

## Relationship between Bone Mineral Density and Oral Health Status among Iranian Women

### Abstract

**Background:** In the present research, we aimed to evaluate dental and periodontal condition in relation to bone mineral density (BMD), to determine the possible association between oral health status and bone density. **Methods:** Fifty-nine women aged older than 30 years, who had BMD assessment, were enrolled in the study. They were given dental and periodontal examination by the means of oral hygiene index (OHI), periodontal disease index (PDI), and decayed, missing, and filled teeth (DMFT). Participants answered a questionnaire regarding oral hygiene condition, socio-economic status, and physical activity level. Their BMD using dual X-ray energy absorptiometry in femoral and spinal regions was also recorded. **Result:** In this research, there was a negative correlation between DMFT and T-score of spine and femur but not with Z-scores. There was no association found between PDI and T-scores or Z-scores for BMD ( $P > 0.05$ ). In addition, there was a significant negative correlation between number of missing teeth and T-score of both femoral and spinal regions; however, such an association was not found with Z-scores. In addition, a strong positive correlation was observed between OHI and DMFT. **Conclusions:** This investigation suggests a negative association between bone mineral status and oral health condition regarding DMFT and number of missing teeth. It could be concluded that inadequate bone mass could coexist with higher number of missing teeth or a worse oral health condition; nevertheless, further studies are required to assess these relationships precisely.

**Keywords:** Absorptiometry, bone density: Oral health, dental caries, dual-energy X-ray absorptiometry scan, osteoporosis, periodontal diseases

### Introduction

Periodontitis and osteoporosis are considered as major issues in public health,<sup>[1]</sup> and reduction in bone mass is the common feature of both diseases.<sup>[2]</sup> In osteoporosis, the bone loss is systemic; however, in periodontitis, it is localized and limited to the alveolar bones.<sup>[3]</sup>

Osteoporosis and osteopenia are characterized by deterioration of bony microarchitecture.<sup>[4]</sup> It should be mentioned that osteopenia is indicative of moderately low bone density, whereas osteoporosis is the marker of severe bone loss. Osteopenia can cause osteoporosis if treatment was not received.<sup>[5]</sup>

Periodontal diseases are highly prevalent, and it has remained a major cause of tooth loss in adults. It is found that periodontal diseases have a prevalence of 5% to 55% in adults depending on the severity and measurement

techniques.<sup>[6]</sup> It is described as gingival recession (GR) at a relatively early stage with dentin hypersensitivity, followed by bone loss, tooth mobility, and finally, tooth loss in late stages. Hence, it can affect chewing and speech function, esthetics, and finally, decreases the quality of life. As a matter of fact, osteoporosis shares common etiologic features with periodontal disease such as bone loss. In addition, some metabolic processes can affect bone and teeth simultaneously. Some authors suggest that there is association between systemic and alveolar bone loss.<sup>[7-10]</sup> It is proved that low bone density may cause faster resorption of alveolar bone;<sup>[7]</sup> nevertheless, there are some studies reporting reverse results.<sup>[6,10]</sup> Moreover, a number of previous studies have demonstrated a relationship between tooth loss and systemic low bone mineral density (BMD),<sup>[11-13]</sup> whereas there are also some investigations that do not support this idea.<sup>[9,14]</sup>

Hence, it is not clear whether bone diseases such as osteoporosis or osteopenia could have certain oral implications or not.

