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Research Article

Osteoporosis, Tooth Loss and Periodontitis in Brazilian Postmenopausal Women

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Abstract

Objective: The aim of the present study was to investigate a possible association between osteoporosis and oral health conditions (periodontitis and tooth loss) among postmenopausal (PM) Brazilian woman.

Methods: A cross-sectional analytical study was conducted among 113 PM women, enrolled at the main osteoporosis diagnostic service in Feira de Santana, Bahia, Brazil. Periodontal disease was diagnosed through a complete periodontal clinical examination, confirmed by the use of panoramic radiography. The diagnosis of osteoporosis (OP) was based on bone densitometry reports from the lumbar spine and femur. Descriptive and logistic analyses were applied to the data gathered.

Results: Odds ratio measurements were converted into prevalence ratios through the Poisson model (significance level of 5%). Significant negative correlations between probing depth (r = -0.191; p = 0.04), number of teeth present (r = -0.196; p = 0.04) and bone mineral density of the lumbar spine were found. No association was found between OP and periodontitis and tooth loss. PR_{crude} = 1.18; 95%CI: 0.51 - 2.72, even after adjustment for age and BMI: $PR_{adjusted}$ = 1.28; 95%CI: 0.53 - 3.05.

Conclusion: Osteoporosis does not appear to significantly influence the prevalence of periodontal disease and tooth loss, although a correlation between bone mineral density and oral health conditions has been described. However, further studies are required that could control all the possible confounding variables.

Keywords: *Periodontal Disease; Osteoporosis; Epidemiology; Oral-Systemic Disease*

Introduction

Osteoporosis (OP) is the most common metabolic bone disease and skeletal disorder, and is considered a major public health issue, with a dramatic social and financial impact. Its prevalence increases with age, and it affects all bones in the body, including the jaw bone, resulting in cortical thinning and a reduction of cancellous bone [1]. Bone loss is a common feature of both periodontitis and osteoporosis, and it is biologically plausible that periodontal destruction is influenced by systemic bone loss. Although numerous studies have investigated a possible relationship between the two disease processes, most have been plagued by small sample sizes and inadequate control of confounding factors [1].

Different studies have reported contradictory results about the effect of OP on periodontal status [3-5]. While some observational studies showed no association between OP and periodontal disease [6-13] a significant association between these two diseases has been extensively documented in the literature [3,14-20].

OP is characterized by reduction of bone mineral density (BMD) below the minimum level required to ensure adequate mechanical support. It is also known to present degeneration of the bone microarchitecture, which increases fragility and the risk of fractures [21]. Osteoporosis (OP) affects more than 20 million people and results in nearly 2 million fractures per year; most of which are in women. It is a physiologic, gender, and age-related condition resulting from bone mineral content loss and structural changes in bone [2]. Its prevalence among Brazilian women over the age of 50 years is between 15 and 20% [22].

Periodontal disease is the most common cause of tooth loss and edentulism among adults. Its worldwide prevalence ranges from 10 to 15%, although it may reach 80% in certain areas [23]. Periodontitis has a multifactorial nature and certain systemic conditions, including OP, act as additional predisposing factors. Both OP and periodontitis are chronic inflammatory diseases associated with bone loss mediated by local and systemic factors. The two diseases share common risk factors [24]. Postmenopausal women with OP and periodontitis have a more dramatic response to dental plaque biofilm, as shown by increased bleeding on probing, dentoalveolar bone loss and diminished alveolar BMD [15].

A better understanding of the relationship between periodontal diseases and OP in postmenopausal females will greatly contribute to the prevention and control of these two diseases, diminishing their impact in general health and quality of life [3]. In the present study, we examined whether there is any association between postmenopausal OP (PMO), periodontitis and tooth loss among Brazilian women.

Material and Methods

Study design and sample

This was a cross-sectional analytical study of 113 postmenopausal women 50 years of age and older, who were treated at the Human Reproduction Research and Support Center (CEPARH) and the Municipal Diagnostic Imaging Center (CMDI), in the city of Feira de Santana, Bahia, Brazil. Of the 258 patients initially screened for their oral health condition between June 2008 and December 2009, 145 did not meet the inclusion criteria, as they presented the following conditions: diabetes (11), thyroid problems (8), edentulism (29), fewer than four teeth (13), less than 50 years of age (10) or termination of menstruation less than one year earlier (3). In addition, 71 patients refused to participate because they lived outside the city.

The final sample consisted of 113 women who fulfilled the following eligibility criteria: minimum age of 50 years, bone mineral densitometry report produced less than six months earlier, at the postmenopausal stage for at least one year, at least four teeth present; and no history of systemic diseases like hyperparathyroidism that could influence the skeletal bone mineral density (BMD).

