Original Article

Association of Skeletal Bone Mineral Density and Periodontitis in Postmenopausal Women of the Electricity Generating Authority of Thailand (EGAT)

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Abstract

This study aimed to investigate the association between skeletal bone mineral density (BMD) and periodontitis in postmenopausal women of the Electricity Generating Authority of Thailand (EGAT) workers. This cross-sectional study comprised of 395 postmenopausal women, aged 35-82 years old. BMD was assessed at three skeletal sites by using dual-energy X-ray absorptiometry. BMD values at each site were converted into T-scores. The t-score at the worst site was used to categorize each participant into osteoporosis, osteopenia, or normal BMD groups. The periodontal assessments included probing depth (PD), clinical attachment level (CAL), plaque score, and number of remaining teeth. The participants were classified into the no/mild periodontitis or moderate/severe periodontitis groups. The mean BMD between the periodontitis groups and the mean periodontal variables between BMD categories were compared. The degree of association between the BMD groups and periodontitis, adjusted for known confounders, was analyzed using binary logistic regression. Comparing the two periodontitis groups, there was no significant difference in the mean BMD at any skeletal sites or at the worst site. Among the BMD groups, there was no significant difference in mean number of remaining teeth, mean PD, and mean plaque score, while the mean CAL difference of 0.3 mm was demonstrated between the osteopenia and osteoporosis groups. (P<0.001). After adjusting for confounders, there was no significant association between osteoporosis and periodontitis in postmenopausal participants, whereas increasing age and plaque score $\geq$ 40 % were the factors significantly associated with moderate/severe periodontitis (P<0.05). There was no significant association between osteoporosis and periodontitis in postmenopausal women of the EGAT population. However, studies in various populations should confirm this finding.

Keywords: Bone density, Osteoporosis, Periodontal-systemic disease interactions, Periodontitis, Postmenopausal

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Introduction

Periodontitis is a chronic inflammatory disease. Besides the bacterial plaque biofilm which is the key etiologic factor of periodontitis; other factors, such as genetics, smoking, and various systemic conditions may also trigger the host immune system and hasten the disease progression.[1] In the literature, osteoporosis is one of the potential risk factors leading to a more severe periodontal breakdown.[1]

Osteoporosis is a systemic skeletal bone disease that results in decreased bone mineral density (BMD), weakened bone architecture, and increased risk of bone fracture.[2] This condition is usually found in the elderly and especially in postmenopausal women.[2] Previous surveys with Thai women aged 40-80 years old,[3] according to the Thai BMD reference, showed that the prevalence of osteoporosis and osteopenia was 14-20 % and 27-37 %, respectively. Both osteoporosis and periodontitis are chronic diseases demonstrating cumulative effect with age and feature bone loss. Moreover, these two diseases share several common risk factors including age, sex, body size, socioeconomic status, smoking, diabetes, and alcohol consumption.[4] Therefore, there is a biological possibility that periodontal destruction is influenced by systemic bone loss.[5,6]

Associations between decreased BMD or osteoporosis and periodontitis were well documented in the literature; however, the association of these two diseases in postmenopausal women was still inconclusive.[1] This may be attributed to the differences in sample size, population groups, methods of investigation, and surrogate outcomes of periodontal disease. Only one study[7] reported the association between osteoporosis and periodontal disease in the Thai population. However, the influence of confounding factors was not analyzed. Therefore, the objective of this study was to investigate the association between skeletal BMD and periodontitis, controlling for known confounding factors, in a large sample of postmenopausal women of the Electricity Generating Authority of Thailand (EGAT) population.

Materials and Methods

This cross-sectional study was conducted on postmenopausal women who were current and ex-employees of the EGAT with the initial aim of studying cardiovascular risk factors. The survey was extended to investigate skeletal BMD and periodontal disease. The cohort profile of the EGAT surveys has been previously described.[8] Our study included two consecutive participant groups, 174 participants (35-60 years old) from the second survey of the third cohort (EGAT 3/2, June-August 2014), and 221 participants (60-82 years old) from the fifth survey of the first cohort (EGAT 1/5, June-August 2012).

