Risk factors of periodontal disease: Latin America and the Caribbean Consensus 2024

Abstract:

There is scarcity of information on the determinants of periodontitis in Latin America and Caribbean countries. We conducted a comprehensive review of studies examining the association of smoking and diabetes with periodontitis outcomes in this region. We searched for population-based, cross-sectional and prospective cohort studies from Latin America and the Caribbean region that reported on the association between smoking or diabetes and periodontitis. Databases were searched up to October 2023 by two reviewers. Subsequently, two authors independently conducted a rigorous data extraction process, focusing on study characteristics, the definition of exposures, and periodontitis outcomes, including measures of association and main findings. The results revealed a significant association between smoking and periodontitis, with a stronger effect observed in heavy smokers. Conversely, while some studies observed a higher prevalence of periodontitis among diabetic individuals, the association between diabetes and periodontitis was not significant after adjusting for confounding factors. These findings underscore a significant research gap in population-based studies on the effect of smoking and diabetes on periodontitis within Latin American and Caribbean countries, particularly when it comes to cohort studies. Addressing these gaps is crucial for a deeper understanding of these associations, which could lead to more effective prevention and treatment strategies in the region.

Keywords: Periodontitis; Risk factors; Smoking; Diabetes Mellitus.

INTRODUCTION

Periodontitis poses a public health problem due to its high prevalence, chronic nature, impact on quality of life, and role in health disparities (Peres et al., 2019). Moreover, the economic burden associated with its treatment costs places strains on healthcare systems (Watt et al., 2019).

As with many non-communicable diseases, such as cancer, type 2 diabetes mellitus and cardiovascular diseases, the development and progression of periodontitis are influenced by a combination of genetic, environmental, and behavioral factors (Loos et al., 2020).

Some exposures that have been associated with periodontitis include age, socioeconomic status, stress, obesity and genetic predisposition (Genco, Borgnakke, 2013; Martinez-Herrera et al., 2017; Decker et al., 2020). Evidence robustly identifies smoking and type 2 diabetes as well-established causes for periodontitis (Genco, Borgnakke, 2020; Leite et al., 2018; Papapanou et al., 2018), playing pivotal roles not only in disease pathogenesis but also in its prevention and treatment response (Sanz et al., 2020; Leite et al., 2023).

This paper reviews the studies investigating the association of smoking and diabetes with periodontitis outcomes in Latin America and Caribbean countries. Synthesizing information in such areas is crucial for several reasons. First, Latin American populations may encounter unique genetic, environmental, and lifestyle factors influencing such associations, emphasizing the need to tailor public health interventions and clinical management. Second, understanding the findings can help address health inequities, facilitate targeted awareness and prevention programs, and guide the development of effective public health interventions. Furthermore, it can foster interdisciplinary collaboration among health professionals and public health experts, ultimately enhancing oral and systemic health outcomes in this region.

MATERIAL AND METHODS

Inclusion and exclusion criteria

Population-based, cross-sectional and prospective cohort studies conducted in countries from Latin America and the Caribbean were targeted. Only those presenting data on smoking and/or diabetes as exposure, with periodontitis as the outcome, were included. Those assessing smoking or diabetes but lacking reported associations with periodontitis were excluded.

Search strategy

MEDLINE-PubMed, SCOPUS, and EMBASE databases were searched up to October 2023. The search strategy can be found on the Open Science Framework webpage (https://osf.io/wt5bv/?view_only=d3fdff9e108e43c6ad57227a195f17ba). Two authors (PM and GR) independently screened the retrieved articles. Studies meeting the inclusion criteria and those with insufficient information in titles and abstracts were submitted for full manuscript evaluation. Subsequently, the selected studies underwent data extraction.

Data extraction

Two reviewers (MAAP and BRV) independently extracted the following data:

Publication details: authors and publication year.

