Obesity and periodontal disease are inversely associated in a population of adults in southern Brazil

Sabrina Trinca Soares Boschin
Caroline Formolo Dalla Vecchia
Giovana Formolo Dalla Vecchia
Alessandra Natacha Rinaldo Maliska
Daiane Cerutti Kooplin
Carlos Alberto Feldens

ABSTRACT

Objective: Investigate the association between obesity (measured using the body mass index and abdominal circumference) and periodontal disease in adults. **Methods**: A cross-sectional study was conducted with 280 adults (102 men and 178 women) who sought dental care at the clinic of the dentistry course of the Lutheran University of Brazil (*Cachoeira do Sul* campus). The participants answered a questionnaire addressing socioeconomic, demographic, behavioral and health-related characteristics. Height, body weight and waist measurements were determined in a standardized way for the calculation of the variables used to define obesity: body mass index (BMI) and abdominal circumference (AC). Oral clinical examinations were performed by two examiners who had undergone training and calibration exercises. Periodontal disease was recorded when clinical attachment loss was ≥ 5 mm in ≥ 30% of the teeth. Statistical analysis involved simple and multivariate Poisson regression with robust variance. **Results**: The prevalence of periodontal disease was 49.6% (139/280). The multivariate models indicated a lower likelihood of periodontal disease in individuals considered obese based on BMI (PR=0.64; 95% CI: 0.47-0.88) and AC (PR=0.72; 95% CI: 0.55-0.93). Moreover, the prevalence of the outcome was significantly higher in older individuals, those with less schooling, smokers and individuals with diabetes. **Conclusion**: An inverse association was found between obesity measured using both criteria and periodontal disease. The present data suggest that care and counseling for the prevention and control of periodontal disease should be equally directed at individuals in the ideal weight range as well as those with overweight or obesity.

Keywords: periodontal disease; periodontitis; obesity; epidemiology.

Sabrina Trinca Soares Boschin – MSc in Dentistry. Department of Periodontology. Universidade Luterana do Brasil.
Caroline Formolo Dalla Vecchia – MSc in Dentistry. Department of Periodontology. Universidade Luterana do Brasil.
Giovana Formolo Dalla Vecchia – MSc in Dentistry. Department of Periodontology. Universidade Luterana do Brasil.
Alessandra Natacha Rinaldo Maliska – MSc in Dentistry. Department of Periodontology. Universidade Luterana do Brasil.
Daiane Cerutti Kooplin – PhD in Dentistry. Department of Collective oral Health. Universidade Federal do Rio Grande do Sul.
Carlos Alberto Feldens - PhD in Epidemiology. Department of Pediatric Dentistry. Universidade Luterana do Brasil.

Corresponding author: Sabrina Trinca Soares Boschin. Endereço: Rua Honório Silveira Dias 1483/1302, Higienópolis, Porto Alegre-RS. Brazil. CEP 90540-070. E-mail: sabrinaboschin@icloud.com

Obesidade e doença periodontal estão inversamente associadas em uma população de adultos do sul do Brasil