The study protocol was approved by the Human Research Ethics Committee of the Faculty of Dentistry, Chulalongkorn University and the Institutional Review Board and Committee on Human Rights Related to Research Involving Human Participants, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Thailand. The participants gave informed consent prior to the study. The participants' sociodemographic and health-related characteristics including age, diabetes, body mass index (BMI), smoking status, alcohol consumption, monthly income, education level, medications (including calcium/vitamin D supplements, hormone replacement therapy, and anti-bone resorption drugs) and menopausal age were acquired via questionnaires, interviews, physical examinations, and laboratory tests of blood chemistry by trained personnel from Ramathibodi Hospital. The data were stratified as shown in Table 1.

The participants' BMD was assessed using dual energy X-ray absorptiometry (DXA) analysis unless they met any of the exclusion criteria or conditions potentially affecting bone metabolism or DXA analysis: 1) any lesions or artifact at the L1–L4 vertebrae, 2) low-energy fracture at any site, 3) traumatic fracture involving the spine or femur, 4) any treatment and/or illness expected to affect bone metabolism except calcium/vitamin D supplementation, hormone replacement therapy, and anti-bone resorption drugs, 5) spinal surgery (such as orthopedic implant, laminectomy, or vertebroplasty),

6) early or surgical menopause and/or orchiectomy, or 7) scoliosis of the lumbar spine, with a Cobb angle of more than 20 degrees.[9]

The BMD assessment was performed as previously described.[10] The participants underwent DXA (QDR 4500W; Hologic, Bedford, MA) at the lumbar spine (L1-L4) and left proximal femur (femoral neck and total hip). A daily quality control procedure was performed every morning, using a spine phantom, to assure an accuracy of the machine to be greater than 98.5 %. The participant's examined site BMD was converted to the T-score using the mean BMD and standard deviation (SD) of the three skeletal sites from non-Hispanic white women aged 20–29 years old from the United States National Health and Nutrition Examination Survey (US NHANES)[11] as normal reference values.[2]

$$T\text{-score} = \frac{\textit{patient's BMD- mean BMD of young normal adults}}{\textit{SD of BMD of young normal adults}}$$

The worst site T-score in each participant was used to categorize the participant's BMD status into the groups according to the WHO guidelines:[2] (1) osteoporosis: T-score > 2.5 SD below the reference values; (2) osteopenia: T-score ranged from 1-2.5 SD below the reference values; (3) normal: T-score above the osteopenia cutoff.

Participants who were at risk for bacterial endocarditis or hematogenous joint infection, undergoing hemodialysis, or requiring antibiotic prophylaxis were excluded from the dental examinations. Individuals who were fully edentulous or unwilling to have a dental examination were also excluded. The dental examinations, similar to the previous EGAT study protocol,[12] consisted of the determination of the number of remaining teeth, presence of supragingival plaque, probing depth (PD), and gingival recession (RE). All fully erupted teeth, except third molars and retained roots were examined. The presence of supragingival plaque was assessed by running a probe across two sites per tooth: mesio-buccal and mid-buccal aspects in quadrants 1 and 4 and mesio-lingual and mid-lingual aspects in quadrants 2 and 3. PD and RE were measured using a PCP-UNC15 probe in millimeters and were rounded down to the nearest millimeter on six sites per tooth: mesio-buccal, mid-buccal, disto-buccal, mesio-lingual, mid-lingual, and disto-lingual. The PD was the distance from the free gingival margin to the bottom of the gingival sulcus/pocket. The RE was the distance from the cementoenamel junction (CEJ) to the free gingival margin. The clinical attachment level (CAL), was the sum of the PD and RE.[12] The examinations were performed by eight periodontists who were calibrated for the periodontal measurements prior to the survey. The intraclass correlation coefficient (ICC) for the inter-examiner agreement on PD and RE was 0.83 and 0.86, respectively. The intra-examiner agreement on PD was 0.87-0.94 and for RE was 0.94-0.99. The percent of inter-examiner agreement (within ±1 mm) for PD and RE was 99.75 % and 100 %, respectively. The percent of intra-examiner agreement for PD and RE was 99.02 % - 100 % and 100 %, respectively. At the end of the dental examination, each participant was given a report of their dental treatment needs.