Based in the skeletal bone mineral density (BMD) report (proximal femur and/or lumbar spine) the study population was divided into two groups: Group 1, 85 cases postmenopausal women with OP and Group 2 consisted of 50 postmenopausal women without OP (control) based on bone mineral densitometry reports. This study was approved by the Ethics Committee of the Bahia Science Development Foundation, Salvador, Bahia, Brazil (register no. 047/2005). The study was conducted in accordance with the Declaration of Helsinki of 1975 (revised in 2013). All of the patients were informed about the objectives and methodology and provided written informed consent to participate in the study.

Interview and clinical examination

A structured questionnaire to obtain sociodemographic, biological and lifestyle data was used to interview eligible individuals, followed by clinical oral examination. Panoramic radiographic examination was performed as a complement to the clinical oral examination.

The following variables were assessed: 1) number of present teeth, not including third molars (28 maximum); 2) probing depth (PD); clinical attachment loss (CAL); bleeding on probing (BOP) and plaque index (PI).

All the teeth were examined, with the exception of the third molars, using a manual periodontal probe graduated in millimeters*. Measurements were performed in six sites per tooth (mesiovestibular, mid-vestibular, distovestibular, mesiolingual, mid-lingual and distolingual), as described by [25]. The clinical attachment loss (CAL) was obtained for each of these six sites [26]. Bleeding on probing was also determined at each of these six sites, consisting of observation of whether bleeding was seen within ten seconds after removing the periodontal probe from the pocket or sulcus [27]. The plaque index was evaluated at four sites per tooth (buccal, lingual, mesial, and distal) based on the presence of visible biofilm deposit on the tooth surface [28].

All clinical periodontal measurements were performed by a single trained examiner, blind to the BMD of the patient under assessment. Reproducibility was evaluated by means of periodontal measurements that were replicated using an experience periodontist as the reference. Around 10% of the sample was used for this purpose. The between-examiner kappa indices (± 1 mm) for probing depth and gingival recession or hyperplasia were 0.60 and 0.69, respectively. For within-examiner concordance, the kappa indices Kappa (± 1 mm) for probing depth and gingival recession or hyperplasia were 0.61 and 0.68, respectively.

Diagnosis of periodontal disease

Females were considered to have periodontitis when in the clinical evaluation they presented four or more teeth with one or more sites showing a probing depth greater than or equal to 4 mm, and a clinical attachment loss greater than or equal to 3 mm at the same site, along with the presence of bleeding on probing [29]. In threshold situations, in which the clinical descriptors came close to the criteria established, but were insufficient to conclude the diagnosis, radiographs were used to determine the presence of periodontal disease. In such cases, periodontitis was deemed to be present when the radiographic interpretation showed that four or more teeth had one or more sites with periodontal bone reabsorption greater than or equal to 3 mm apically in relation to the cement-enamel junction.

Diagnosis of Osteoporosis/Osteopenia

BMD report for each participant was requested at the time of the interview, in order to define whether OP was present. The methods and criteria used in the diagnosis of OP were those established by the World Health Organization in the Consensus Development Conference (1994) [21]. According to these criteria, if osteopenia/OP was recorded in at least one of the two segments analyzed (proximal femur and/or lumbar spine), the participant was considered to have osteoporosis.

Statistical Analysis

Statistical analysis was performed using STATA (version 8.0) and SPSS (version 10.0). Preliminary descriptive analyses were conducted by means of bivariate models, using the chi-square test (categorical variables) and the Student t or Mann-Whitney test (continuous variables). Statistical differences were deemed to exist when $p \leq 0.05$. The relationship between the BMD of the proximal femur and lumbar spine regions and some of the clinical oral variables was ascertained by means of Spearman or Pearson correlation analysis.

Unconditional logistic regression analysis was applied to estimate crude and adjusted odds ratios (OR) and the respective 95% confidence intervals. The odds ratio measurements were converted into prevalence ratios by means of the Poisson model. The data were adjusted for confounding variables and controlled for effect-modifying covariables. The effect modifiers were identified by means of the likelihood ratio test ($p < 0.05$). Covariables that produced a proportional difference in the estimated coefficients of more than 10% were considered to be confounders [30].

Results

General socioeconomic demographic characteristics and relevant variables regarding health and lifestyle status of the 113 postmenopausal females with and without OP which participated in the study are listed in table 1. There was a certain degree of homogeneity between the groups, except for the covariables body mass index (BMI) and household density, which presented statistically significant differences ($p = 0.01$ and 0.01, respectively). Most women in both groups had natural menopause, were nonsmokers and did not consume alcoholic drinks. With regards to other characteristics, both groups are equivalent.