RESUMO

Objetivo: Investigar a associação entre obesidade, medida a partir do Índice de Massa Corporal (IMC) e da medida da Circunferência Abdominal (CA), e doença periodontal em adultos. **Metodologia**: A amostra deste estudo transversal foi composta por 280 sujeitos (102 homens e 178 mulheres) que buscaram atendimento odontológico no Ambulatório do Curso de Odontologia da Universidade Luterana do Brasil (ULBRA), campus Cachoeira do Sul, Brasil. Os sujeitos responderam a questionário estruturado, incluindo variáveis socioeconômicas, demográficas, comportamentais e de saúde. Altura, peso corporal e medida da cintura foram obtidos de forma padronizada para cálculo das variáveis que definiram obesidade: Índice de Massa Corporal (IMC) e Circunferência Abdominal (CA). Exame clínico odontológico foi realizado por dois examinadores calibrados, sendo doença periodontal considerada quando houvesse perda de inserção proximal ≥ 5mm em ≥ 30% dos dentes presentes. A análise estatística foi realizada por meio de regressão de Poisson com variância robusta simples e multivariável. **Resultados**: A prevalência de doença periodontal foi de 49,6% (139/280). Os modelos multivariáveis indicaram menor probabilidade de doença periodontal em sujeitos obesos a partir do IMC (RP 0,64; IC 95% 0,47-0,88) e a partir da CA (RP 0,72; IC 95% 0,55-0,93). Além disso, a prevalência do desfecho foi significativamente maior em indivíduos com maior idade, menor escolaridade, fumantes e diabéticos. **Conclusão**: Foi observada associação inversa entre obesidade, medida por ambos os critérios, e doença periodontal. Esses dados sugerem que a atenção e orientações para prevenção e controle de doença periodontal devem ser igualmente dirigidas a sujeitos com peso normal, sobrepeso ou obesos.

Palavras-chave: doença periodontal; periodontite; obesidade; epidemiologia.

INTRODUCTION

Periodontal disease is one of the most prevalent chronic inflammatory diseases in the world. A national epidemiological survey conducted in Brazil in 2010 estimated that 27.7% of adults between 35 and 44 years of age had shallow periodontal pockets and 6.9% had deep pockets (1). Periodontal disease can cause halitosis (2), is the most frequent cause of tooth loss (3) and exerts an impact on oral health-related quality of life (4). Associations with premature birth and low birth weight have also been suggested (5).

Although associations between periodontal disease and tobacco use (6), diabetes mellitus (7), cardiovascular disease (8) and respiratory complications (9) have been determined, there is no consensus regarding an association with obesity. Although most studies describe a positive association between overweight/obesity and periodontal disease (10-14), some studies have found no such association (15-17) and others have found an inverse association between the exposure and outcome (18). In a systematic review, Chaffee and Weston (2010) concluded that there is limited evidence implicating obesity as a risk factor for periodontal disease (19).

The clarification of factors associated with different adverse health conditions in each population is fundamental to guiding prevention and control strategies (20). Therefore, the aim of the present study was to investigate the association between obesity

measured using the body mass index and waist circumference and periodontal disease defined as clinical attachment loss ≥ 5 mm in ≥ 30% of the teeth in a population of adults in southern Brazil.

METHODS

Study design and participants

A cross-sectional study was conducted with 280 adults (102 men and 178 women) who sought dental care at the clinic of the dentistry course of the Lutheran University of Brazil (*Cachoeira do Sul* campus). The municipality has a population of 83,827 residents (IBGE 2010) and is located in the center of the state of Rio Grande do Sul, Brazil.

The inclusion criteria were age 18 years or older and having at least three teeth present. Pregnant and nursing mothers were excluded from the study.

The sample size was calculated considering a 95% confidence level, 90% power and a 40% frequency of periodontal disease of among non-exposed individuals and 70% among exposed individuals (21), determining a minimum of 168 participants. Thirty percent was added to enable multivariate analysis, leading to a sample of 218 individuals. To compensate for refusals and dropouts, 330 individuals were invited to participate in the study.

Data collection

Data were collected through interviews, the determination of anthropometric characteristics and an oral clinical examination.

Interview (demographic, socioeconomic and health-related characteristics)

All participants answered a previously employed questionnaire (22) administered in interview format addressing demographic (gender, age and ethnic group), socioeconomic (income and schooling), behavioral (use of tobacco and tooth brushing frequency) and health-related (diabetes) characteristics. A single interviewer underwent a training exercise for the procedures involved in the collection of these data to ensure the standardized administration of the questionnaire. Income was collected in Brazilian currency ($R) using the Brazilian monthly minimum wage as the unit of analysis and categorized based on the median. Schooling was collected in complete years of study and subsequently dichotomized as ≤ eight or > eight years.