The periodontitis case definitions of the Centers for Disease Control and Prevention-American Academy of Periodontology (CDC-AAP)[13] were used to define the participants' periodontal condition as stated: "no periodontitis: no evidence of mild, moderate, or severe periodontitis; mild periodontitis: ≥2 interproximal sites with CAL ≥3 mm, and ≥2 interproximal sites with PD ≥4 mm (not on the same tooth) or 1 site with PD ≥5 mm; moderate periodontitis: ≥2 interproximal sites with CAL ≥4 mm (not on the same tooth), or ≥2 interproximal sites with PD ≥5 mm (not at the same tooth); severe periodontitis: ≥2 interproximal sites with CAL ≥ 6 mm (not on the same tooth) and ≥1 interproximal site with PD 5 mm." For data analyses, the participants were categorized into two periodontal groups based on different clinical treatment needs:[14] (1) no/mild periodontitis and (2) moderate/severe periodontitis.

All analyses were performed using a standard software package (IBM SPSS, Statistics for Windows, Version 24.0, IBM Corp., Armonk, NY). The participants' variables were described as frequency distributions and/or mean ± SD. The independent sample *t*-test was used to compare the mean skeletal BMD between the two

periodontal groups. One-way analysis of variance (ANOVA) with Bonferroni post-hoc test was used to compare the mean periodontal variables between BMD status. The association between BMD status and periodontitis were determined using the Pearson's chi-square test. Binary logistic regression analysis was used to investigate the degree of association between BMD status and the risk of having moderate/severe periodontitis, along with other variables of interest. These variables were age, plaque score, diabetes, BMI, smoking, alcohol consumption, income, education, medications (calcium/vitamin D supplements, hormone replacement therapy, and anti-bone resorption drugs) and menopausal age. Variables were also used to adjust for confounding effects. The crude (unadjusted) and adjusted odds ratios (ORs) and their confidence intervals (CIs) were calculated for each variable. For all statistical tests, significance was considered at $P<0.05$.

Results

Of the 494 postmenopausal participants, 99 individuals were excluded due to incomplete medical or dental records, leaving 395 participants in the study. The participants' sociodemographic and health-related characteristics according to the periodontal status are demonstrated in Table 1.

Table 1 *Characteristics of participants according to the periodontal status*

Characteristic	No/mild periodontitis[a] (n=89)	Moderate/severe periodontitis[a] (n=306)	Total (n=395)	*P* value[b]
Age (years), mean ± SD	56.0 ± 10.3	62.4 ± 8.4	61.0 ± 9.2	<0.001
Plaque score, n (%)				
80-100%	12 (13.5)	112 (36.6)	124 (31.4)	<0.001
40-79%	59 (66.3)	161 (52.6)	220 (55.7)	
0-39%	18 (20.2)	33 (10.8)	51 (12.9)	
BMD status, n (%)				
Normal	11 (12.4)	39 (12.7)	50 (12.7)	
Osteopenia	54 (60.6)	152 (49.7)	206 (52.1)	0.15
Osteoporosis	24 (27.0)	115 (37.6)	139 (35.2)	
Diabetes, n (%)				
Poorly controlled (HbA1c≥7%)	4 (4.5)	19 (6.3)	23 (5.8)	0.54
Well controlled (HbA1c<7%)	6 (6.7)	13 (4.2)	19 (4.8)	
No	79 (88.8)	274 (89.5)	353 (89.4)	
BMI (kg/m^2),n (%)				
Underweight (<18.5)	6 (6.7)	13 (4.2)	19 (4.8)	0.07
Normal (18.5-22.9)	42 (47.2)	111 (36.3)	153 (38.7)	
Overweight (≥23)	41 (46.1)	182 (59.5)	223 (56.5)	
Smoking status, n (%)				
Current smokers	0 (0.0)	2 (13.0)	2 (0.5)	<0.001
Former smokers	0 (0.0)	13 (31.5)	13 (3.3)	
Non-smokers	89 (100.0)	291 (55.5)	380 (96.2)	
Alcohol consumption, n (%)				
Current drinkers	3 (3.4)	4 (1.3)	7 (1.8)	
Former drinkers	21 (23.6)	70 (22.9)	91 (23.0)	0.42
Non-drinkers	65 (73.0)	232 (75.8)	297 (75.2)	

Table 1 *Characteristics of participants according to the periodontal status (cont.)*