Characteristics of the study: country of data collection, study design, sample characteristics, sample size calculation, potential confounders and other variables, methods used to assess diabetes and/or smoking (exposures), and periodontitis (outcome).

Results: measure of association between the exposure and periodontitis, and the main findings.

After data extraction, a descriptive analysis of the articles was performed.

RESULTS

For the association between smoking and periodontitis, 230 publications in PUBMED, 225 in Embase, and 258 in Scopus were found (total: 713 hits with 209 duplicates, resulting in 504 publications to read title and abstract). For the

relationship between diabetes and periodontitis, 114 publications in PUBMED, 163 in Embase, and 184 in Scopus were retrieved (Total: 461 hits with 142 duplicates, resulting in 319 publications to analyze titles and abstracts). After full-text reading, 11 studies had data extracted.

SMOKING

A total of 11 studies on the association between smoking and periodontitis were included (Table 1). Eight studies were conducted in Brazil (Susin et al., 2004, Susin & Albandar 2005, Moimaz et al., 2009, Silva et al., 2010, Frias et al., 2011, Susin et al., 2011, Haas et al., 2014, Schuch et al., 2019), two in Chile (López et al., 2001, Gamonal et al., 2010) and one in Colombia (Serrano & Suárez 2019). Most of the studies were cross-sectional, except for two prospective population-based cohorts: one with a 5-year follow-up (Haas et al., 2014) and another with individuals born in 1982 (Schuch et al., 2019).

The sample size ranged from 165 (Moimaz et al., 2009) to 9,821 individuals (Serrano & Suárez 2019), with ages ranging from 12 (López et al., 2001) to 103 years (Susin et al., 2004). Sample size estimation was calculated *a priori* in 10 of the 11 studies, apart from one study (Moimaz et al., 2009).

In six studies, the exposure definition was based on total number of packs smoked (López et al., 2001, Susin et al., 2004, Susin & Albandar 2005, Moimaz et al., 2009, Susin et al., 2011, Haas et al., 2014). Two investigations categorized subjects as either smokers (current or former smokers) or never-smokers (Gamonal et al., 2010; Schuch et al., 2019), and the remaining three studies did not report their definition of smoking status.

Clinical attachment loss (CAL) was the main clinical outcome used to define the periodontal status in nine of the included studies. Another study used the presence of periodontal pockets as its outcome (Moimaz et al. 2009) and one defined periodontitis based on the Community Periodontal Index (CPI) (Frias et al., 2011). Age, sex, diabetes, dental consultation attendance, education, and other socioeconomic factors were the main covariables evaluated in the studies.

A significant positive association between smoking and periodontitis was observed in most of the studies, with a stronger association observed among heavy smokers. After adjusting for confounding factors, the association vanished in one study using an adolescent population, probably due to the reduced sample size and still reduced exposure to tobacco along the life course (López et al., 2001).

DIABETES

Six studies on the association between diabetes and periodontitis were included in the current review (Table 2). Three studies were developed in Brazil (Susin et al., 2004, Silva et al., 2010, Haas et al., 2014), two in Chile (López et al., 2001, Gamonal et al., 2010) and one in Colombia (Serrano & Suárez 2019). Five studies were cross-sectional (López et al., 2001, Susin et al., 2004, Silva et al., 2010, Gamonal et al., 2010, Serrano & Suárez 2019) and one was a prospective population-based cohort with 5-year follow-up (Haas et al., 2014). The sample ranged from 300 (Silva et al., 2010) to 9,821 individuals (Serrano & Suárez, 2019) aged from 12 to 103 years. Sample size estimation was performed before conducting all six studies. One study defined diabetes based on medical diagnosis (Silva et al., 2010), three studies used the patient's self-report of diabetes (Gamonal et al., 2010, Haas et al., 2014, Serrano & Suárez 2019) while two articles did not report how the diabetic status was determined (López et al., 2001, Susin et al., 2004). CAL was the main clinical outcome used to define the periodontal status in all included studies. Age, sex, smoking status, education and socioeconomic factors were the main other variables evaluated in the studies. Significant positive statistical associations between diabetes and periodontitis were observed in most studies (Susin et al., 2004, Silva et al., 2010, Gamonal et al., 2010, Haas et al., 2014, Serrano & Suárez 2019), except for one (López et al., 2001). However, the association between diabetes and periodontitis was no longer significant in some studies when confounding factors were considered (Susin et al. 2004, Gamonal et al. 2010, Haas et al. 2014). A potential explanation is the unawareness of the current blood glucose level of study