Anthropometric characteristics

Height (cm), body weight (kg) and waist measurement (cm) were determined by two trained and calibrated undergraduate dental students between April 2006 and October 2007. These data were used to calculate the body mass index (BMI) and abdominal circumference (AC). Weight was measured on a common portable scale (Sensimax, Metalúrgica Promesul, São Leopoldo, RS, Brazil) in kilogram units previously evaluated by the *Instituto Nacional de Metrologia, Normalização e Qualidade Industrial* (INMETRO [National Institute of Metrology, Normalization and Industrial Quality]). Height was measured with the volunteers barefoot using a metal ruler (component of an electronic scale [Brião, Metalúrgica Brião, Cachoeira do Sul, RS, Brazil, approved by INMETRO – ordinance 236) with a precision of 0.5 cm attached to a steel support on which the volunteers stood. AC was measured using a metric tape with the volunteer shirtless and wearing light clothing on the legs to interfere as little as possible with the precision of the reading. BMI was calculated by dividing weight by height squared (kg/m²).

Agreement regarding the anthropometric characteristics was evaluated using the intraclass correlation coefficient (ICC) with 12 volunteers who were not part of the sample. Intra-examiner coefficients were 0.99 for BMI (both examiners) and 0.98 and 0.99 for AC (examiner 1 and 2, respectively). Inter-examiner coefficients for BMI and AC were 0.99 and 0.98, respectively.

Obesity – exposure variables

Obesity was defined based on BMI and AC. The classification of the participants according to BMI followed the criteria of the World Health Organization for adults (23): < 24.9 kg/m² = ideal weight; 25 to 29.9 kg/m² = overweight; ≥ 30 kg/m² = obesity. AC was categorized using different cutoff points for men (< 94 cm = ideal; 94 to 102 cm = overweight; ≥ 102 cm = obesity) and women (< 80 cm = ideal; 80 to 88 cm = overweight; ≥ 88 cm = obesity) (24).

Periodontal disease - outcome

The oral clinical examinations were performed by two trained and calibrated examiners at the clinic of the dentistry course of the Lutheran University of Brazil (*Cachoeira do Sul* campus), with similar equipment, instruments and methods. Training involved definitions of the clinical variables, execution of the procedures and the evaluation of diagnostic errors. Repeated measures of probing depth, gingival recession, the visible plaque index and plaque retention factors were performed to determine the reproducibility of the clinical data during a 10-day period. The volunteers examined in the pilot study were not included in the sample of the main study. The Kappa statistic was used for the determination of agreement considering site as the unit of analysis. Intra-examiner Kappa coefficients were 0.73 and 0.82 for gingival recession and 0.92 and 0.93

for probing depth (examiner 1 and 2, respectively). Inter-examiner Kappa coefficients were 0.79 and 0.89 for gingival recession and probing depth, respectively.

The clinical examinations were performed with the aid of a mouth mirror (Duplex, Brazil), periodontal probe with marks at 1, 2, 3, 5, 7, 8, 9 and 10 millimeters (HuFriedy, CP10SE, USA) and tweezers for cotton (EDLO, Brazil). The examination included the assessment of clinical variables related to periodontal disease, which were recorded on a standard chart. All permanent teeth were examined, except third molars. The clinical variables were assessed at six sites per tooth (mesiobuccal, buccal, distobuccal, mesiolingual, lingual and distolingual) as follows: visible plaque index (VPI) 0 = absence of visible plaque; 1=presence of visible plaque; gingival bleeding index (GBI) 0=absence of bleeding; 1=presence of bleeding; probing depth (PD) – distance from gingival margin to most apically probed portion in mm; and gingival recession – distance from the cementoenamel junction to the gingival margin (in mm), assuming a negative value when the cementoenamel junction was located apically to the gingival margin. Clinical attachment loss (CAL) was calculated from the sum of probing depth and gingival recession. Periodontal disease was defined in the present study as CAL≥5 mm in ≥30% of the teeth present (25).