Characteristic	No/mild periodontitis[a] (n=89)	Moderate/severe periodontitis[a] (n=306)	Total (n=395)	*P* value[b]
Income (Baht/month), n (%)				
< 20,000	15 (16.9)	84 (27.5)	99 (25.1)	0.01
20,000-49,999	25 (28.1)	107 (35.0)	132 (33.4)	
≥ 50,000	49 (55.1)	115 (37.6)	164 (41.5)	
Education level, n (%)				0.23
< Bachelor's degree	21 (23.6)	94 (30.7)	115 (29.1)	
≥ Bachelor's degree	68 (76.4)	212 (69.3)	280 (70.9)	
Medications[c], n (%)				0.71
Yes	19 (21.3)	71 (23.2)	90 (22.8)	
No	70 (81.7)	235 (76.8)	305 (77.2)	
Menopausal age (years), mean ± SD	47.2 ± 5.4	48.5 ± 5.5	48.2 ± 5.5	0.06

[a]*CDC-AAP periodontitis case definitions.*[13]

[b]*Independent sample t-test for continuous data; Pearson's chi-square test for categorical data.*

[c]*Medications comprised of calcium/vitamin D supplements, hormone replacement therapy, and anti-bone resorption drugs.*

The participants' age ranged from 35 to 82 years old (mean ± SD = 61.0 ± 9.2). The prevalence of moderate/severe periodontitis was 77.5 %. Only 12.9 % of the participants had fair oral hygiene (plaque score <40 %). The prevalence of diabetes was 10.6 %, with 5.8 % poorly controlled and 4.8 % well controlled diabetes. More than half (56.5 %) of the participants were overweight. Only 3.8 % reported ever smoking, of which only two participants (0.5 %) were current smokers. In addition, 1.8 % of the participants currently drink alcohol. Less than half (41.5 %) of the participants had a monthly income of at least 50,000 Thai Baht. Moreover, 70.9 % of the participants had at least a bachelor's degree. Postmenopausal women comprised of 44 % of the total female participants of the two surveys. The mean age at menopause was 48.2 ± 5.5 years. Of these participants, 6.1 % had premature menopause[15] (<40 years of age); 14.7 % had early menopause[15] (40 to <45 years of age). Almost 23 % of the study participants (22.8 %) received medications that enhanced or stabilized their BMD including calcium (22 %)/vitamin D supplements (3.5 %), hormone replacement therapy (1 %), and anti-bone resorption drugs (0.3 %). Comparing the two periodontal status groups, there were significant differences in age, plaque score, smoking status and income observed.

The participants' BMD status according to their periodontal status is shown in Table 1. The prevalence of participants with osteopenia and osteoporosis was 52.1 % and 35.2 %, respectively. The mean BMD according to periodontal status is demonstrated in Table 2.

Table 2 *BMD according to the periodontal status (Mean ± SD) (g/cm^2)*

Sites of measurement	No/mild periodontitis	Moderate/severe periodontitis
Femoral neck*	0.658 ± 0.107	0.646 ± 0.114
Total hip*	0.838 ± 0.126	0.816 ± 0.126
Lumbar spine*	0.877 ± 0.120	0.840 ± 0.132
The worst site*	0.658 ± 0.107	0.646 ± 0.113

**No significant difference between periodontal status (P>0.05), by using independent sample t-test.*

Among the three skeletal sites examined, the femoral neck most commonly demonstrated the worst site BMD with a prevalence of 99.2 %. There was no significant difference in the mean BMD at any skeletal sites or at the worst site between the two periodontal groups.

Pearson's correlation coefficients between the worst site BMD and periodontal variables are shown in Table 3.

The worst site BMD significantly correlated with the number of remaining teeth (r=0.15) and mean CAL (r=-0.14) (P<0.05), but was not significantly correlated with mean PD and plaque score.

The participants' periodontal variables according to the BMD status are illustrated in Table 4.

The mean periodontal variables between the BMD status groups were compared using ANOVA. There was no significant difference in the mean number of remaining teeth, mean PD, and mean plaque score between the BMD groups. The mean CAL of the osteoporosis group was higher than the osteopenia and normal BMD groups. A significant difference in the mean CAL between the osteopenia and osteoporosis was observed with the mean difference of 0.3 mm (P= 0.03).

The association between BMD status and periodontitis was identified by the Pearson's chi-square test Figure 1.