* Williams (Hu-Friedy, USA)

Characteristics	With osteoporosis (n = 85)	Without osteoporosis (n = 28)	*p*[a]
Age (years)			0.19
Mean ± SD	59.6 ± 6.7	57.7 ± 7.2	
Age at menarche (years)			0.94
Mean ± SD	13.6 ± 1.8	13.6 ± 2.1	
Age at menopause (years)			0.46
Mean ± SD	46.7 ± 6.2	47.7 ± 6.7	
BMI [kg/m², (n, %)]			0.01
≤ 25	42 (49.4)	6 (21.4)	
> 25	43 (50.6)	22 (78.6)	
Type of menopause[b] (n, %)			
Natural	54 (64.3)	19 (67.9)	
Surgical	30 (35.7)	9 (32.1)	0.73
Conjugal situation (n, %)			0.35
With companion	34 (40.0)	14 (50.0)	
Without companion	51 (60.0)	14 (50.0)	
Race/Skin color (n, %)			
White/others	16 (18.8)	4 (14.3)	0.58
Black/mixed	69 (81.2)	24 (85.7)	
Number of children (n, %)			
≤ 3 children	42 (49.4)	13 (46.4)	0.78
> 3 children	43 (50.6)	15 (25.9)	
Family income[b] (n, %)			
> 1 minimum monthly salary	70 (83.3)	23 (82.1)	
≤ 1 minimum monthly salary	14 (16.7)	5 (16.9)	0.89
Schooling level (n, %)			
> 4 years	22 (25.9)	7 (25)	
≤ 4 years	63 (74.1)	21 (75)	0.93
Number of people living in the home (n, %)			
≤ 3 people	55 (64.7)	10 (35.7)	
> 3 peoples	30 (35.3)	18 (64.3)	0.01
Smoking habit			0.54
No	79 (92.9)	25 (89.3)	
Yes	6 (7.1)	3 (10.7)	
Alcohol beverage consumption[b]			
No	68 (80.9)	18 (64.2)	
Yes	16 (19.0)	10 (35.7)	0.07

Physical activity practice[b]			0.91
No	41 (48.8)	14 (50.0)	
Yes	43 (51.2)	14 (50.0)	
Last visit to the dentist			
< 2 years ago	38 (44.7)	15 (53.6)	0.41
> 2 years ago	47 (55.3)	13 (46.4)	

Table 1: *Some characteristics among postmenopausal women with and without osteoporosis. Feira de Santana, Bahia, Brazil, 2009 (n = 113).*

[a]p value. Statistical significance: p ≤ 0.05.

[b]One datapoint lost

The periodontal condition of the sample is described in table 2. Both the mean number of teeth present and the mean for clinical periodontal parameters (probing depth, bleeding on probing, plaque index and clinical attachment level) were similar in the two groups.

Characteristics	With osteoporosis (n = 85)	Without osteoporosis (n = 28)	*p**
Probing depth (mm)			
Mean ± SD	2.1± 0.4	2.1 ± 0.6	
Min-Max	1.1-3.7	1.2-3.7	0.89
Clinical attachment level (mm)			
Mean ± SD	2.8 ± 0.8	2.6 ± 0.7	
Min-Max	1.6-4.8	1.8-4.7	0.43
Bleeding on probing (%)			
Mean ± SD	15.7 ± 15.8	18.4 ± 9.6	
Min-Max	0-80.0	0-73.8	0.46
Plaque index (%)			0.33
Mean ± SD	24.3 ± 21.2	29.0 ± 24.5	
Min-Max	0-87.5	0.0-85.7	
Number of present teeth			
Mean ± SD	13.5 ± 6.4	12.3 ± 5.4	0.35
Min-Max	4-27	5-23	
Number of teeth with clinical attachment level 1 - 2 mm			
Mean ± SD	2.2 ± 2.9	2.3 ± 3.3	0.92
Min-Max	0-8	0-10	
Number of teeth with clinical attachment level 3 - 4 mm			
Mean ± SD	7.5 ± 5.6	7.0 ± 4.4	
Min-Max	0-21	0-15	0.66
Number of teeth with clinical attachment level ≥ 5 mm			
Mean ± SD	2.0 ± 2.2	1.5 ± 1.8	
Min-Max	0-10	0-7	0.26

Table 2: *Distribution of periodontal condition among the postmenopausal women with and without osteoporosis/osteopenia. Feira de Santana, Bahia, Brazil, 2009 (n = 113).*

** p value. Statistical significance: p ≤ 0.05.*

Concerning the correlation between BMD and oral condition variables, it was observed that probing depth (r = -0.191; p = 0.04) and number of present teeth (r = -0.196; p = 0.04) showed statistically significant negative correlations with BMD of the lumbar spine (Table 3). The crude prevalence ratios (PR) for the association between osteoporosis and periodontal disease was: PR = 1.18; 95%CI: 0.51 - 2.72; p = 0.50. After adjustment for age and BMI, this value increased: PR = 1.28; 95%CI: 0.53 - 3.05; p = 0.580, however, no statistical significance was observed in either of the models.