Data analysis

Statistical analysis was performed with the aid of the Statistical Package for the Social Sciences (SPSS, Chicago, IL, USA). The prevalence of periodontal disease was compared between categories of the control variables and obesity using the chi-square test. Unadjusted prevalence ratios (PR) and 95% confidence intervals (CI) were estimated using Poisson regression with robust variance. Next, two multivariate models were run: one with obesity determined based on BMI and the other with obesity determined based on AC. In each model, all variables were incorporated into the initial model and successively eliminated (stepwise backward method) until only those with a p-value < 0.20 remained. The level of statistical significance was set at 5% ($p < 0.05$).

Ethical aspects

This study received approval from the Human Research Ethics Committee of the School of Dentistry of the Lutheran University of Brazil. All volunteers agreed to participate by signing a statement of informed consent. All individuals with treatment needs were sent for dental care.

RESULTS

The final sample was composed of 280 individuals. Age ranged from 28 to 70 years, with a mean (standard deviation [SD]) of 45.8 (9.8) years and a median (P25-P75) of 45.0

(38.0-52.0) years. The female gender (63.7%), whites (85.6%), more than eight years of schooling (59.1%) and income more than three times the Brazilian monthly minimum wage (52.3%) predominated. Table 1 displays the characteristics of the sample.

BMI ranged from 16.7 to 50.2, with a mean (SD) of 27.5 (5.3) and median (P25-P75) of 27.0 (23.8-30.0). The classification of the 280 individuals based on BMI indicated that 33.9% were in the normal weight range, 41.1% were overweight and 25.0% were obese. AC among the men ranged from 71.5 to 146 cm, with a mean (SD) of 95.4 (12.2) cm and median (P25-P75) of 94.0 (86.5-103.0) cm. AC among the women ranged from 63.3 to 138 cm, with a mean (SD) of 86.1 (12.9) and median (P25-P75) of 84.5 (76.0-94.0) cm. Based on the AC, 39.6% of the sample were in the normal range, 23.9% were overweight and 36.5% were obese.

The number of teeth ranged from three to 28, with a mean (SD) of 20.0 (6.4) and median (P25-P75) of 22 (17-25). The proportion of teeth affected by periodontal disease ranged from 0 to 100%, with a mean (SD) of 35.7% (31.9%) and median (P27-975) of 29.9% (8.1%-56.7%). The prevalence of periodontal disease in the sample was 49.6% (139/280).

The unadjusted model (Table 1) demonstrated that periodontal disease was more prevalent among the men ($p=0.001$), older individuals ($p<0.001$), those with a lower income ($p=0.026$), those with less schooling ($p<0.001$), smokers ($p<0.001$) and individuals with diabetes ($p=0.011$). No significant difference was found in the unadjusted analysis among individuals with ideal weight, overweight or obesity based on either BMI or AC.

Table 1 - Characteristics of sample, prevalence of periodontal disease, undadjusted prevalence ratios (PR) and 95% confidence intervals (CI) according to control variables and obesity based on body mass index (BMI) and abdominal circumference (AC).

