Epidemiology of periodontitis in Brazilian adults: an integrative literature review of large and representative studies

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Abstract

Several epidemiological studies have estimated periodontitis prevalence and distribution. In Brazil, national epidemiological surveys assessing the periodontal status of the population were conducted. Other regional studies have also used different methodologies. However, comparability of findings in different regions and in the country is yet to be addressed. This integrative review aimed to evaluate the epidemiology of periodontitis in Brazilian adults and summarize prevalence estimates of the disease in the country. Searches were performed in the electronic databases SciELO, LILACS, and PubMed. Cross-sectional studies that assessed the prevalence of periodontitis in adults (≥18 years) using a sample size of at least 100 individuals were selected. Twenty studies and three national surveys were included. All national surveys applied partial recording and used the community periodontal index. Only three studies assessed clinical attachment loss by full-mouth examination in regional representative samples. Considering only these well-designed studies, it is estimated that periodontitis may affect more than 50% of the population; higher than other developed countries. However, the analyzed literature does not allow a real estimate of the prevalence of periodontitis in Brazil due to great methodological drawbacks. We recommend that new studies use well-designed approaches, including full-mouth assessment, and adopt internationally recognized disease definitions.

Keywords: epidemiology; periodontitis; prevalence; Brazil.

Introduction

Periodontitis is a multifactorial chronic inflammatory disease associated with dysbiotic biofilm and is recognized for its progressive destruction of the dental support apparatus (Papapanou *et al.*, 2018). The multifactorial nature of periodontitis interferes with the progression and manifestation of the disease, requiring a thorough clinical examination and analysis of potential risk factors to determine the correct diagnosis and treatment (Preshaw 2015; Aljehani 2014). Important issues about periodontal diagnosis are the periodontal recording protocol used and the difference between parameters and criteria for defining the disease used in clinical examinations and epidemiological surveys (Romito *et al.*, 2020).

Epidemiological surveys comprise the basis for understanding disease distribution and etiology, contributing to the development of prevention and intervention strategies (Botero *et al.*, 2015; Davey and Ibrahim, 2001; Baelum *et al.*, 1997). Thus, they are considered an essential tool for planning public health policies (Eke *et al.*, 2012; Albandar and Rams, 2002).

The epidemiology of periodontal diseases has been widely studied; however, a large variation in the estimates of the diseases is found in the literature, due to the lack of homogeneity and standardization of the examination protocols and disease definition criteria applied (Romito *et al.*, 2020; Oppermann *et al.*, 2015; Khalifa *et al.*, 2012). Moreover, such variation can be explained by different regional characteristics, environmental, behavioral factors, and socioeconomic status (Haas *et al.*, 2015; Oppermann *et al.*, 2015; Coelho *et al.*, 2008).

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Several epidemiological studies show that the prevalence of periodontitis varies significantly in different regions of the world. A systematic review by Kassebaum *et al.* (2014) estimated that the global prevalence of severe periodontitis in 2010 was 10,8%, affecting one million people and representing the sixth most prevalent disease condition in humans. The southern regions of Latin America and eastern Sub-Saharan Africa were reported to have higher disease prevalence (20%).

In Brazil, the most relevant data on the prevalence and distribution of periodontitis in adults are found in national epidemiological surveys conducted by the Ministry of Health (2010, 2003, 1986) (Brasil 2012; Brasil 2004; Brasil 1988). Regional epidemiological studies with representative samples and well-designed methodology have also been conducted (Romito *et al.*, 2020; Haas *et al.*, 2012). Nevertheless, prevalence estimates of periodontitis in Brazil have not been summarized and described in a standardized manner. Also, these estimates have not been described in the light of methodological drawbacks of the available national and local studies.

An integrative literature review is one of the most comprehensive methodological approach of reviews; its vast sampling of studies in conjunction with the multiplicity of proposals provide a comprehensive and consistent overview of concepts, theories and health problems (Cooper 1998, Whiteermore and Knafl, 2005, Souza *et al.*, 2010). As a consequence, it allows a broad view of knowledge and incorporates the results obtained in evidence-based practice. A unique characteristic of integrative reviews is related to the types of studies to be included, since this type of review is wide, including both experimental and non-experimental studies, as opposed to systematic reviews that seek evidence in research related to a specific topic, accompanied by a rigorous method of search, selection, quality and validity of studies, which can be combined with meta-analyses. Integrative reviews are also completely different from classic narrative reviews, as random selection of studies and subjectivity of the authors to influence the interpretation of information are not allowed (Rother 2007, Souza *et al.*, 2010).

This integrative review aimed to evaluate the epidemiology of periodontitis in Brazilian adults and summarize prevalence estimates of the disease in the country.