participants, introducing bias in the analyses by including people with high glucose levels in the ‘health’ category and also by placing people living with diabetes but maintaining adequate glucose levels in the ‘diabetes’ category.

CONCLUSION, RESEARCH GAPS AND FUTURE PERSPECTIVES

Compiling scientific epidemiological data on the relationship between periodontitis, diabetes, and smoking in Latin American and Caribbean populations is of utmost importance. This effort can reveal the unique challenges faced in these countries, help guide public health preventive and therapeutic strategies, highlight gaps in the existing literature, and identify areas for future research. Due to the design of the studies, the influence of specific environmental factors and genetic traits in the association between smoking or diabetes and periodontitis could not be determined. Future studies may focus on these areas to help define public policies and recommendations tailored to the Latin American and Caribbean populations.

The findings of this review are consistent with a previous systematic review (Leite et al., 2018) that underscores cigarette smoking as a risk factor for periodontitis, particularly among heavy smokers. This consistent association across various investigations in different Latin American countries reinforces the harmful impact of smoking on periodontal health, indicating the need for targeted public health interventions. As previously demonstrated (Leite et al. 2023), especially for heavy smokers, the reduction or cessation of tobacco smoking before periodontal treatment is crucial for the improvement of periodontitis lesions.

There is substantial biological plausibility to support the relationship between diabetes and the onset and progression of periodontitis (Graves et al., 2020; Bitencourt et al., 2023). Moreover, the assumption that diabetes is a risk factor for periodontitis has been supported by a range of classic and contemporary clinical studies conducted in diverse populations (Chávarry et al. 2009; Nascimento et al. 2018). In this review, while most studies reported associations between diabetes and periodontitis outcomes, unexpectedly, only two found a

statistically significant relationship after accounting for confounding factors (Silva et al. 2010; Serrano & Suárez 2019). However, these findings should be interpreted with caution due to certain methodological aspects of the included studies. These comprise discrepancies in the population ages and methods used to diagnose diabetes, the limited number of prospective studies, and the overall small sample size of participants with diabetes in the studies, which may have reduced the statistical power to observe the real impact of diabetes on periodontitis. Therefore, well-designed population-based prospective studies are still needed to study the association between diabetes and periodontitis in Latin American and Caribbean countries further. Noteworthy, the current review identified only two population-based prospective cohort studies, indicating a gap in longitudinal research within Latin America and the Caribbean. Moreover, the studies were limited to three South American countries (Brazil, Chile, and Colombia), pointing to a need for more extensive research across these regions. Filling these research gaps will offer a more thorough understanding of the association between smoking and diabetes and periodontitis, aiding in the development of more effective prevention and treatment approaches in the areas.

Current evidence points out that tobacco exposure cessation and diabetes-related lifestyle interventions can significantly reduce the risk of periodontitis (Rosa et al., 2014; Leite et al., 2019; Saengtipbovorn et al., 2015; Nishihara et al., 2017; Mizutani et al., 2024). Therefore, oral health professionals should be trained in techniques to open the conversation about the use of tobacco products and awareness of blood glucose levels in the clinical practice (Ramseier et al., 2020). Considering the proximity of oral health professionals to patients due to multiple visits along their lives, it is important that they feel welcomed to discuss smoking-related and diabetes-related themes and that professionals are versed on the proper stakeholders and other healthcare professionals who can attend to the patient´s needs. For instance, the Very Brief Advice (VBA) is an intervention that all healthcare professionals can implement in nearly every consultation with smoking patients. It consists of concise, evidence-based recommendations to

motivate individuals to quit smoking and directs them to a trained smoking cessation specialist (Papadakis & McEwen, 2021).