Variables	N	(%)	Periodontal disease		p*	Unadjusted model		p
			n	(%)		PR	(95% CI)	
Demographic characteristics								
Gender					0.001			
Male	102	(36.4)	64	(62.7)		1.49	(1.19-1.87)	0.001
Female	178	(63.7)	75	(42.1)		1.00		
Age (years)					0.000†			
< 40	90	(32.1)	28	(31.1)		1.00		
40-50	102	(36.4)	51	(50.0)		1.61	(1.12-2.31)	0.011
> 50	88	(31.4)	60	(68.2)		2.19	(1.56-3.08)	0.000
Socioeconomic characteristics								
Income					0.026			
≤ 3 x BMMW	132	(47.7)	75	(56.8)		1.31	(1.03-1.66)	0.027
> 3 x BMMW	145	(52.3)	63	(43.4)		1.00		
Schooling (years)					0.000			
≤ 8	114	(40.9)	75	(65.8)		1.70	(1.34-2.14)	0.000
> 8	165	(59.1)	64	(38.8)		1.00		
Behavioral characteristics								
Tobacco use					0.000			
No	224	(80.3)	99	(44.2)		1.00		
Yes	55	(19.7)	39	(70.9)		1.60	(1.28-2.01)	0.000
Tooth brushing frequency (per day)					0.427			
≤ 1	32	(11.4)	18	(56.2)		1.15	(0.83-1.60)	0.400
> 1	248	(88.6)	121	(48.8)		1.00		
Health-related characteristics								
Diabetes mellitus					0.011††			
No	263	(94.9)	127	(48.3)		1.00		
Yes	14	(5.1)	12	(85.7)		1.77	(1.39-2.27)	0.000
Body Mass Index					0.302†			
Normal	95	(33.9)	50	(52.6)		1.00		
Overweight	115	(41.1)	58	(50.4)		0.96	(0.74-1.25)	0.751
Obese	70	(25.0)	31	(44.3)		0.84	(0.61-1.16)	0.297
Abdominal circumference					0.449†			
Normal	111	(39.6)	59	(53.2)		1.00		
Overweight	67	(23.9)	31	(46.3)		0.87	(0.64-1.19)	0.383
Obese	102	(36.5)	49	(48.0)		0.90	(0.69-1.18)	0.458

BMMW = Brazilian monthly minimum wage

* chi-square test

† chi-square test for linear trend

†† Fisher's exact test

However, the multivariate models indicated that obesity measured using both methods was inversely associated with periodontal disease. Independently of demographic and socioeconomic characteristics, obese individuals were 36% less likely to have periodontal disease (PR=0.64; 95% CI: 0.47-0.88) when classified based on BMI (Table 2) and 28% less likely to have periodontal disease (PR = 0.72; 95% CI: 0.55-0.93) when based on AC (Table 3). Moreover, the multivariate analysis indicated that the likelihood of periodontal disease was higher among older individuals, those with less schooling, smokers and diabetics. In contrast, the association with gender and income lost its significance in the multivariate analysis.

Table 2 - Final model: prevalence ratios (PR) and 95% confidence intervals (CI) according to control variables and obesity based on body mass index (BMI).

Variables	Adjusted model		
	PR	(95% CI)	p
Gender			
Male	1.23	(0.98-1.53)	0.069
Female	1.00		
Age (years)			
< 40	1.00		
40-50	1.60	(1.13-2.25)	0.007
> 50	2.12	(1.53-2.95)	0.000
Schooling (years)			
≤ 8	1.52	(1.22-1.89)	0.000
> 8	1.00		
Tobacco use			
No	1.00		
Yes	1.42	(1.15-1.74)	0.001
Diabetes mellitus			
No	1.00		
Yes	1.60	(1.13-2.28)	0.008
Body Mass Index			
Normal	1.00		
Overweight	0.79	(0.63-1.01)	0.058
Obese	0.64	(0.47-0.88)	0.005

Table 3 - Final model: prevalence ratios (PR) and 95% confidence intervals (CI) according to control variables and obesity based on abdominal circumference (AC).

Variables	Adjusted model		
	PR	(95% CI)	p
Age (years)			
< 40	1.00		
40-50	1.57	(1.11-2.21)	0.010
> 50	2.15	(1.55-2.98)	0.000
Schooling (years)			
≤ 8	1.55	(1.24-1.93)	0.000
> 8	1.00		
Tobacco use			
No	1.00		
Yes	1.45	(1.17-1.79)	0.001
Diabetes mellitus			
No	1.00		
Yes	1.72	(1.23-2.42)	0.002
Abdominal circumference			
Ideal	1.00		
Overweight	0.82	(0.61-1.09)	0.173
Obese	0.72	(0.55-0.93)	0.013