Materials and Methods
Search strategy
The search strategy was carried out using terms in English and Portuguese, with no restrictions on the year and the status of the publication. Searches in PubMed, LILACS and SciELO databases were performed with the keywords: epidemiology; periodontitis; prevalence and Brazil, followed by the boolean operator 'AND'. Searches on the Ministry of Health website were made to incorporate national epidemiological surveys in oral health. Two researchers freely selected the studies (TCCM and AAS), and all studies that met the inclusion criteria were selected, independently of agreements.

Data collection and report
Two researchers collected the data on excel sheets. Year of publication, sample characteristics (size, source, sampling strategy), age of the participants, periodontal recording protocol applied, periodontal parameters assessed and outcomes data were recorded.

The findings were reported separating studies with representative and convenience samples, as well as partial and full mouth periodontal examination protocols. For those studies assessing CAL, prevalence of periodontitis was defined by the percentage of individuals having the condition, whereas the extent of periodontitis was defined by the percentage of teeth with the condition. The authors from the studies by Susin *et al.*, 2004 and 2005, were contacted to provide estimates of periodontitis using CDC/AAP criteria, if possible. For those studies recording exclusively PPD, the outcomes were reported according to shallow and deep pockets.

Study selection
Cross-sectional observational studies were considered eligible to be included in the review. Only studies in which the primary outcome was the prevalence of periodontitis in Brazilian adults were included.

A priori, only national and regional representative studies that have been carried out in Brazilian adults were eligible to be included in the review. Nonetheless, after a preliminary search, it was found that very few studies would be included and important regional studies with large convenience samples would be out of the review. Therefore, national epidemiological surveys and regional studies that have been carried out in Brazilian adult populations (≥18 years) with a sample of more than one hundred participants were eligible for the review. Moreover, at least one of the following indexes had to be applied in the studies: Periodontal Index (PI) (Russell 1956); Periodontal Disease Index (PDI) (Ramfjord 1959); Extension and Severity Index (ESI) (Carlos *et al.*, 1986); Community Periodontal Index of Treatment Needs (CPITN) (Ainamo *et al.*, 1982); Community Periodontal Index (CPI) (WHO 1997); Periodontal Attachment Loss Index (PAL) (WHO 1997) and the Periodontal Profile Phenotype System (P3) (Morelli *et al.*, 2017). Additionally, studies that have used clinical parameters of periodontal evaluation such as clinical attachment level (CAL), pocket probing depth (PPD), and dental mobility (DM)

(Armitage 2004), and studies that used the criteria defined by EFP (Tonetti and Claffey, 2005) and CDC/AAP for the diagnosis of periodontitis (Page and Eke, 2007), were also included.

Literature review

After the search, 616 articles and 5 national epidemiological surveys were identified. A manual screening of non-duplicate studies after reading the titles and abstracts excluded 492 studies and 02 epidemiological surveys. Full-text reading was performed for the remaining 124 reports and 03 epidemiological surveys, and 65 studies were excluded because they did not determine the prevalence of periodontitis. Additionally, 39 articles were excluded because they did not meet the inclusion criteria. Thereafter, 20 studies and 3 epidemiological surveys were included (Figure 1).