Universities, dental associations and government agencies shall collaborate to advocate for an agenda of investigations into the determinants of periodontal disease in the Latin America and Caribbean region. Additionally, there should be a collaborative effort to design and implement strategies to train oral health professionals to discuss smoking and diabetes with their patients and how to handle their questions and needs appropriately. Oral healthcare providers must also be aware of the available infrastructure for patient referrals. The involvement of the oral healthcare team in managing individual risk factors may depend on the ability to collaborate with other professionals, such as psychologists, endocrinologists, nurses, and others. Such collaborations can be fostered within the academic setting, aiming to have professionals who advocate for the comprehensive health of the individual. Policies shall support tobacco cessation programs, screening of patients with pre-diabetes and diabetes and improvement of diabetes care in various healthcare segments. Finally, public health campaigns shall also raise awareness about the risks of smoking and poor diabetes control on oral health. All these measures could potentially contribute to the reduction of periodontitis prevalence and progression in Latin America and Caribbean countries.

Acknowledgments

This paper was prepared for the consensus meeting titled “Periodontal disease and its impact on general health in Latin America - Latin American Consensus 2024”, promoted by the Latin American Oral Health Association (LAOHA) and Colgate-Palmolive Co. with the participation of experts from the region, including representatives from Periodontal Societies of Latin America and FIPP. All participants had the opportunity to review the content, and eventually make their own contributions. The authors report no conflicts of interest.

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Tables

Table 1: Descriptive analysis of the articles related to smoking and periodontitis.

Authors (Year)	Country	Study design	Population and sample	Age Range (yr.)	Prior sample size estimation	Exposure Definition (DM)	Outcome definition	Other variables	Association of periodontitis with smoking. Effect size [95% CI]	Main findings
López et al. (2001)	Chile	Cross-sectional	9,203 students from 98 high schools in the province of Santiago	12-21	Yes	Number of packs smoked, defined as "the number of cigarettes smoked daily *365* duration of smoking in years/20." Exposure was categorized as: 1 to 250, 251 to 500, >500 packs.	Occurrence of ≥ 2 teeth with interproximal CAL ≥1 mm, or ≥ 1 tooth with interproximal CAL ≥ 3 mm	Age, gender, tooth brushing frequency, last visit to the dentist, governmental support, Diabetes	**OR - Presence of ≥ 2 teeth with CAL ≥ 1mm:** All sites 1-250: 0.90 [0.78; 1.03] 251-500: 1.00 [0.83; 1.20] > 500: 1.16 [0.93; 1.46] Interproximal only 1-250: 0.94 [0.82; 1.07] 251-500: 1.00 [0.83; 1.21] > 500: 1.15 [0.93; 1.43] **OR - Presence of ≥ 1 teeth with CAL ≥ 3mm:** All sites 1-250: 1.02 [0.74; 1.41] 251-500: 0.96 [0.64; 1.44] > 500: 1.14 [0.75; 1.74] Interproximal only 1-250: 0.98 [0.71; 1.36] 251-500: 0.98 [0.63; 1.53] > 500: 1.10 [0.68; 1.74]	The study failed to demonstrate a strong and statistically significant association between smoking and CAL