An additional analysis was performed to identify variables that confounded the associations in the unadjusted model. With both measures of obesity, age was the only variable to confound the effect on periodontal disease. After the adjustment for this variable, significant effects were detected for obesity measured by BMI (PR=0.69; 95% CI: 0.50-0.95) and AC (PR=0.74; 95% CI: 0.57-0.96). Moreover, Pearson's correlation test identified that age in this sample was correlated with obesity measured by BMI (p=0.005; r=0.169) and by AC (p<0.001; r =0.266), confirming it as a confounding factor.

DISCUSSION

The present study investigated the association between periodontal disease and obesity measured using the body mass index (BMI) and abdominal circumference (AC) in a population of adults. The most important finding was an inverse association between periodontal disease and obesity measured using both criteria independently of the demographic, socioeconomic and behavioral characteristics of the volunteers analyzed.

Most studies have reported that obese individuals have a greater likelihood of exhibiting or developing periodontal disease (11-13,21). The biological mechanisms of a possible association are not fully understood, but it is plausible that inflammatory

pathways are involved. Adipose tissue is capable of producing a set of biologically active molecules, including several cytokines, such as tumor necrosis factor alpha (TNF-α) and some interleukins (IL-1β, IL-6 and IL-8) (14). High levels of TNF-α in the organism of obese individuals are believed to interfere with the bonding of insulin to its receptor on the surface of cells, thereby impairing the uptake of peripheral glucose (14). Obesity may determine a change in the production and release of important defense cells, such as neutrophils, which are recognized as the first line of defense for periodontal tissues. Such changes may exert a negative influence on the immune-inflammatory response of the host (14).

However, some studies have not found such an association even in longitudinal investigations (16-17), whereas others have found that the prevalence of periodontal disease is lower in obese individuals (18), which is in agreement with the present findings. It is difficult to find explanations for the inverse association between these variables. The present study was conducted with adults who sought dental care, which presupposes a reasonable degree of self-perception regarding health. It is possible that the obese individuals who participated in this study had a lower level of periodontal disease in comparison to obese individuals who did not participate in the study, which would indicate a certain degree of selection bias. As occurs in investigations conducted at healthcare services, it was not possible to collect the characteristics of non-participants, which impedes the measurement of this effect.

The different criteria that define obesity and periodontal disease may also explain the conflicting results. Inconsistencies in the definition of periodontal disease affect estimates that describe the distribution of the disease. Clinical attachment loss is the most widely used measure to express the extent and severity of cumulative periodontal disease throughout the life of an individual. Even considering only this aspect to define periodontal disease, the cutoff point varies widely across studies, which may partially explain the differences reported (19,25). The association found between obesity and periodontal disease seems to be restricted to the initial inflammatory stages of the disease. The fact that a threshold of greater severity was used in the present study for the definition of periodontal disease may also explain the results observed.

Kongstad et al. (18) also found that the prevalence of periodontal disease was lower in obese individuals, but obesity was determined based on self-reported weight and height, which may have led to a certain degree of measurement bias. In the present study, obesity was measured using two variables (BMI and AC), for which training and calibration exercises had previously been performed, which indicates a low probability of this type of bias. BMI is easily determined and widely used as a measure that enables the comparison of adiposity in individuals with different heights and weights and can be used in different populations (14,19). However, this measure does not distinguish between adipose mass and muscle mass, which could lead to incorrect suppositions. Likewise, BMI classifies individuals with the same height and weight in the same category, although their body compositions may be different. The measurement of waist circumference is widely used in epidemiological studies due to its simplicity, reproducibility and the fact that it

is strongly associated with metabolic function. There is evidence that sex and age affect the measurement of AC and some studies suggest the influence of ethnicity. In general, there is no universally accepted variable for defining obesity.