Table 3 *Correlation between the worst site BMD and periodontal variables*

	Number of remaining teeth	Plaque score	Mean PD	Mean CAL
The worst site BMD	0.15*	-0.03	0.05	-0.14*

** Significant correlation at P<0.05, by using Pearson's correlation coefficients.*

Table 4 *Periodontal variables according to the BMD status (Mean ± SD)*

Variables	Number of remaining teeth	Plaque score (%)	Mean PD (mm)	Mean CAL* (mm)
Normal (n=50)	23.6 ± 5.8	63.4 ± 21.5	2.3 ± 0.6	2.6 ± 0.9
Osteopenia (n=206)	23.7 ± 5.3	65.3 ± 23.8	2.2 ± 0.5	2.6 ± 0.9
Osteoporosis (n=139)	21.8 ± 6.6	67.2 ± 23.7	2.3 ± 0.5	2.9 ± 1.2
Total (n=395)	22.7 ± 5.9	65.7 ± 23.5	2.2 ± 0.5	2.7 ± 1.0

** Significant different between the osteoporosis and osteopenia groups (P=0.03) with the mean CAL difference of 0.3 mm, using ANOVA and Bonferroni post-hoc analysis.*

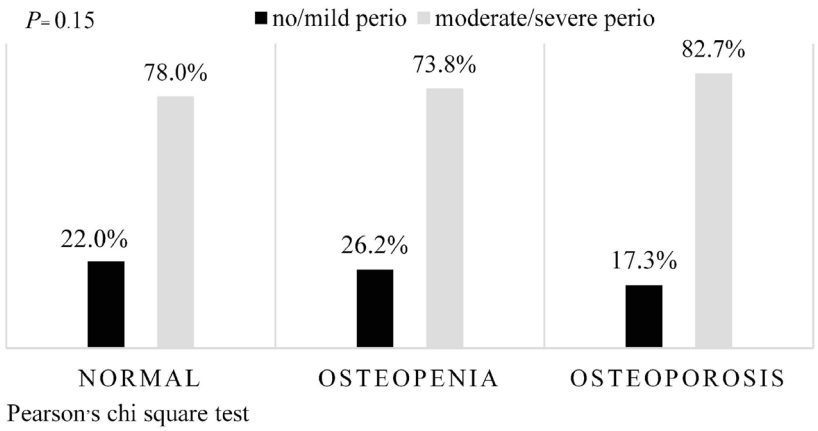

Figure 1 *Proportion of participants in the 2 periodontitis groups according to the BMD status.*

The percentage of participants with periodontitis was the highest in the osteoporosis group, with descending percentages found in the normal and osteopenia groups. In contrast, the percentage of the no/mild periodontitis participants was the highest in the osteopenia group, with descending percentages found in the normal and osteoporosis groups. However, there was no significant association between the periodontitis groups and BMD status observed (*P*=0.15).

The degree of association between BMD status and periodontitis was analyzed using binary logistic regression (Table 5).

Table 5 *Crude and adjusted odds ratios and 95% confidence intervals for the risk of moderate/severe periodontitis in the study population.*

Variables	Crude*		Adjusted*	
	OR	95%CI	OR	95%CI
Age (1 year)	1.09	1.06-1.12‡	1.09	1.06-1.13‡
Plaque score				
80-100 %	5.09	2.23-11.64‡	5.94	2.47-14.27‡
40-79 %	1.49	0.78-2.84	1.84	0.91-3.71
0-39 %[a]				
Bone status				
Osteoporosis	1.35	0.61-3.01	0.70	0.29-1.70
Osteopenia	0.79	0.38-1.66	0.61	0.27-1.34
Normal[a]				
Diabetes				
Poorly controlled	1.37	0.43-4.14	-	-
Well controlled	0.63	0.23-1.70		
No[a]				
BMI (kg/m^2)				
Overweight	1.68	1.03-2.74‡	-	-
Underweight	0.82	0.29-2.30		
Normal[a]				
Alcohol consumption				
Current drinker	0.37	0.82-1.71	-	-
Former drinker	0.93	0.53-1.64		
Non-drinker[a]				
Income (Baht/month)				
<20,000	2.37	1.25-4.54†	-	-
20,000-49,999	1.82	1.05-3.16†		
≥ 50,000[a]				
Education	1.44	0.83-2.48	-	-
< Bachelor's degree				
≥ Bachelor's degree[a]				
Medication[b] (yes)	1.21	0.64-2.30	-	-
Menopausal age (1year)	1.00	0.95-1.06		

[a]*reference group*

[b]*Medications comprised of calcium/vitamin D supplements, hormone replacement therapy, and anti-bone resorption drugs.*

** ORs and 95% CIs were obtained by binary logistic regression analysis using individuals with no/mild periodontitis as the reference group. Adjusted by age, plaque score, diabetes, BMI, alcohol consumption, income, education, medications, and menopausal age.*

† P <0.05 and >0.01.