Susin et al. (2004)	Brazil	Cross-sectional	843 subjects ≥30 years living in the metropolitan Porto Alegre area	30-103	Yes	Number of packs consumed in a life-time: number of cigarettes smoked per day multiplied by the number of years of habit, and divided by 20 (one pack): Non-smokers, light (1 to 2,734 packs), moderate (2,735 to 7,300 packs) and heavy smokers (≥7,300 packs).	Percentage of teeth with: Severe CAL: CAL ≥ 5mm in > 50% of teeth Moderate CAL: CAL ≥ 5mm in 15% to 50% of teeth Slight or no CAL: below moderate category	Age, gender, race, socioeconomic status, dental visits, Diabetes	**CAL (RRR)** Non-smoker (reference) Moderate CAL Light: 1.1 [0.7; 1.9] Moderate: 2.1 [1.4; 3.2]* Heavy: 3.0 [1.6; 5.8]* Severe CAL Light: 1.4 [0.6; 3.2] Moderate: 3.4 [2.6; 4.4]* Heavy: 8.2 [5.5; 12.2]*	Aging and moderate to heavy cigarette smoking significantly increased the risk for moderate and severe CAL
Susin & Albandar (2005)	Brazil	Cross-sectional	612 youngs living in the metropolitan Porto Alegre area	14-29	Yes	Non-smokers (<1 cigarette packs in a lifetime) Light (1 to 912 packs) Moderate/ heavy smokers (>912 packs)	AgP depending on age: Aged 14-19: ≥4 teeth with CAL ≥4 mm. Aged 20-29: ≥4 teeth with CAL ≥5 mm.	Socioeconomic status Supragingival calculus	**AgP (**OR): None (reference) Light: 0.6 [0.1; 2.4] Moderate/heavy: 3.1 [1.2; 8.3]*	Smoking was a significant risk indicator for AgP in this young population.

Moimaz et al. (2009)	Brazil	Cross-sectional	165 individuals ≥30 years living in rural Araçatuba	35-66	NR	Number of packs smoked: number of cigarettes smoked daily multiplied by the number of days of habit and divided by 20 (one pack). Former smoker: who had smoked in the past but do not smoke any more. Never- smokers Light (1 to 2,734 packs) Moderate (2,735 to 7,300 packs) Heavy smokers (≥7,300 packs)	Presence of periodontal pockets, defined as having ≥1 periodontal pocket of ≥ 4 mm around the index teeth (CPI scores: 3 and 4)	NR	**Presence of periodontal pockets** (OR) Non-smokers: reference Current smokers: 11.18 [4.69; 26.62]* Former smokers: 9.24 [3.29; 25.96]*	Smoking was strongly associated with periodontitis. There was a relationship with dose and duration of smoking.
Gamonal et al. (2010)	Chile	Cross-sectional	1561 adults. Clinical evaluations in dental public primary care health centers	Two groups: 35-44 & 65-74	Yes	Never-smokers or Smokers (current or former smokers).	Prevalence of CAL, defined as the percentage of participants with ≥1 site with the condition. Extent was defined as the percentage of teeth displaying the condition.	Age, sex, Education, monthly income, Diabetes	**CAL** (OR): ≥3 mm 1.4 [0.9; 2.3] ≥4 mm 1.3 [1.0; 1.8]* ≥5 mm 1.3 [1.0; 1.6]* ≥6 mm 1.3 [1.0; 1.7]*	Age (65 to 74 years), sex (male), low education level (≤12 years of education), and smoking were risk indicators for CAL >6 mm in ≥1 site