Hereafter, research reports and national surveys will be commonly named 'studies'. The methodological characteristics of all studies included are described in Table 1. Of the twenty-three studies included, fifteen used a partial mouth examination protocol and eight used a complete examination protocol (full-mouth assessment). The age groups, sample size, and sample source showed high variability. Most regional studies were conducted in the southeast region (n=13; 57%), followed by the northeast (n=4; 17%), south (n=2; 9%) and central-west (n=1; 4%), in addition to national epidemiological surveys (n=3; 13%). Thirteen regional studies did not mention sample size calculation (67%). Only the national epidemiological surveys and five regional studies applied sampling strategies that resulted in representative samples, whereas the vast majority assessed convenience samples (n=15; 65%).
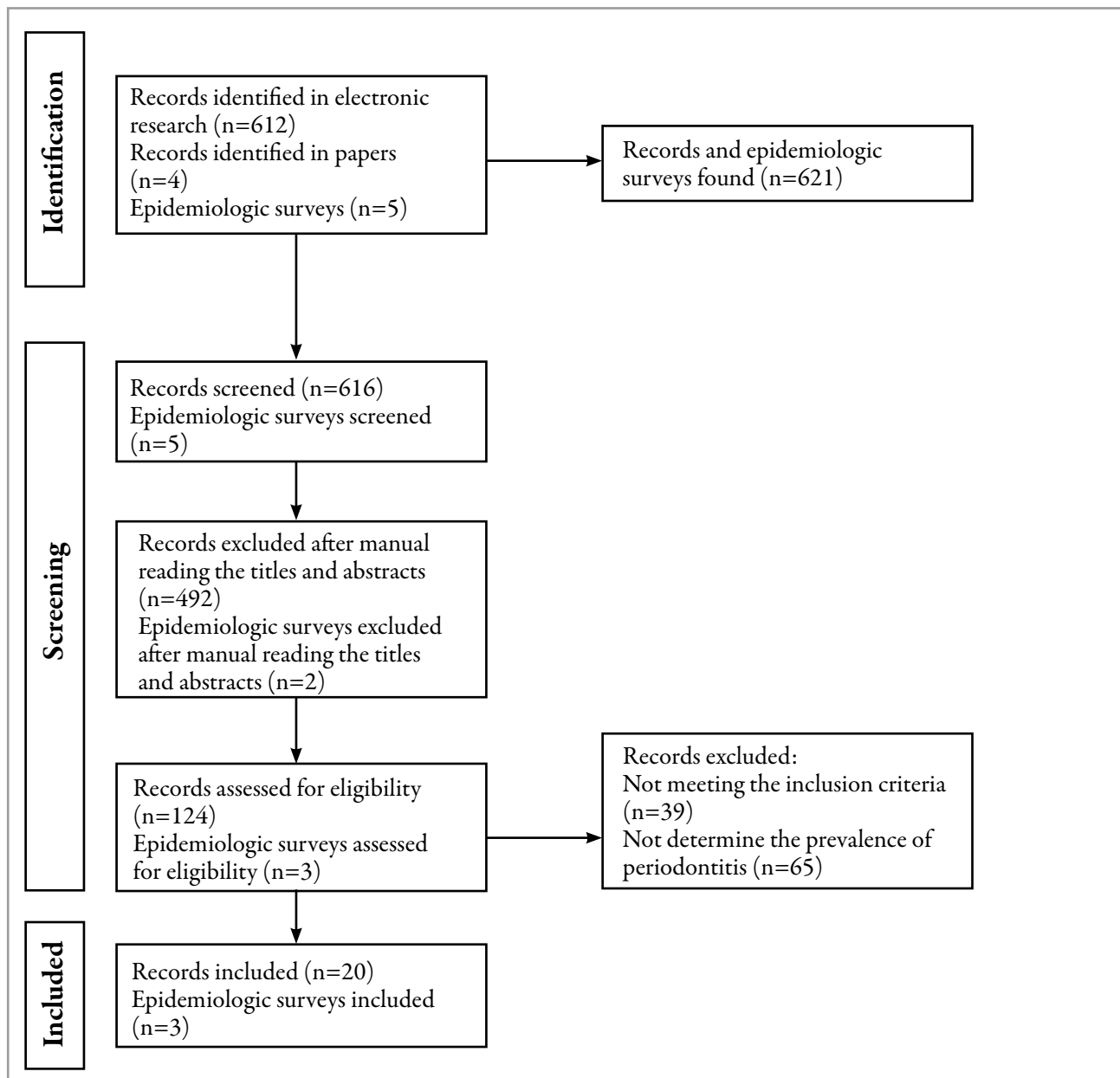

Figure 1. Flowchart of study selection.

Table 1. Methodological characteristics of regional studies and national epidemiologic surveys conducted in Brazil and included in this integrative review.

AUTHOR/YEAR	SAMPLE SIZE	AGE	PROTOCOL	SAMPLE AREA	SAMPLE SOURCE	REPRESENTATIVITY	SAMPLE SIZE CALCULATION
DINI (1993)	528	18-64	Partial	Araraquara/SP	Alcohol and sugar plant workers	Convenience	Yes
CARNEIRO *et al.* (1999)	293	65->75	Partial	São Paulo/SP	Elderly people living in 5 nursing homes in the east of São Paulo	Convenience	No
SILVA e VALSECKI JR (2000)	194	≥ 60	Partial	Araraquara/SP	Elderly people living in 2 nursing homes and individuals in the Araraquara Eldery Program	Convenience	No
CANGUSSU *et al.* (2001)	157	35-≥65	Partial	Itatiba/SP	Adults: employees of city hall and industries, individuals who sought medical attention in health units Elderly: city hall social gatherings	Convenience	No
GESSER *et al.* (2001)	286	18	Partial	Florianópolis/SC	Enlisted in the Brazilian Army in Florianópolis	Convenience	Yes
TOMITA *et al.* (2002)	831	30-92	Partial	Bauru/SP	Japanese-Brazilian population of the 1st and 2nd generation	Convenience	No
REIS *et al.* (2003)	289	≥60	Partial	Goiânia/GO	Elderly people living in 10 nursing homes in Goiânia	Convenience	No
RAGGHIANTI *et al.* (2004)	380	20-≥50	Full mouth	Bauru/SP	Individuals attended at the Dental Clinic of University of São Paulo-USP	Convenience	No
SILVA *et al.* (2004)	202	35-74	Partial	Rio Claro/SP	Adults: professors and employees of public and private schools Elderly: health service users and guild members	Convenience	No
SUSIN *et al.* (2004 and 2005)	853	30-103	Full mouth	14 cities in the metropolitan region of Porto Alegre/RS	Residents of 14 cities in the metropolitan region of Porto Alegre	Representative	Yes

