites/mouth CAL ≥ 5 mm (%)	0.1 (0.05)†	0.03 (0.01)†	0.08 (0.02)
Proportion of teeth/mouth CAL ≥ 1 mm (%)	59.1 (1.7)	56.3 (1.7)	57.7 (1.2)
Proportion of teeth/mouth CAL ≥ 3 mm (%)	11.3 (1.0)†	6.8 (0.8)†	9.1 (0.6)
Proportion of teeth/mouth CAL ≥ 5 mm (%)	0.5 (0.1)†	0.2 (0.07)†	0.4 (0.08)
Mean CAL (mm)	0.5 (0.03)	0.4 (0.02)	0.5 (0.02)
PPD measures			
Prevalence PPD ≥ 4 mm	58.9 (0.02)	59.6 (0.02)	59.3 (0.02)
Proportion of sites/mouth PPD ≥ 4 mm (%)	4.6 (0.4)	3.5 (0.3)	4.1 (0.4)
Proportion of teeth/mouth PPD ≥ 4 mm (%)	15.1 (0.9)	11.9 (0.9)	13.6 (0.6)
Mean PPD (mm)	1.9 (0.02)†	1.8 (0.02)†	1.9 (0.01)
BoP measures			
Prevalence BoP ≥ 25%	189 (34.1)‡	117 (22.7)‡	306 (28.6)
Mean BoP (%)	22.9 (24.7)†	16.8 (22.9)†	19.9 (24.1)
PI measures			
Prevalence PI ≥ 30%	384 (69.2)	339 (65.8)	723 (67.6)
Mean PI (%)	50.0 (30.7)†	46.1 (29.3)†	48.1 (30.1)
Tooth count	27.4 (1.1)	27.5 (1.1)	27.5 (1.1)

BoP, Bleeding on probing; CAL, Clinical attachment loss; PI, plaque index; PPD, pocket probing depth. CAL measures and PPD measures are presented as percentage (standard error [SE]) or means (SE). BoP measures, PI measures are presented as number of subjects (percentage) or mean (standard deviation [SD]). Tooth count (excluding third molars) is presented as mean (SD).
*Student test.
†Mann–Whitney *U*-test.
‡Fisher's exact test, $p < 0.05$.

Table 3. Clinical characteristics of study subjects with periodontal examination according to the demographics, school, behavioural and clinical variables

Variables	Categories	Mean CAL (mm)	Mean PPD (mm)	Mean BoP (%)	Mean PI (%)
Gender	Female	0.5 (0.03)	1.9 (0.02)*	22.9 (24.7)*	50.0 (30.7)*
	Male	0.4 (0.02)	1.8 (0.02)*	16.8 (22.9)*	46.1 (29.3)*
School	Private	0.5 (0.02)*	1.8 (0.02)*	14.1 (18.0)*	43.0 (26.5)*
	Public	0.4 (0.03)*	2.0 (0.02)*	25.3 (27.5)*	52.9 (32.3)*
Smoking	No	0.5 (0.02)*	1.9 (0.02)*	20.5 (24.3)*	48.7 (30.9)
	Yes	0.6 (0.02)*	1.8 (0.03)*	18.4 (23.5)*	46.6 (27.7)
BoP	<25% sites	0.4 (0.02)*	1.7 (0.01)*	7.3 (6.8)*	37.1 (26.1)*
	≥25% sites	0.8 (0.04)*	2.3 (0.03)*	51.6 (22.5)*	75.7 (20.1)*
PI	<30% sites	0.3 (0.02)*	1.6 (0.02)*	4.8 (6.6)*	14.1 (9.0)*
	≥30% sites	0.6 (0.03)*	2.0 (0.02)*	27.2 (25.9)*	64.5 (21.9)*
Total		0.5 (0.02)	1.9 (0.01)	19.9 (24.1)	48.1 (30.1)

BoP, Bleeding on probing; CAL, Clinical attachment loss; PPD, pocket probing depth; PI, plaque index. CAL measures and PPD measures are presented as means (standard eror [SE]). BoP measures, PI measures are presented as mean (standard deviation [SD]).
*Mann–Whitney *U*-test, $p < 0.05$

Brazil (Lopez et al. 2001, Collins et al. 2005, Corraini et al. 2008, Susin et al. 2011). The differences between studies might be due to partial recording protocols used in the studies of Lopez et al. and Collins et al., which tended to underestimate the CAL prevalence rates in both adolescents and adults (Susin et al. 2005, Peres et al. 2012). Additionally, the studies performed in Porto Alegre (Brazil) and Santiago (Chile) rounded measurements to the next-lowest millimetre, contrary with our study, where the closest millimetre was considered during rounding. In Cajaiba (Brazil), the study consisted of a rural population; in contrast, ours was based on an urban population.