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Fahimeh  
Rezazadeh,  
Sara Emad<sup>1</sup>,  
Mohammadreza  
Emad<sup>2</sup>

*Oral and Dental Disease Research Center, Department of Oral and Maxillofacial Medicine, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran, <sup>1</sup>Student Research Committee, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran, <sup>2</sup>Department of Physical Medicine and Rehabilitation, Shiraz University of Medical Sciences, Shiraz, Iran*

**Address for correspondence:**  
Dr. Mohammadreza Emad,  
Department of Physical  
Medicine and Rehabilitation,  
Shiraz University of Medical  
Sciences, Shiraz, Iran.  
E-mail: mrezaemad@gmail.com

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As skeletal bones and teeth are tissues with similar structures, both can be affected by similar metabolic disturbances, so it could be assumed that the same processes could lead to bone loss and teeth caries.<sup>[15]</sup> In addition, it is proved that lower bone density detected by Dual-energy X-ray absorptiometry (DEXA) is related to lower alveolar bone mass, and a correlation between bone mineralization parameters and oral health indices is found. Therefore, there comes a hypothesis that strategies to prevent osteoporosis could lead to reduction of tooth loss and periodontal problems.<sup>[16]</sup>

Although the role of osteoporosis in the loss of alveolar bone, tooth loss, and the dental caries has not been obviously clarified, this relationship remains a matter of interest among researches. Therefore, in the present study, we aimed to determine the relationship between skeletal BMD and oral health condition in women older than 30 years.

## Methods

This cross-sectional study was performed between June 2016 and February 2016, on patients referring from physical medicine and rehabilitation clinics of Shiraz medical schools (Shiraz, Iran). This study was approved by the local ethics committee of Shiraz University of Medical Sciences, Shiraz, Iran. Totally, 59 women older than 30 year (mean age of 49.2 year) were recruited in this investigation. They had undergone DEXA. Subjects with metabolic or systemic diseases that might cause secondary osteoporosis or the ones used medicines such as bisphosphonate, anti-anxiety agents, antidepressants, high blood pressure medications, smokers, and also patients with less than 10 teeth were excluded from the research.

Women were enrolled after signing informed consent forms and their personal information remained confidential. The participants completed a questionnaire regarding their menopause status, demographic information, dental hygiene status, and physical activity level. According to the questionnaire, each individual was assigned a score ranging from 0 to 11 (higher scores indicate better oral hygiene status). The questions we used were about frequency of brushing teeth, using dental floss, mouth wash, and performing routine dental checkups. In the next stage, we recorded BMD status measured by DEXA. Body areas used for this measurement included lumbar spine (L2-L4 segment) and femoral neck. The final BMD diagnoses were categorized into three groups: normal, osteopenia, and osteoporosis.

Further, the state of the teeth was evaluated, and all examinations of the oral cavity were carried out by the same trained dentist. We recorded decayed, missing, and filled teeth (DMFT) index on the basis of World Health Organization.<sup>[17]</sup> The state of the periodontium was assessed using periodontal disease index (PDI).<sup>[18]</sup> Finally, we used

oral hygiene index (OHI) to evaluate the individual's oral hygiene condition quantitatively.<sup>[19,20]</sup> According to this score, patients were categorized into three groups of oral hygiene condition: (score: 0 to 4 = good, 4.1 to 8 = moderate, and 8.1 to 12 = poor).

Data were statistically analyzed using SPSS, version 22 (SPSS Inc., Chicago, IL, USA). The Chi-square test and independent samples *t*-test were used to compare the group differences for qualitative and quantitative variables, respectively. In addition, regression test was used for assessing the correlation between variables, and one-way ANOVA was utilized to find out whether there are any statistically significant differences between the means of three or more independent groups. In all statistical analysis,  $P < 0.05$  was considered significant.

## Results

The results of our examination show that 64% of participants had diploma or lower degrees, 87% of them earned maximum of 500\$ monthly, and only 27% performed routine exercise. Regarding patient's BMD test, 26% of individuals were diagnosed with osteoporosis. According to the OHI scoring, oral health status of 86.4% of participants was good. A strong negative correlation was found between OHI and oral hygiene scores, which was obtained from the questionnaire ( $r = -0.389$ ,  $P = 0.002$ ).