Silva et al. (2010)	Brazil	Cross-sectional	300 individuals with diabetes from Public health facilities in Belo Horizonte	30-86	Yes	NR	Prevalence of periodontitis defined as CAL ≥ 3 mm in ≥ 2 non-adjacent teeth or CAL ≥ 5 mm in 30% of the teeth (EFP; Tonetti & Claffey, 2005).	Gender, age, income, schooling, marital status, missing teeth, dental care, diabetes	**CAL** (PR) non-smokers: Reference Tobacco users: 1.71 [1.10; 2.65]*	Multiple determinants, among them smoking, are associated to the prevalence of periodontitis among patients with diabetes
Frias et al. (2011)	Brazil	Cross-sectional	263 subjects living in Guarulhos	35-44	Yes	NR	Two outcomes: Bleeding (CPI = 1) and dental calculus (CPI = 2), and presence of moderate (CPI=3) or deep (CPI=4) periodontal pockets	Sex, education and access to dental care	**Periodontal pockets** (PR) Bleeding & dental calculus 1.11 [1.02; 1.21]* Periodontal pockets 1.71 [1.07; 2.73]*	Prevalence of gingival bleeding and dental calculus were significantly associated to male sex (PR=1.12), smoking (PR=1.11), school level < eight years of study (PR=1.14), & no dental care for ≥2 years (PR=1.19).
Susin al. (2011)	Brazil	Cross-sectional	612 individuals living in the metropolitan area of Porto Alegre	14-29	Yes	Non-smokers (<1 pack of cigarettes in a lifetime) Light (1–499 packs) Moderate (500–1499 packs) Heavy smokers (≥1500 packs).	Chronic periodontitis defined as CAL ≥3mm affecting the interproximal sites of ≥2 teeth.	Age, supragingival calculus, Dental visits Supragingival calculus	Chronic Periodontitis **CAL** (OR) Non-smokers = reference Light/moderate: 0.9 [0.6; 1.3] Heavy: 1.7 [1.1; 2.7]*	Age, socioeconomic status, smoking and supragingival calculus were significantly associated with chronic periodontitis.

Haas et al. (2014)	Brazil	Prospective population-based cohort of 5 years of follow-up	653 individuals from the Metropolitan area of Porto Alegre	>14	Yes	Packyears of smoking calculated by multiplying the number of packs consumed per day by the number of years of habit. To facilitate the interpretation of the results, estimates of lifetime smoking were divided by 10 so that risk estimates reflect changes in risk for 10 packyears of smoking. Smoking exposure 0 packyears 1–14 packyears ≥15 packyears	CAL progression at a given site, calculated by subtracting the baseline CAL from that of the 5-year follow-up examination. Two case definitions were used with CAL progression cases, defined as individuals having proximal CAL progression ≥3mm in ≥2 and ≥4 teeth over the 5 years of follow-up	Age, gender, marital status, skin color, education, socioeconomic status, interproximal cleaning, dental care, diabetes	**CAL** progression ≥3mm in ≥2 teeth (RR) 0 = reference 1-14: 1.12 [0.91; 1.40] >15: 1.39 [1.10; 1.76]* CAL progression ≥3mm in ≥4 teeth (RR) 0 = reference 1-14: 1.22 [0.88; 1.71] >15: 1.54 [1.06; 2.24]*	Age, gender, education and smoking were independent risk factors for CAL progression in an urban population from South Brazil.