Table 1 continued.

Study	N	Age	Examination	Location	Population	Sampling	
GAIÃO et al. (2005)	160	≥65	Partial	Fortaleza/CE	Elderly people living in a nursing home in Fortaleza	Convenience	No
FRIAS et al. (2006)	263	35-44	Partial	Guarulhos/SP	Guarulhos population	Representative	Yes
MACEDO et al. (2006)	172	20-60	Full mouth	Feira de Santana/BA	Rural population of Matinha dos Pretos	Convenience	No
CORRAINI et al. (2008)	175	20-≥50	Full mouth	6 beaches of São Paulo and Rio de Janeiro	Pouso de Cajaíba in Juatinga Ecological Reserve	Representative	No
BOGHOSSIAN et al. (2009)	491	21-70	Full mouth	Rio de Janeiro/RJ	Individuals attended at the Dental Clinic of Federal University of Rio de Janeiro-UFRJ	Convenience	No
FERREIRA et al. (2009)	332	60-105	Partial	Belo Horizonte/MG	Elderly people living in 65 nursing homes in Belo Horizonte	Representative	Yes
CYRINO et al. (2011)	284	18-60	Full mouth	Belo Horizonte/MG	Workers of a big company in Belo Horizonte	Convenience	No
FIGUEIREDO et al. (2013)	215	19-77	Full mouth	Banzaê/BA Quijingue/BA	Indigenous Reserve Kiriri	Representative	Yes
SOUZA et al. (2013)	306	19-35	Partial	Teresina/PI	University students in Teresina	Convenience	Yes
TEIXEIRA et al. (2019)	420	35-74	Full mouth	São Paulo metropolitan region and 8 inner state cities	Population subgroup with good health habits and abstention from alcohol and tobacco	Convenience	No
SB BRASIL (1986)	NOT REPORTED	35-44 50-59	Partial	Brazil	Brazilian population	Representative	Yes
SB BRASIL (2003)	13431 5349	35-44 65-74	Partial	Brazil	Brazilian population	Representative	Yes
SB BRASIL (2010)	9941 7116	35-44 65-74	Partial	Brazil	Brazilian population	Representative	Yes

Due to the high methodological discrepancy found in non-representative studies (partial mouth examination, convenience sampling, heterogeneity of age groups and different case classifications), only those regional studies reporting estimates from representative samples, in addition to the national surveys, were considered for estimating the prevalence of periodontitis in Brazil.

Two representative regional studies used partial examination protocol (CPI) and were carried out in the southeast region of Brazil (Table 2). Frias *et al.* (2006) found prevalence of shallow and deep pockets in 22.4% and 4.2% of the adult population, respectively. Ferreira *et al.* (2009), evaluating an elderly population, found shallow and deep pockets in 4.8% and 5.7% of the individuals, respectively. This study also evaluated PAL, which ranged from 0.6% (0-3 mm) to 9.4% (6-8 mm).

Representative regional studies with full-mouth periodontal examination protocols are described in Table 3. Among the three included studies, the study by Susin *et al.* evaluated an urban area of a capital city in southern Brazil. The other studies (Corraini *et al.*, 2008; Figueiredo *et al.*, 2013) assessed indigenous populations. The three studies reported prevalence and extent of different thresholds of PPD and CAL. They found that the prevalence of individuals with CAL ≥ 3 mm in at least one tooth was between 93.9% to 100% in all age groups. Higher thresholds of CAL were still observed in a great proportion of the studied populations. For instance, the overall prevalence of CAL ≥ 5mm and ≥ 7mm equaled 79.2% and 51.9%, respectively, in the study by Susin *et al.* The prevalence of individuals with high CAL thresholds increased with advancing age in all studies.