The possibility that the association encountered was due to chance cannot be discarded, especially since the sample size was not very large. However, two measures of obesity were used. Although a degree of correlation between these variables is expected, the two measures assess different domain concepts and the possibility that both associations occurred by chance is low.

It is interesting to note that the present study captured the effects of different risk factors of periodontal disease recognized in the literature. As occurred in previous studies, the likelihood of periodontal disease was greater in individuals with diabetes (7), those who smoked (6) and those with a lower socioeconomic status. Schooling remained associated even after the multivariate adjustment. In contrast, income lost its significance. Although the mechanisms by which a better socioeconomic status affects different health outcomes are not yet recognized, some suppositions may be made. Unlike income, which represents the possibility of acquiring goods, schooling may reflect self-care better and may be considered a predictor of periodontal disease.

Unmeasured confounding factors can exert an influence on estimates of the association between obesity and periodontal disease (19). An important implication of the present study for future investigations is the clear definition that age is a variable with a strong capacity to confound this association. This variable fulfilled the requirements of a confounder in the present study, such as being related to both the outcome (periodontal disease) and exposure (obesity) and not being a link in the chain in the association between the exposure and outcome. It is noteworthy that age was the only variable responsible for confounding the association in the present study.

The present results do not lend support to the hypothesis that obese individuals are more likely to have periodontal disease. Among the clinical implications, adults with a higher BMI and larger AC do not require greater attention and control regarding periodontal disease compared to individuals categorized in the ideal weight range. It is possible that both conditions (obesity and periodontal disease) are the result of less self-care rather than having a causal relationship. In contrast, the present results confirm the need for greater attention to adults who smoke, those with diabetes and those with a lower socioeconomic status.

The present findings can be generalized to populations with similar cultural and demographic characteristics that live in southern Brazil and seek dental services at a university (predominantly white, relatively low socioeconomic level and residing in a developing country).

In conclusion, the present study found an inverse association between periodontal disease and obesity measured by both the body mass index and abdominal circumference independently of the demographic, socioeconomic and behavioral characteristics of the

individuals investigated. Moreover, the likelihood of periodontal disease was greater among adults with a lower level of schooling, older individuals, smokers and individuals with diabetes.

REFERENCES

1. Brasil, Ministério da Saúde/Secretária de Atenção à Saúde. Projeto SB Brasil 2010. Pesquisa Nacional de Saúde Bucal - Resultados principais. Brasília: Ministério da Saúde; 2011.[Acessado em 21 jan 2014]. Disponível em: http://189.28.128.100/dab/docs/geral/projeto_sb2010_relatorio_final.pdf

2. Amou T, Hinode D, Yoshioka M, Grenier D. Relationship between halitosis and periodontal disease – associated oral bactéria in tongue coatings. Int J Dent Hyg. 2013;26:DOI: 10.1111/idh. 12046.

3. Taani DSMQ. Periodontal reasons for tooth extraction in an adult population in jordan. J of Oral Rehabilitation. 2003;30:110-112.

4. Nagarajan S, Chandra RV. Perception of oral health related quality of life (OHQoL-UK) among periodontal risk patients before and after periodontal therapy. Community Dent Health. 2012;29(1):90-94.

5. Ali TB, Abidin KZ. Relationship of periodontal disease to pre-term low birth weigth infants in a selected population-a prospective study. Community Dent Health 2012;29(1):100-105.

6. Mohamed S, Janakiram C. Periodontal status among tobacco users in Karnataka, India. Indian J Public Health. 2013;57(2):105-108.

7. Borgnakke WS, Ylöstalo PV, Taylor GW, Genco RJ. Effect of periodontal disease on diabetes: systematic review of epidemiologic observational evidence. J Clin Periodontol 2013;40(14):135-152.

8. Saffi MA, Furtado MV, Montenegro MM, Ribeiro IW, Kampits C, Silva ER, Polanczyk CA, Rösing CK, Haas AN. The effect of periodontal therapy on C-reactive protein, endotelial function, lipids and proinflammatory biomarkers in patients with stable coronary artery disease: study protocol for a randomized controlled trial. Trials 2013;14:283-290.