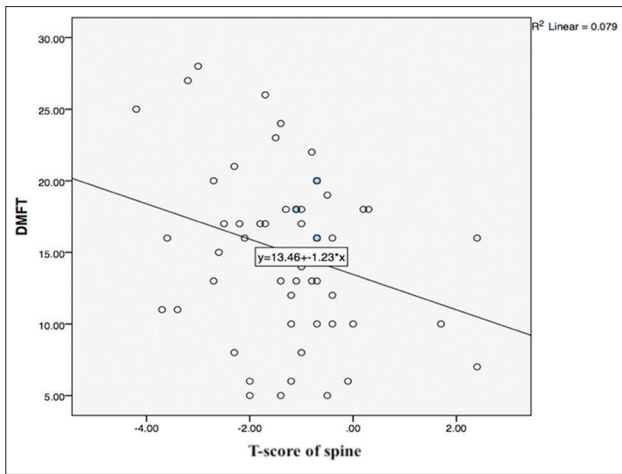
There was a significant negative correlation between DMFT and T-score of both spinal and femoral regions. (Pearson Correlation;  $r = -0.280$ ,  $P = 0.032$  and  $r = -0.284$ ,  $P = 0.029$ , respectively) [Graphs 1 and 2].

There was no significant correlation between DMFT and Z-score of both femoral and spinal regions. ( $P = 0.759$  and  $0.522$ , respectively). In addition, there was no correlation between DMFT and BMD diagnosis (osteoporosis, osteopenia, or normal) (one-way ANOVA;  $P = 0.19$ ).

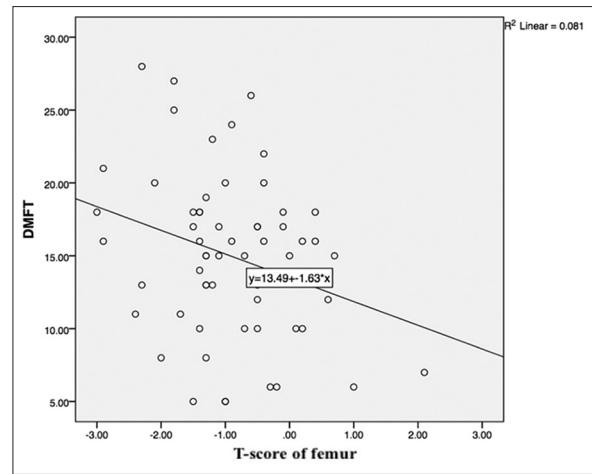
Number of missing teeth was negatively correlated with T-score of both femoral and spinal regions [Graphs 3 and 4] ( $r = -0.277$ ,  $P = 0.034$  and  $r = -0.390$ ,  $P = 0.002$ , respectively). While, there was no significant relationship between number of missing teeth and Z-score of both femoral and spinal regions. ( $P = 0.430$  and  $0.081$ , respectively).

Moreover, number of missing teeth was significantly correlated with BMD diagnosis (osteoporosis, osteopenia, or normal) ( $P = 0.021$ ).

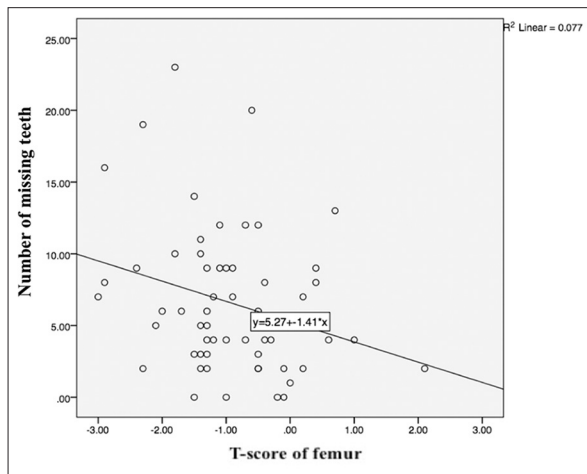
PDI was not significantly correlated with T-score nor with Z-score of femoral and spinal regions. ( $P = 0.326$  and  $0.078$  for T-score and  $P = 0.871$  and  $0.532$  for Z-score). In addition, a meaningful correlation between PDI and BMD diagnosis was not found (osteoporosis, osteopenia, or normal) ( $P = 0.529$ ).