The prevalence of individuals (30-39 years) with PDD ≥ 5 mm ranged from 61.6% to 37.5%; and PPD ≥ 7 mm ranged from 19.4% to 10% in the studies by Susin *et al.* and Corraini *et al.* When the 40-49 age group is analyzed, the same studies showed that PPD ≥ 5 mm ranged from 69.5% to 70.8% and PPD ≥ 7mm ranged from 29.2% to 32.9%. Meanwhile, the study by Figueiredo *et al.* (2013) showed a higher prevalence of individuals (35-44 years) with PPD ≥ 5mm (85%) and PPD ≥ 7 mm (45%), when compared to the other studies.

Although prevalence estimates were high in all studies, the percentage of teeth affected by advanced CAL was small, with the highest numbers reaching no more than 30% of teeth. In regards to periodontitis definition, only Figueiredo *et al.* (2013) used the definition criteria proposed by the CDC/AAP in their original publication. They observed that most individuals aged 19-44 years had no or mild periodontitis (55 to 74.6%). However, most individuals aged ≥ 45 years presented severe periodontitis (63.8%). Susin *et al.* provided data for the CDC/AAP criteria upon request and they observed that the overall prevalence of periodontitis (all-cases definition) equaled 87.0% of adults 30 years and older. Mild, moderate and severe periodontitis were observed in 2.2%, 45.2% and 39.6% of the individuals, respectively. Among individuals ≥ 45 years, 43.6% and 50.7% had moderate and severe periodontitis, respectively.

The three national epidemiological surveys carried out in Brazil applied the CPI (Table 4). Data found in the 1986 epidemiological survey (Brasil, 1988) could not be compared with the other surveys as the results were stratified according to family income. In the epidemiological surveys of 2003 (Brasil, 2004) and 2010 (Brasil, 2012), the prevalence of shallow pockets for adults was 7.8% and 15.2%, while for the elderly population the percentages were 4.4% and 2.5%, respectively. In the same years, the prevalence of deep pockets was 2.1% and 4.2% for adults and 1.8% and 0.8% for the elderly. For adults and elders, the greatest range of attachment loss was 0-3mm (51.3% and 6%, respectively) and the smallest range was ≥12mm (0.2% and 0.1%, respectively).

Table 2. Regional studies with representative sample size that applied partial periodontal examination.

AUTHOR/ YEAR/INDEX	MEASUREMENT UNIT	AGE	EXCLUDED	GINGIVAL BLEEDING	SHALLOW POCKETS	DEEP POCKETS	CALCULUS	PAL
FRIAS *et al.* (2006) CPI	% INDIVIDUALS	35-44	NR	9.1%	22.4%	4.2%	53.6%	NA
FERREIRA *et al.* (2009)	% INDIVIDUALS	≥ 60	78%	0.6%	14.8%	5.7%	0.9%	0-3mm 0.6% 4-5mm 4.2% 6-8mm 9.4% 9-11mm 6.3% ≥12mm 1.5%
CPI	% SEXTANTS		89%	0.7%	7%	1.8%	1.1%	0-3mm 0.7% 4-5mm 5.1% 6-8mm 3.2% 9-11mm 1.5% ≥12mm 0.4%

CPI: Community Periodontal Index; CPITN: Community Periodontal Index of Treatment Needs; PAL: Periodontal Attachment Loss; NR: Not reported; NA: Not applied.

Table 3. Regional studies with representative sample size applying full-mouth examination protocols.