As described in the literature, adults men have a higher probability of CAL (Kocher et al. 2005, Shiau & Reynolds 2010). The literature is inconclusive regarding data in adolescents (Botero et al. 2015). In this study, we observed that females had higher means PPD, BoP and PI. Also, they had a higher prevalence and extent of CAL ≥3 and ≥5 mm, prevalence of BoP ≥25% and PI ≥30%. Hormonal, genetic and environmental factors may contribute to this difference (Ghazeeri et al. 2011).

Socioeconomic status has been proposed as a CAL risk indicator (Lopez et al. 2006, Borrell & Crawford 2012). School was used as a proxy for socioeconomic position (Lopez & Baelum 2007). In this study, adolescents from public high schools had a higher mean CAL, PPD, BoP and PI. Also, they presented a higher prevalence of CAL ≥3 mm compared to private high school students (35.9% *versus* 28.9%). These results are consistent with the literature. In Santiago de Chile, Chile, the prevalence of CAL ≥3 mm was higher in adolescents in public schools than in private schools (5.1% *versus* 3.3%) (Lopez et al. 2001). In Porto Alegre (Brazil), adolescents from a low socioeconomic level had a higher prevalence of CAL ≥3 mm in interproximal sites of ≥2 teeth compared with those from middle and upper socioeconomic levels (56.7% *versus* 34.7%) (Susin et al. 2011). In the same population, adolescents from low socioeconomic levels had a higher prevalence of CAL ≥4 mm in ≥4 teeth in 14- to 19-year-old adolescents and CAL ≥5 mm in ≥ 4 teeth in 20- to 29-year-old young adults when compared with middle and high socioeconomic levels (9.4% *versus* 2.8%) (Susin & Albandar

2005). In the study from Lopez et al. (2006) performed with adolescents from Santiago de Chile, a possible explanation for the impact of socioeconomic variables for CAL may be related to a higher education among parents which either reduce exposure to harmful factors and/or reinforce protective health behaviours (Lopez et al. 2006).

Bleeding on probing is an indicator for gingival inflammation that suggests its pivotal role in CAL initiation in adolescents and adults (Suda et al. 2000, Schatzle et al. 2003). The adolescents of Santiago de Chile and Porto Alegre, Brazil, with CAL ≥3 mm in ≥2 teeth had more sites with BoP (Santiago de Chile: 72.3% *versus* 22.8%; Porto Alegre: 30.4% *versus* 24.5%) (Lopez et al. 2001, Susin et al. 2011). The absence of BoP is an excellent predictor for periodontal stability (Lang et al. 1990, Griffiths et al. 2001), with a score of <25% considered a good predictor of a stable condition (Lang & Tonetti 2003). The results of this study are consistent with literature showing less periodontal destruction in adolescents with lower BoP. Thus, adolescents with BoP <25% showed a lower mean CAL, PPD and PI. The prevalence of CAL ≥3 mm was lower (22.5% *versus* 57.8%).

Bacterial plaque is considered the main etiological factor in the development of periodontal disease (Loe et al. 1965). A PI between 20% and 40% can be tolerated in a majority of subjects (Lang & Tonetti 2003). Plaque has been associated with a higher risk of CAL in adolescents and adults in some longitudinal studies (Albandar et al. 1998, Timmerman et al. 2000, Schatzle et al. 2003). In Cajaiba, Brazil a 73.2% prevalence of CAL ≥5 mm in ≥1 sites was observed when presenting PI ≥75% (Corraini et al. 2008). In Porto Alegre, Brazil there was a higher prevalence of CAL ≥3 mm in interproximal sites of ≥2 sites in subjects with PI ≥10% (55.5% *versus* 28.6%) (Susin et al. 2011). In this study, PI ≥30% was associated with higher mean CAL, PPD and BoP and with a higher prevalence of CAL ≥3 mm in ≥1 sites (39.4% *versus* 18.4%) when compared to PI <30%.

The adjusted logistic regression analysis revealed that smoking (OR = 1.6), attending public school (OR = 2.3), having a BoP ≥25% (OR = 4.2) and living in Santiago de Chile, Chile (OR = 9.5), Buenos Aires, Argentina (OR = 3.3) and in Quito, Ecuador (OR = 520.2) were significantly positively associated with at least one site with CAL ≥3 mm. The results of this study are consistent with literature. The role of smoking as a risk factor for periodontitis in adults is well established (Genco & Borgnakke 2013), however, limited data are available for

Table 4. Prevalence of CAL ≥ 3 mm in at least 1 site according to the demographics, school, behavioural and clinical variables

Variables	Categories	Prevalence CAL ≥ 3 mm ≥ 1 site		
		n	%	*p*-Value
Gender	Female	199	35.8	0.022*
	Male	150	29.1	
School	Private	148	28.9	0.016*
	Public	201	35.9	
Smoking	No	233	29.8	0.002*
	Yes	116	40	
Bleeding on probing	<25% sites	172	22.5	0.001*
	≥25% sites	177	57.8	
Plaque index	<30% sites	64	18.4	0.001*
	≥30% sites	285	39.4	
Total		349	32.6	

CAL, clinical attachment loss.
*Fisher's exact test, $p < 0.05$.