Serrano & Suárez (2019)	Colombia	Cross-sectional	9821 adults from a national sample of Colombian adults, held by the Colombian Health Ministry, living in urban and rural areas	18-79	Yes	Presence of smoking behavior was analyzed by a self-reported questionnaire, categorized as: current smokers, occasional smokers, former smokers or non-smokers. Definitions were not reported.(NR)	Periodontitis according to two classification systems: 1) AAP-CDC (Page, et al., 2012): mild, moderate and severe periodontitis. Severe periodontitis cases: ≥ 2 interproximal sites with CAL ≥ 6 mm, and ≥ 1 site with PD ≥ 5 mm. 2) EFP periodontitis case definition (Tonetti and Claffey, 2005).	Age, gender, Living area (rural / urban), health insurance system, income, Toothbrushing, Dental floss use, Reason for dental visits, Diabetes	**Periodontitis (CDC-AAP)** (OR) Non-smoker: reference Current smoker: 1.09 [0.9; 1.3] Former smoker: 1.28 [1.2; 1.4]* Periodontitis (EFP) (OR) Non-smoker: reference Current smoker: 1.57 [1.2; 1.7]* Former smoker: 1.14 [1.0; 1.2]	Prevalence of severe periodontitis was significantly associated with age, gender, income, smoking behavior, and diabetic status.
Schuch et al. (2019)	Brazil	Prospective population-based birth cohort	539 individuals from 3 maternity hospitals in Pelotas city. All 5,914 children born in 1982 were invited to participate.	31	Yes	Smoking status and dental hygiene at age 24 were the mediators between socioeconomic position and periodontitis. Smoking status was dichotomized as current or former smoker versus non-smoker.	Periodontitis according to CDC and AAP: Mild: ≥ 2 interproximal sites with CAL ≥3 mm, and ≥2 interproximal sites with PD ≥4 mm (not on the same tooth) or one site with PD ≥5 mm. Moderate: ≥2 interproximal sites with CAL ≥4 mm (not on the same tooth), or ≥2 interproximal sites with PD ≥5 mm (not on the same tooth). Severe: ≥2 interproximal sites with CAL ≥6 mm (not on the same tooth)	Sex, socioeconomic position, income, Dental calculus Education	**Periodontitis** (RR) **CAL** Crude RR mild periodontitis Non-smoker: reference Smoker at age 24: 1.2 [0.7; 2.0] Crude RR Moderate to Severe periodontitis Non-smoker: reference Smoker at age 24: 1.6 [0.9; 2.8]	An association was observed between the more severe level of periodontitis and being a smoker at age 24, as well as having undertaken less than 12 years of study

							and ≥1 interproximal site with PD ≥5 mm.			

AgP – Aggressive periodontitis, NR – not reported, CAL – clinical attachment loss, PD – probing depth, OR – odds ratio, RRR – relative risk ratio, PR – prevalence ratio, RR – risk ratio, CPI – Community periodontal index, CDC – Center for Disease Control and Prevention, AAP – American Academy of Periodontology, EFP – European Federation of Periodontology

* Statistically significant

Table 2: Descriptive analysis of the studies reporting the association between diabetes and periodontitis.

Authors (Year)	Country	Study design	Population and sample	Age Range (yr.)	Prior sample size estimation	Diabetes Definition	Outcome definition	Other variables	Association of periodontitis with smoking. Effect size [95% CI]	Main findings

López et al. (2001)	Chile	Cross-sectional	9,203 students from 98 high schools in the province of Santiago	12-21	Yes	NR	Occurrence of ≥ 2 teeth with interproximal CAL ≥1 mm, or ≥ 1 tooth with interproximal CAL ≥ 3 mm	Age, gender, tooth brushing frequency, last visit to the dentist, governmental support, smoking	**OR - Presence of ≥ 2 teeth with CAL ≥ 1mm:** All sites 1.27 [95% CI = 0.74; 2.19] Interproximal sites 1.68 [95% CI =0.98; 2.86] **OR - Presence of ≥ 1 teeth with CAL ≥ 3mm:** All sites 1.87 [95% CI I =0.76; 4.61] Interproximal sites 1.30 [95% CI 0.41; 4.06]	Diabetic status was not associated with CAL after adjusting for other variables.

Susin et al. (2004)	Brazil	Cross-sectional	843 subjects ≥30 years living in the metropolitan Porto Alegre area	30-103	Yes	NR	Percentage of teeth with: Severe CAL: CAL ≥ 5mm in > 50% of teeth Moderate CAL: CAL ≥ 5mm in 15% to 50% of teeth Slight or no CAL: below moderate category	Age, gender, race, socioeconomic status, dental visits, smoking	**CAL (RRR)** Significant higher percentage of teeth with CAL ≥ 3mm and ≥ 5mm in patients with DM. **RRR - Moderate CAL:** Non-diabetic: Reference Diabetic: 1.7 [0.8; 3.5] **RRR - Severe CAL:** Non-diabetic: Reference Diabetic: 3.3 [1.1; 10.6]*	Diabetic status was not associated with CAL after adjusting for other variables.
Silva et al. (2010)	Brazil	Cross-sectional	300 individuals with diabetes from Public health facilities in Belo Horizonte	30-86	Yes	medical diagnosis	Prevalence of periodontitis defined as CAL ≥ 3 mm in ≥ 2 non-adjacent teeth or CAL ≥ 5 mm in 30% of the teeth (EFP; Tonetti & Claffey, 2005).	Gender, age, income, schooling, marital status, missing teeth, dental care, smoking	**CAL** (PR) Periodontitis was significantly more prevalent among participants with type 2 DM.	More than 8 years duration of DM was associated with periodontitis.