AUTHOR/ YEAR	UNIT	AGE	PARAMETERS	PPD	CAL	PERIODON-TITIS
SUSIN *et al.* (2004, 2005)	% INDIVIDUALS	Total 30-39 40-49 50-59 60-69 ≥ 70	PPD/CAL	≥ 4mm 79.6% ≥ 5mm 65.2% ≥ 7mm 25.4% ≥ 4mm 79.1% ≥ 5mm 61.6% ≥ 7mm 19.8% ≥ 4mm 83% ≥ 5mm 69.5% ≥ 7mm 32.9% ≥ 4mm 78.5% ≥ 5mm 68.3% ≥ 7mm 27.8% ≥ 4mm 76.1% ≥ 5mm 64.5% ≥ 7mm 21.8% ≥ 4mm 71% ≥ 5mm 58.7% ≥ 7mm 23.1%	≥ 3mm 97.4% ≥ 5mm 79.2% ≥ 7mm 51.9% ≥ 3mm 93.9% ≥ 5mm 64.3% ≥ 7mm 32% ≥ 3mm 100% ≥ 5mm 84.6% ≥ 7mm 62.1% ≥ 3mm 99.4% ≥ 5mm 94.4% ≥ 7mm 65.3% ≥ 3mm 100% ≥ 5mm 92.3% ≥ 7mm 70.7% ≥ 3mm 100% ≥ 5mm 98% ≥ 7mm 80.6%	
	% TEETH PER INDIVIDUAL	30-39 40-49 50-59 60-69 ≥ 70		≥ 4mm 24% ≥ 5mm 13.7% ≥ 7mm 2.6% ≥ 4mm 34.2% ≥ 5mm 23.5% ≥ 7mm 7% ≥ 4mm 33.4% ≥ 5mm 21.9% ≥ 7mm 5.1% ≥ 4mm 32.2% ≥ 5mm 20.2% ≥ 7mm 3.8% ≥ 4mm 32.4% ≥ 5mm 23% ≥ 7mm 4.4%	≥ 3mm 51.1% ≥ 5mm 18.1% ≥ 7mm 5.3% ≥ 3mm 74.2% ≥ 5mm 41.9% ≥ 7mm 20.5% ≥ 3mm 80.5% ≥ 5mm 48.3% ≥ 7mm 22.3% ≥ 3mm 88.8% ≥ 5mm 55.2% ≥ 7mm 27.4% ≥ 3mm 93.5% ≥ 5mm 71.9% ≥ 7mm 37.5%	
	CDC/AAP % INDIVIDUALS	19-34 35-44 ≥ 45	MILD			4.7% 5.0% 0.2%
		19-34 35-44 ≥ 45	MODERATE			38.7% 45.2% 43.6%
		19-34 35-44 ≥ 45	SEVERE			8.1% 34.4% 50.7%
CORRAINI *et al.* (2008)	% INDIVIDUALS	Total 20-29 30-39 40-49 ≥50	PPD/CAL	NR ≥ 3mm 100% ≥ 5mm 30.7% ≥ 7mm 4.8% ≥ 3mm 100% ≥ 5mm 37.5% ≥ 7mm 10% ≥ 3mm 100% ≥ 5mm 70.8% ≥ 7mm 29.2% ≥ 3mm 96.7% ≥ 5mm 60% ≥ 7mm 20%	NR ≥ 3mm 100% ≥ 5mm 37.1% ≥ 7mm 8.1% ≥ 3mm 100% ≥ 5mm 70% ≥ 7mm 20% ≥ 3mm 100% ≥ 5mm 83.3% ≥ 7mm 66.7% ≥ 3mm 100% ≥ 5mm 100% ≥ 7mm 83.3%	NA
FIGUEIREDO *et al.* (2013)	% INDIVIDUALS	Total 19-34 35-44 ≥ 45	PPD/CAL	≥ 4mm 92.9% ≥ 5 mm 68.8% ≥7 mm 25.5% ≥ 3mm 100% ≥ 5mm 62% ≥ 7mm 19.7% ≥ 3mm 100% ≥ 5mm 85% ≥ 7mm 45% ≥ 3mm 100% ≥ 5mm 74.4% ≥ 7mm 25.5%	≥ 4mm 83.5% ≥ 5 mm 63.8% ≥7 mm 30.8% ≥ 3mm 96.4% ≥ 5mm 48.9% ≥ 7mm 13.9% ≥ 3mm 100% ≥ 5mm 85% ≥ 7 mm 52.5% ≥ 3mm 100% ≥ 5mm 89.3% ≥ 7mm 61.7%	
	% TEETH PER INDIVIDUAL	19-34 35-44 ≥ 45		≥ 3mm 83.4% ≥ 5mm 12.2% ≥ 7mm 1.6% ≥ 3mm 94.3% ≥ 5mm 27.7% ≥7 mm 6.5% ≥ 3mm 91.5% ≥ 5mm 26.9% ≥ 7 mm 5.6%	≥ 3mm 35.8% ≥ 5mm 6.1% ≥ 7mm 1.1% ≥ 3mm 66.7% ≥ 5mm 25.9% ≥ 7mm 10.7% ≥ 3mm 76.5% ≥ 5mm 47.9% ≥ 7mm 25.9%	
	% SITES PER INDIVIDUAL	19-34 35-44 ≥ 45		≥ 3mm 46.5% ≥ 5mm 3.3% ≥ 7mm 0.3% ≥ 3mm 62.7% ≥ 5mm 9.5% ≥ 7mm 1.8% ≥ 3mm 60.7% ≥ 5mm 9.3% ≥7mm 1.6%	≥ 3mm 12.8% ≥ 5mm 1.7% ≥ 7mm 0.2% ≥ 3mm 32.2% ≥ 5mm 11.7% ≥ 7mm 3.9% ≥ 3mm 47% ≥ 5mm 27.5% ≥ 7mm 13.9%	
	CDC/AAP % INDIVIDUALS	19-34 35-44 ≥ 45	NONE/MILD			74.6% 55.0% 21.3%
		19-34 35-44 ≥ 45	MODERATE			12.3% 0.0% 14.9%
		19-34 35-44 ≥ 45	SEVERE			12.3% 45.0% 63.8%

CAL: Clinical Attachment Loss; PPD: Pocket Probing Depth; NA: Not applicable, Not reported.