‡ P <0.001.

In the unadjusted analysis, osteoporosis was not significantly associated with moderate/severe periodontitis. Increasing age (1-year increment), having a plaque score ≥80 %, being overweight, and having an income less than 50,000 Baht were significantly associated with moderate/severe periodontitis. After adjusting for confounders, increasing age, and having a plaque score ≥80 %, were factors significantly associated with moderate/severe periodontitis (P<0.001).

Discussion

The main objective of this study was to determine the association between skeletal BMD and periodontitis in postmenopausal participants of the EGAT population. In our study, the significant difference in the mean CAL of 0.3 mm was demonstrated between the osteoporosis and osteopenia groups, suggesting the greater severity of periodontitis as BMD status worsened. However, the association between osteoporosis and moderate/severe periodontitis was not significantly demonstrated in the bivariate logistic analysis after adjusting for age, plaque score, diabetes, BMI, smoking habit, alcohol consumption, income, education, medications (calcium/vitamin D supplements, hormone replacement therapy, and anti-bone resorption drugs) and menopausal age. When analyzing the data using different periodontitis grouping (non-severe and severe periodontitis groups), there were also no significant association between osteoporosis and severe periodontitis (data not shown). Our results correlated with the findings of other studies,[16-19] but may not concur with several previous studies.[20-28]

In our study, the mean BMD and standard deviation of the non-Hispanic white women aged 20-29 years[11] was used as a normal reference in calculating T-score based on the WHO recommendations.[2] Even though there was the recommendation of using the normal reference mean of the same ethnic and sex,[29,30] there was not enough information regarding the mean and standard deviation of skeletal BMD values of all three examination sites in Thai women aged 20-29 years.

Worldwide prevalence of osteoporosis is difficult to determine because of the differences in definitions and diagnosis. In our study, the prevalence of osteopenia and osteoporosis in participants aged 35-82 years old was 35 % and 52 %, respectively. These findings were similar to those of a Thai study.[3] Using the Thai BMD reference, the prevalence of osteoporosis increased after the age of 50, reaching a level of more than 50 % after the age of 70.[3] According to the U.S. Department of Health and Human Services 2010,[31] 29 % of non-hispanic white women was diagnosed as having osteoporosis. The reason of the lower prevalence of osteoporosis in Caucasians may be partly explained by the smaller builds in our participants, as compared with the Caucasians.[32] The bones in our participants are likely to be smaller due to the areal-based nature.

In this study, the mean BMD differences between the periodontal groups at various skeletal sites and at the worst site ranged from 0.012 to 0.037 g/cm^2. Even though there was no significant difference in the mean BMD between the periodontitis groups, it is important to note that a decrease of 0.01 g/cm^2/year in total hip BMD is associated with an increased risk of fragility fracture with adjusted odds ratio of 1.15 (95%CI: 1.01; 1.32) in women.[33]

The periodontitis case definitions of the CDC-AAP recommended for population-based surveillance of periodontitis[13] was used in our study. The results demonstrated that 79 % of our participants had periodontitis (data not shown). Using the same CDC-AAP definitions, the prevalence of periodontitis in asian american women age 30 years or older from the NHANES 2011-2012 data[34] was 37.4 %. The almost 2-fold higher prevalence of periodontitis in our study were mainly due to the large percentage of our participants (87.4 %) with poor oral hygiene.

In our study, the worst site BMD was positively correlated with number of remaining teeth and negatively correlated with the mean CAL. However, when analyzing the association between the BMD groups and mean periodontal variables, there was no significant difference

in the mean number of remaining teeth, mean PD and mean plaque score between the BMD groups. In our study, plaque score was assessed, while plaque index or calculus index were evaluated in other studies.[16,18] Although different variables used to assess oral hygiene status, our result was similar to previous studies[16,18] that reported no association between oral hygiene and BMD status. The non-significant correlation between the mean number of remaining teeth and mean PD found in our study concurred with previous studies.[17,19,35,36] One study[35] reported no significant difference in periodontal status as determined by PD, RE and gingival bleeding between osteoporotic women and women with normal BMD. Another study[17] reported no significant correlation between systemic BMD and mean PD and number of missing teeth in women aged 46-55 years old. Moreover, there are two studies that reported a non-significant correlation between skeletal BMD and number of remaining teeth[36] and the deepest probing depth site per person[19] in postmenopausal women. These study results suggest that systemic bone mass may not be an important factor in the pathogenesis of periodontitis in postmenopausal women. In contrast, previous studies conducted with asian postmenopausal women reported a lower mean number of remaining teeth with worsening BMD status.[25,37] The longitudinal study in postmenopausal japanese women[37] reported decreased BMD of the lumbar spine and femoral neck were associated with the number of tooth loss. When interpreting results, it is important to note that the underlying cause for tooth loss was often unknown.