									PR – Prevalence of periodontitis/duration of DM: ≤ 8 years: Reference > 8 years: 1.63 [1.12; 2.38]*	
Gamonal et al. (2010)	Chile	Cross-sectional	1,561 adults (young/senior) Public health facilities in 15 administrative regions	35-44 65-74	Yes	Self-reported	Prevalence of moderate to severe CAL, i.e. CAL ≥3, ≥4, ≥5, and ≥ 6 mm present in ≥1 sites. Missing teeth, percentage of BoP, mean PD, and mean CAL.	Age, sex, education, income, smoking	Young adults with DM had significantly higher mean full-mouth CAL. **OR - CAL in ≥1 sites:** CAL ≥3 mm: 3.2 [0.7; 13.7] CAL ≥4 mm: 1.3 [0.7; 2.3] CAL ≥5 mm: 1.3 [0.8; 2.0] CAL ≥5 mm: 1.3 [0.9; 2.0]	Diabetic status was not associated with CAL after adjusting for other variables.
Haas et al. (2014)	Brazil	Prospective population-based cohort of 5 years of follow-up	653 individuals from the Metropolitan area of Porto Alegre	>14	Yes	Self-reported	Percentage of subjects with CAL progression of ≥3mm in ≥2 and ≥4 teeth over 5 years.	Age, gender, marital status, skin color, education, socioeconomic status, interproximal cleaning, dental care, smoking	**RR - CAL progression of ≥3mm in ≥2 teeth:** No diabetes = reference Diabetes: 1.33 [1.07; 1.64]*	DM was significantly associated with CAL progression in the univariable, but not in the multivariate analysis when other variables were considered.

									RR - CAL progression of ≥3mm in ≥4 teeth: No diabetes = reference Diabetes: 1.52 [1.11; 2.09]*	
Serrano & Suárez (2019)	Colombia	Cross-sectional	9821 adults from a national sample of Colombian adults, held by the Colombian Health Ministry, living in urban and rural areas	18-79	Yes	Self-reported	Prevalence of severe cases of periodontitis: ≥2 interproximal sites with CAL ≥ 6 mm, and ≥ 1 site with PD ≥ 5 mm (AAP-CDC; Page et al. 2012) Interproximal CAL ≥ 5 mm in ≥ 30% of teeth (EFP; Tonetti & Claffey, 2005).	Age, gender, Living area (rural / urban), health insurance system, income, Toothbrushing, Dental floss use, Reason for dental visits, Smoking	**OR - Periodontitis (CDC-AAP):** Non-diabetic: reference Diabetic: 1.97 [1.5; 3.0]* **OR - Periodontitis (EFP):** Non-diabetic: reference Diabetic: 3.19 [2.6; 3.3]*	DM was associated with severe periodontitis after adjusting for confounding factors.

380 NR – not reported, CAL – clinical attachment loss, PD – probing depth, OR – odds ratio, RRR – relative risk ratio, PR – prevalence ratio, RR – risk ratio, EFP – European Federation of Periodontology, CDC – Center for Disease Control and Prevention, AAP – American Academy of Periodontology, DM – diabetes mellitus

* Statistically significant


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