Data from regional studies involving convenience samples are found in the Supplementary material. Studies applying partial protocols (Supplementary Material 1) reported prevalence rates of shallow pockets between 7.7% to 50%. Deep pockets were observed in 0% to 17.6% of the individuals. In elders, the prevalence of individuals with shallow pockets ranged between 0.5% to 83% and between 0% to 49% for deep pockets. Some studies have also evaluated PAL. Reis *et al.*, (2005) and Silva *et al.*, (2004) showed PAL of 0-3 mm a higher prevalence, reaching 37% and 86.3% of the individuals, respectively. On the other hand, PAL of 4-5 mm and 6-8 mm was more frequent in the studies of Tomita *et al.* (2002) and Carneiro *et al.* (2005), affecting 50% and 33.4% of the subjects, respectively. In regional studies with complete examination protocols (Supplementary Material 2), Ragghianti *et al.* (2004) and Boghossian *et al.* (2009) demonstrated that the mean of PPD ranged between 2.89 (±0.74) and 2.9 (±0.10), while the mean of CAL ranged between 3.18 (±0.92) and 3.9 (±0.14) in individuals aged 50 and over.

Table 4. National epidemiological surveys.

NATIONAL SURVEYS	MEASUREMENT UNIT	SAMPLE SIZE	AGE	HEALTHY	GINGIVAL BLEEDING	SHALLOW POCKETS	DEEP POCKETS	CALCULUS	EXCLUDED	PAL
SB BRASIL (1986) CPITN	% SEXTANTS	NR	35-44	17.4%	11.1%	6.7%	1.6%	23.3%	39.6%	NA
		NR	50-59	5.5%	4.9%	4.7%	2.3%	11.8%	70.8%	
SB BRASIL (2003) CPI	% INDIVIDUALS	13431	35-44	21.9%	9.9%	7.8%	2.1%	46.7%	11.3%	NA
		5349	65-74	7.8%	3.2%	4.4%	1.8%	21.7%	60.8%	
	MEAN PER SEXTANTS		35-44	1.87	0.5	1.1	0.04	1.3	2.1	
			65-74	0.4	0.1	0.08	0.03	0.5	4.85	
	% INDIVIDUALS	9441	35-44	17.8%	1.9%	15.2%	4.2%	28.6%	32.3%	
		7116	65-74	1.8%	0.2%	2.5%	0.8%	4.2%	90.5%	
SB BRASIL (2010) CPI	MEAN PER SEXTANTS		35-44	NA	1.4	0.6	0.1	1.8	NA	
			65-74	NA	0.4	0.2	0.04	0.6	NA	
	% INDIVIDUALS	9333	35-44						30.5%	0-3 mm 51.3% 4-5 mm 13.2% 6-8 mm 4% 9-11mm 0.8% ≥12 mm 0.2%
		7061	65-74						90.1%	0-3 mm 6% 4-5 mm 2.3% 6-8 mm 1.2% 9-11mm 0.3% ≥12 mm 0.1%

CPI: Community Periodontal Index; CPITN: Community Periodontal Index of Treatment Needs; PAL: Periodontal Attachment Index; NR: Not reported; NA: Not applicable.

Discussion

Epidemiological studies are important for improving public health, as they allow quantitative assessment of the distribution of health-disease processes. Specifically in Brazil, this importance has been reinforced by the National Oral Health Policy Guidelines that reoriented the model of care and advocated the use of epidemiology to support the planning of programs aiming at prevention and promotion of oral health (Brasil 2004). Despite these efforts, it is still not possible to accurately estimate the prevalence of periodontitis from national epidemiological surveys in Brazil. However, based on the few well-designed representative studies included in this review, if we consider the CDC/AAP criteria or a threshold of CAL ≥ 3mm, it is suggested that the prevalence of periodontitis in Brazil is higher than in developed countries. While in the US the prevalence of severe periodontitis in adult populations (as defined using the CDC/AAP criteria) ranged from 6.7 to 11.7% (Eke *et al.*, 2012), in Brazil it ranged from 34.4% to 63.8% in individuals aged 35 or over (Susin *et al.*, 2004,2005; Corraini *et al.*, 2008). Kassebaum *et al.* (2014) found an estimated prevalence of severe periodontitis (as defined by any site with CPITN=4, PPD>5 mm, or CAL>6 mm) ranging from 8.6 to 14.9% in Asia, 9.4 to 14% in Europe, 15.1 to 20.6% in Latin America, 8.9 to 20,3% in Africa and 7.2% in North America.