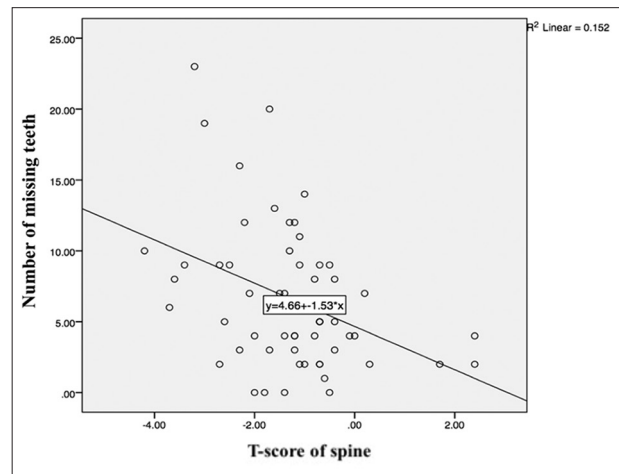
Graph 1: Correlation between DMFT and T-score of spine



Graph 2: Correlation between DMFT and T-score of femur



Graph 3: Correlation between number of missing teeth and T-score of femur



Graph 4: Correlation between number of missing teeth and T-score of spine

**Table 1: The correlation of age with DMFT and PDI**

	<i>r</i> (Pearson's correlation)	<i>P</i>
DMFT	0.409	0.001
PDI	0.356	0.006

There was a strong positive association between age and two other criteria: DMFT and PDI [Table 1]. A similar positive correlation was observed between OHI and DMFT ( $r = 0.440$ ,  $P = 0.008$ ).

### Discussion

As skeletal bones and teeth are tissues with similar structures and origins, there are diseases such as Hypophosphatasia and Cherubism, which can affect both tissues simultaneously.<sup>[10]</sup> The idea of our study comes from this fact that both bones and teeth can be affected by similar metabolic disturbances, and the same process could be responsible for bone loss and teeth caries.<sup>[21]</sup>

In this study, 87% of participants earned less than 500\$ monthly, which is considered as poverty line in Iran. In

addition, about 90% of them were married and more than 60% had diploma or lower degrees. Therefore, we can declare that majority of respondents were socio-economically equal. Moreover, the overall oral hygiene status of the subjects was defined as good (86.4%; according to the scoring of OHI values). Hence, it can be claimed that we could minimized the interfering effect of oral hygiene condition on our results. Furthermore, none of the participants did smoke. That is because of the fact that smokers are more likely to deal with periodontitis<sup>[22]</sup> and smoking can also result in reduced BMD.<sup>[23]</sup> It is assumed that hormone therapy and bisphosphonate drugs may affect the process of bone loss and slow down the progression of periodontal disease.<sup>[24]</sup> As a result, none of the subjects were on a regime of regular medication to limit interventional factors as much as possible.

The result of this study showed that there was a significant correlation between the number of missing teeth and diagnosis of BMD test. This could suggest that bone diseases such as osteoporosis or osteopenia may lead to tooth loss due to periodontal disorders or dental caries. Further data showed a negative correlation between

number of missing teeth and T-score of femur and spine, but such correlation was not found with Z-scores. It can be justified that T-score is related to senile or primary osteoporosis, whereas low Z-score is indicative of secondary osteoporosis. Hence, it can be concluded that low BMD due to secondary osteoporosis is not associated with periodontal diseases. However, there is relationship between primary osteoporosis and oral health condition. In addition, we observed a strong negative correlation between DMFT and T-score (in both femoral neck and spinal region). Hence, it is suggested that dental problems appear more often in women with lower bone density when compare to young, normal, sex-matches adults.