Table 5. Univariable and multivariate logistic regression analysis of the effect of demographics, school, behavioural factor and clinical variables on the prescence of CAL ≥ 3 mm in at least 1 site ($n = 349$)

Variable	Categories	Univariable analysis		Multivariable analysis			
				Full model		Reduced final model	
		OR	*p*-Value	OR	*p*-Value	OR	*p*-Value
Gender (reference = Female)	Male	0.7	0.019	1	0.965	–	–
Age (years)		1.1	0.002	1.1	0.388	–	–
Smoking (reference = No)	Yes	1.6	0.002	1.6	0.017	1.6	0.009
School (reference = Private)		1.4	0.015	2.3	0.001	2.3	0.001
BOP (reference = <25%)	≥25%	4.7	0.001	4.4	0.001	4.2	0.001
PI (reference = <30%)	≥30%	2.9	0.001	0.9	0.743	–	–
Santiago de Chile, Chile (reference = Mendoza, Argentina)		4.3	0.001	9.4	0.001	9.5	0.001
Buenos Aires, Argentina (reference = Mendoza, Argentina)		3.9	0.001	3.3	0.002	3.3	0.003
Córdoba, Argentina (reference = Mendoza, Argentina)		1.2	0.581	–	–	–	–
Medellín, Colombia (reference = Mendoza, Argentina)		2.1	0.057	–	–	–	–
Montevideo, Uruguay (reference = Mendoza, Argentina)		1.9	0.236	–	–	–	–
Quito, Ecuador (reference = Mendoza, Argentina)		435.8	0.001	531.5	0.001	520.2	0.001

BoP, bleeding on probing; CAL, clinical attachment loss; PI, plaque index; OR, Odds ratio.

adolescents. In Chile, there was no association between CAL and smoking (Lopez et al. 2001). In Porto Alegre, Brazil, smoking was positively associated with CAL ≥3 mm in ≥2 teeth (OR = 1.7) (Susin et al. 2011) and with CAL ≥4 mm in ≥4 teeth (OR = 3.1) (Susin & Albandar 2005). As mentioned above, socioeconomic level is a risk indicator for CAL in adolescents. In Santiago de Chile, attending a public school was positively associated with the occurrence of CAL ≥3 mm (OR = 1.4) (Lopez et al. 2001). In Porto Alegre (Brazil), adolescents of a low socioeconomic level had a higher probability of occurrence of CAL ≥3 mm in interproximal sites of ≥2 teeth (OR = 1.9) (Susin et al. 2011). Living in Santiago de Chile, Buenos Aires, Argentina and Quito, Ecuador, is associated with a higher probability of occurrence of CAL ≥3 mm. However, the goodness of the model was 0.3489. It is necessary to include other variables in order to predict the occurrence of CAL in adolescents in Latin America.

The present study represents one of the first attempts to assess the prevalence of periodontal destruction in Latin America adolescents and possible predictors of this. The limitations of this study include the fact that the sample size was selected proportional to the population of each city participating in the multicenter study, making it non-representative for each centre individually. Additionally, the sample included only adolescents enrolled in high schools urban areas. It is suggested that further studies consider a representative sample from urban and rural areas and an area-based sampling framework (Matus 2007), that these samplings be performed periodically (i.e., every 10 years) and a full mouth record be included (Eke et al. 2010). Also, it is suggested to perform longitudinal studies to determine pattern and rate progression of CAL and the factors that determine disease progression.

In conclusion, CAL was prevalent in Latin America adolescents, and its presence was associated with smoking, school and BoP. Specific programs of health promotion should be focused to this group to prevent future periodontal destruction.

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Clinical Relevance

Scientific rationale for the study: Few studies have been performed in Latin America adolescents on prevalence and risk indicators, and those existing are difficult to compare.

Principal findings: Periodontal destruction was prevalent in Latin America adolescents and is associated to smoking, socioeconomic level, bleeding on probing index where adolescent is from.

Practical implications: Health promotion and prevention programs in the Latin America must focus on adolescents and reducing risk factors, thus preventing future periodontal destruction.