In 1997, the World Health Organization recommended the CPI for epidemiological surveys addressing periodontal diseases (WHO 1997). Its use for diagnosing periodontal diseases, despite being practical and quick in studies with large populations, has been consistently criticized (Leroy *et al.*, 2010; Kingman *et al.*, 2002; Eaton *et al.*, 2001). This index is based on a hierarchical concept of progression of the periodontitis, representing the worst condition observed in the index tooth. Therefore, lower-graded conditions are excluded very often. Another limitation of this index is the inability to assess periodontal attachment loss and other parameters of periodontal destruction such as mobility and furcation involvement. The amount of information lost in the partial records underestimates the disease, due to the inability of reflecting the health-disease state in the whole mouth (Eke *et al.*, 2012; Eke *et al.*, 2010; Kingman *et al.*, 2008; Kingman *et al.*, 2002). For epidemiological surveys, a full-mouth periodontal examination provides a reliable estimate of the extent and severity of the disease in the population studied, despite the increased amount of time needed for the examination (Leroy *et al.*, 2010; Eaton *et al.*, 2001). Taking all this evidence into account, it is clear that national epidemiological surveys and partial regional studies, even if representative, are very fragile, since they applied the CPI or CPITN methodology, making it difficult to draw solid scientific conclusions.

The use of PPD found different prevalence estimates of shallow and deep pockets in national epidemiological surveys and regional studies with partial protocols. However, this parameter should not be used in isolation for the

diagnosis of periodontitis (Armitage 2004). It has been clearly defined that the gold-standard parameter for the definition of periodontitis is CAL. More recently, the use of CAL alone has been discussed since it could reflect the history of the disease and not the presence of active disease at the time of the examination (Kornman and Papapanou, 2020; Eke *et al.*, 2015; Albandar *et al.*, 1999; Emrich *et al.*, 1991).

Given the observed discrepancies, the establishment of criteria for the classification of periodontitis is important so that the results of research carried out in different regions can be compared. Different case definitions have been described in the literature and used in epidemiological surveys (Tonetti *et al.*, 2018; Page and Eke, 2007; Tonetti and Claffey, 2005). This heterogeneity in the definition of the disease can lead to different prevalence rates, biasing the results. The criterion established by the CDC/AAP has been pointed out by international consensus as to the most suitable for classifying periodontal disease in epidemiological studies (Holtfreter *et al.*, 2015; Eke *et al.*, 2012). In addition to being based on the CAL and PPD parameters, it uses only interproximal sites, which excludes attachment loss due to causes other than periodontitis. For this study, the authors from Susin *et al.*, 2004 and 2005, have applied the CDC/AAP classification in their sample and therefore we could compare it with Figueredo *et al.*, 2013. None/Mild periodontitis was more frequently observed in individuals from the indigenous reserve (Figueredo *et al.*, 2013) than in the metropolitan area of Porto Alegre (Susin *et al.*, 2004 and 2005). The difference is up to 34% in individuals aged 35-44 years. Conversely, moderate and severe periodontitis were more frequently observed in the urban area for all age groups. This suggests that the sample source for each study also affects the estimates of prevalence, probably related to social characteristics and habits of each population, area or community. This is especially important when planning and comparing studies in a country with continental dimensions and multiplicity of regional characteristics, like Brazil.

Regional studies with partial protocols that involved the elderly population showed considerable exclusions due to edentulism. The absence of teeth overestimates the other variables and makes it difficult to establish prevalence (Vettore *et al.*, 2013). To understand the prevalence of periodontal disease, as well as associated potential risk factors, studies with a representative sample are essential. A limitation of this review was the scarce number of such studies. Overall, methodological differences limited the comparison of results and partially justified the data discrepancy between samples/populations.

For future studies, we recommend that well-designed and representative sampling strategies are used,

as well as standardization of age groups and uniformity of units of analysis. We emphasize the need for using full-mouth examination protocol, since partial indexes do not accurately reflect the prevalence of periodontitis; and also reinforce the use of definition criteria that allows comparability with other countries.

Conclusion

It is currently not possible to establish the true prevalence of periodontitis in the Brazilian population, since official national surveys apply limited methodology. Based on a very small number of studies conducted with regional representative samples, it may be suggested that the prevalence of periodontitis in Brazil is higher than other developed countries (above 50% of the population). It is recommended that new studies use well-designed sampling strategies and methodologies and internationally recognized criteria for defining the disease.

Acknowledgments and conflict of interest

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