Similar to our study, a relationship between femoral BMD and teeth state (regarding DMFSurface (DMFS) and number of missing teeth) is reported. However, the correlation between lumbar BMD and the PDI was described negative which differs from our results.<sup>[24]</sup> This could be as a result of unequal sample sizes or different study groups. Another investigation on postmenopausal Brazilian women found a significant association between DMFT and BMD, which is in line with our findings. This study suggests that women with poor oral hygiene may indicate higher rates of lower bone densities.<sup>[25]</sup> However, our result contradicts with a study that described no association between DMFT and BMD.<sup>[26]</sup> This study was done on both genders during growth (aged 14–18 years), whereas our participants were women older than 30 year. This factor could be supposed as the major cause of difference in our findings.

It was observed that as age of the subject increases, OHI, DMFT, and PDI values grow which could be as a result of aging phenomenon. In this study, we did not find a significant relationship between PDI and BMD, revealing that low bone density cannot cause periodontal diseases (confirmed by a high scored PDI); nevertheless, this is a controversial issue.

There are some studies which reported that BMD and periodontal diseases are not significantly correlated.<sup>[14,27]</sup> In addition, it is proved that there is no such an association in elderly women.<sup>[9]</sup>

However, our findings are in contrast with some studies showing that there is an association between skeletal BMD and periodontal diseases: A negative association is proved between BMD and periodontal indices.<sup>[5]</sup> Another study exhibited that periodontal disease severity is significantly different in osteoporotic and non-osteoporotic individuals, and the risk for osteoporosis was higher among patients with severe periodontal disease.<sup>[3]</sup> It is suggested that there is a relationship between periodontal disease and BMD.<sup>[13]</sup> In addition, in other studies a significant association between osteoporosis and periodontal disease (tooth loss, probing depths, and clinical attachment levels) was established.<sup>[28,29]</sup>

According to the results, it is notable that skeletal BMD is related to PDI but not to a statistically significant level.

Because the *P* value of the correlation between PDI score and BMD in our study was equivalent to 0.07, there is a possibility that by increasing the sample size, *P* value becomes significant.

We were aware of the fact that greater sample sizes could lead to more valid results; but, because of certain reasons, population of this study could not be greater. One of them is numerous exclusion criteria, and another one is ethical issues, which prohibit us from ordering BMD test for a patient who suits our criteria.

Finally, it was found that in observed group of women older than 30 years, dental caries and tooth loss seem to be associated with lower bone density. Although the mechanism of this relationship is unclear, it is known that cross-communication and patient referral between physicians and dentists should be highlighted. Additional data depict that skeletal BMD was related to bone mineral status but not to a statistically significant level, implicating that there was no pronounced correlation between PDI and skeletal bone mass in this study. Nevertheless, the slight negative correlation indicates that decreased BMD could be an alarm to periodontal diseases. To the best of author's knowledge, in Iran, similar study using same indices has not been performed yet. This issue needs further investigations, particularly longitudinal, and to consider the effect of geography and population. To follow this field of research, it is suggested to use more precise indices with larger populations. Moreover, it is highly recommended to conduct case-control studies categorizing bone density status in to three groups including normal, osteopenia, and osteoporosis and to evaluate the effect of secondary osteoporosis separately. Considering variety of contributing factors, it is difficult to establish a certain association between systemic BMD, tooth loss, and tooth decay; however, research is highly in progress.

## Conclusions

Consequently, as oral and dental conditions are related to bone mineral status and also many people visit their dentist more often than their physician; dentists have a major role in detecting people who are prone to bone disorders or are already involved. In this situation, dentists can refer patients to the physicians to ensure them about their bone health status. Although scientists are hopeful that treatments for bone diseases could promote oral health status, more investigations are required to confirm that.

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## Conflicts of interest

There are no conflicts of interest.

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