Variables correlated	BMD in proximal femur		BMD in lumbar spine	
	R	p[a]	R	p[a]
Probing depth	-0.165	0.08	-0.191	0.04[a]
Clinical attachment level	-0.078	0.41	-0.089	0.35
Frequency (%) of teeth with clinical attachment level ≥ 5 mm	-0.165	0.08	-0.141	0.13
Number of present teeth	-0.069	0.47	-0.196	0.04[a]
Frequency (%) of gingival bleeding	-0.149	0.12	-0.167	0.08

Table 3: *Analysis on the correlation of bone mineral density (BMD) in the proximal femur and lumbar spine regions with oral condition variables. Feira de Santana, Bahia, 2009.*

[a]p value. Statistical significance: p ≤ 0.05

Discussion

This study was conducted to assess a possible relationship between periodontal disease and OP in Brazilian postmenopausal women. According to our findings, the presence of OP does not influence the prevalence of periodontitis and tooth loss among postmenopausal women. The association hypothesis proposed in this study was not confirmed, even after appropriate treatment for confounding factors, such as age and BMI. In contrast to the present study, some studies found a positive association between these two diseases [8,11,20,24].

In the present study no statistically significant difference was detected between the groups with and without OP, in relation to the clinical periodontal parameters evaluated. However, correlation analyses on the BMD measurements, probing depth and tooth loss showed a statistically significant negative relationship. From an epidemiological point of view, these findings should be considered with caution, given the known limitations of cross-sectional studies. Longitudinal studies would better establish the temporal and correlation conditions that might exist between osteoporosis and clinical periodontal measurements.

In addition, from a methodological point of view, the size of the sample was smaller than what would be required for an investigation of this nature, thus conferring a power of less than the conventional 80% to the study. In this respect, the final adjusted model was limited to considering the covariables mentioned earlier, in order to avoid over adjustment, and consequent interference with the final association measurement. In an attempt to ensure greater methodological rigor and to minimize the abovementioned limitation, both the exposure [21] and the outcome measurements [29] were carefully chosen as clinical criteria that are well validated in the literature, such as the BMD definition.

In regards to the clinical criteria for the diagnosis of periodontal disease, emphasis must be given to the lack of a global standard measurement periodontal criteria, due to the unique characteristics of periodontal diseases. It is well known that periodontitis occurs in outbreaks of activity followed by periods of quiescence, and it is recognized as a locally specific disease. In other words, destruction of the periodontal bone support may occur in a generalized manner, throughout the oral cavity, or at specific sites located in certain groups of teeth or regions of the arches. Currently, there is no standard measurement that might predict the activity level of periodontal disease. Consequently, a set of different clinical descriptors might make the diagnosis of periodontitis more precise.

The fact that we have opted for a complete periodontal examination, rather than a partial recording protocol and the fact that measurements were made by a single blinded examiner are strong points of this study. The criterion chosen to define the presence of periodontitis among the postmenopausal women in this study not only consisted of an evaluation of all teeth but also used an association of four clinical parameters, namely measurements of probing depth, gingival recession/hyperplasia, bleeding on probing and clinical attachment loss. This procedure ensured a more robust outcome measurement, avoiding the inclusion of women with false-positive diagnoses of a periodontal condition. This methodological care is not often found in the literature. Some studies used partial examination of the teeth [31] or only the clinical parameter of probing depth [32] or clinical attachment loss [10]. The present study took into consideration two basic crucial conditions for investigations that aim to understand associations between diseases or factors: robustness of the exposure measurement (osteoporosis) and the outcome measurement (periodontitis), with standardization and qualification of the examiner.

The statistical analysis procedures were used adequately towards estimating the possible association under examination, adjusting the models with confounders that possibly interfere in the main association.

It is evident that additional investigations are necessary, using study designs that are more appropriate, in order to confirm or refute the hypothesis of this investigation and make it possible to obtain conclusions of greater consistency. Additional studies with larger samples and longer periods of observation are needed in order to elucidate the role of OP on the periodontal disease process.

Conclusions

In the present study, OP did not influence the prevalence of periodontitis and tooth loss among postmenopausal women. Additional population-based studies are needed to examine the influence of confounding factors for periodontitis and OP in post-menopausal females.

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