Our finding of a negative correlation between the worst site BMD or worsened BMD status and mean CAL was similar to the cross-sectional study in Thai postmenopausal women[7] that reported significant correlation between decreased lumbar BMD and increased percentage site of CAL 3-4 mm in the posterior teeth. However, that study did not report the degree of association in the regression model. In contrast, a study of postmenopausal caucasian women[5] reported no significant correlation between skeletal BMD and CAL. However, they found a significant correlation between skeletal BMD and interproximal alveolar bone loss.

In our study, the significant difference in mean CAL was observed only between the osteoporosis and osteopenia groups. The non-significant difference in the mean CAL between the osteoporosis and normal BMD groups may be explained by the small sample size of the normal BMD group. In the literature, the significant inverse association between BMD and CAL were well documented in postmenopausal women.[20,21,38,39] The summary of the results were shown in the systematic review and meta-analysis[40] which reported a mean CAL difference of 0.34 mm between the osteoporosis and normal BMD groups. The cohort study of postmenopausal women from Buffalo Clinical Center of the Observational Study[21] reported significant associations between BMD of the spine, forearm, whole body, the worst site T-score and CAL among women without subgingival calculus after adjusting for age, smoking habit, education level and time since last dental cleaning. That study results also suggested that age and oral hygiene were important modifiers of the association between systemic BMD and periodontal disease.

The effect of smoking as a confounder was not analyzed in the binary logistic regression model since there were only two smokers who participated in our study. In the literature, early or premature menopause results in decreased estrogen hormone leading to decreased skeletal BMD and osteoporosis.[2,15] In contrast, a history of taking oral contraceptives or medications including calcium or vitamin D supplements, hormone replacement therapy or anti-bone resorption drugs were shown to provide benefits in increasing or stabilizing skeletal bone mineral bone density[2,15] Thus, this study included time since menopause and medications (calcium/vitamin D supplements, hormone replacement therapy and anti-bone resorption drugs) as confounders for data analysis, while there was no available data regarding the history of contraceptive use. Our study showed that after adjusting for known confounders, the association of osteoporosis and

moderate/severe periodontitis could not be demonstrated. This non-significant association between BMD status and periodontitis contradicted several reports of most post-menopausal women studies[20,22-24,26,37] but concurred with some studies as follows.[16,18,19] A study of US postmenopausal women[19] found no significant association between five periodontal variables including mean CAL and number of sites with CAL of ≥ 4 mm as a unit of analysis and systemic BMD, after controlling for age, smoking habit and number of remaining teeth. Similarly, two other large cross-sectional studies of postmenopausal women in the United Kingdom[16,18] found no significant association between osteoporosis and periodontitis after adjusting for several confounders.

Significant associations between osteoporosis and periodontitis were also reported in other populations of younger age groups,[29] in both sexes.[28,29] Even though a significant association between osteoporosis and periodontitis was not demonstrated in our postmenopausal participants, there might be an association between these two diseases in other Thai population groups. Since osteoporosis and periodontitis are multifactorial diseases, several unknown confounding factors may still influence the association between these two diseases and result in the non-significant finding.

The strengths of this study include its relatively large sample size, use of DXA as it is the gold standard of BMD assessment,[2] full mouth periodontal examination with calibrated periodontists, which is highly accurate in assessing periodontal disease, and controlling for several confounding factors in the data analysis. The limitation of this study was oral bone density and/or oral radiographs was not able to be assessed in the oral examinations of our survey. Moreover, it was conducted in only one population group; therefore, our findings may not completely be able to generalize. Further studies in other Thai populations need to be conducted to confirm this finding.

Conclusion

Osteoporosis was not significantly associated with moderate to severe periodontitis in the postmenopausal women of the EGAT population. Increasing age and poor oral hygiene are the factors that place individuals at risk for periodontitis. However, the association between skeletal BMD and periodontal disease need to be further investigated in other population groups.

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