9. Barros SP, Suruki R, Loewy ZG, Beck JD, Offenbacher S. A cohort study on the impacto f tooth loss and periodontal disease on respiratory events among COPD subjects: Modulatory role of systemic biomarkers of inflammation. PLoS One 2013;8(8):e68592.

10. Yoshihara A, Sugita N, Iwasaki M, Miyazaki H, Nakamura K. The interaction between beta-3 adrenergic receptor polymorphism and obesity to periodontal disease in community-dwelling elderly Japanese. J Clin Periodontol 2014; 41: 460–466.

11. Nascimento GG, Leite FRM, Do LG, Peres KG, Correa MB, Demarco FF, Peres MA. Is weight gain associated with the incidence of periodontitis? A systematic review and meta-analysis. J Clin Periodontol 2015; 42: 495–505. doi:10.1111/ jcpe.12417.

12. Gaio EJ, Haas AN, Ro€sing CK, Oppermann RV, Albandar JM, Susin C. Effect of obesity on periodontal attachment loss progression: a 5-year population-based prospective study. J Clin Periodontol 2016; 43: 557–565. doi: 10.1111/jcpe.12544.
13. Albandar JM, Susin C, Hughes FJ. Manifestations of systemic diseases and conditions that affect the periodontal attachment apparatus: Case definitions and diagnostic considerations. *J Periodontol*. 2018;89 Suppl 1:S183–S203. doi:10.1002/JPER.16-0480.
14. Suvan, J.E, Finer N, D'aiuto F. Periodontal complications with obesity. Periodontol 2000. 2018; v.78, p.98-128.
15. Wakai K, Kawamura T, Umemura O, Hara Y, Machida J, Anno T, et al. Association of medical status and physical fitness with periodontal disease. J Clin Periodontol. 1999;26:664-672.
16. Castilhos ED, Horta BL, Gigante DP, Demarco FF, Peres KG, Peres MA. Association between obesity and periodontal disease in young adults: a population-based birth cohort. J Clin Periodontol. 2012;39:717-724.
17. Saxlin T, Ylostalo P, Suominen-Taipale L, Aromaa A, Knuuttila M. Overweight and obesity weakly predict the development of periodontal infection. J Clin Periodontol. 2010;37:1059-1067.
18. Kongstad J, Hvidtfeldt UA, Grønbæk M, Stoltze K, Holmstrup P. The relationship between body mass index and periodontitis in the Copenhagen city heart study. J Periodontol 2009;80:1246-1253.
19. Chaffee BW, Weston SJ. Association between chronic periodontal disease and obesity: a systematic review and meta-analysis. J Periodontol 2010;81(12):1708-1724.
20. Petersen PE. The World Oral Health Report 2003: continuous improvement of oral health in the 21st century--the approach of the WHO Global Oral Health Programme. Community Dent Oral Epidemiol. 2003;31 Suppl 1:3-23.
21. Saito T. Relationship between upper body obesity and periodontitis. J Dent Res.2001;80(7):1631-1636.
22. Susin C, Oppermann RV, Haugejorden O, Albandar JM. Tooth loss and associated risk indicators in an adult urban population from south Brazil. Acta Odontologica Scandinavica. 2005;63(2):85-93.
23. Deurenberg P, Yap M. The assessment of obesity: methods for measuring body fat and global prevalence of obesity. Baillieres Clin Endocrinol Metab. 1999;13(1):1-11.
24. Lean MEJ, Han TS, Morrison CE. Waist circunference as a measure for indicating need for weight management. BMJ. 1995;15:158-161.
25. Savage A, Eaton KA, Moles DR, Needleman I. A systematic review of definitions of periodontitis and methods tha have been used to identify this disease. J Clin Periodontol. 2009;36:458-467.