Original Article

Investigating the Relationship Between Osteoporosis and Tooth Loss in Postmenopausal Women

Raghad Noori Nawaf[1], Hiba Kareem Salman[2], Kahtan Adnan Kamel[3], Nihad Khalawe Tektook[4] and Manhal Saad Abd[5]

ABSTRACT

Objective: This case-control study aimed to determine whether osteoporosis is associated with tooth loss in postmenopausal women.
Study Design: A case-control study.
Place and Duration of Study: This study was conducted at the Al-Farahidi University / College of Dentistry, Baghdad Iraq between January and September 2024.
Methods: A total of 400 postmenopausal women aged 50–75 years were enrolled, including 200 with osteoporosis (bone mineral density T-score < -2.5) and 200 without osteoporosis (T-score > -1.0). Data on age, body mass index, cigarette use, diabetes, and dental hygiene were collected, and clinical dental examinations were conducted.
Results: Women with osteoporosis had a significantly higher rate of severe tooth loss (<20 teeth) compared to those without osteoporosis (77.5% vs. 40.0%; $p < 0.001$) and a considerably lower number of remaining teeth (14.2 ± 7.5 vs. 20.8 ± 5.9; $p < 0.001$). After adjusting for confounding factors, osteoporosis remained a robust independent predictor of severe tooth loss (adjusted odds ratio: 3.15, 95% CI: 1.98–5.01, $p < 0.001$). Periodontitis was identified as the primary cause of tooth extractions in osteoporotic women.
Conclusion: A strong correlation exists between osteoporosis and tooth loss in postmenopausal women, highlighting the need for integrated medical and dental care.
Key Words: Osteoporosis; Tooth loss; Postmenopausal women; Periodontitis; Dental health; Risk factors.

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INTRODUCTION

A major worldwide public health problem, osteoporosis affects mostly postmenopausal women and is defined by reduced bone mass and microarchitectural degradation of bone tissue[1]. After menopause, estrogen levels drop, which speeds up bone remodelling, causes more bone to be resorbed than formed, and makes bones more brittle and prone to fractures[2].

[1.] Assistant Lecturer, Department of Conservative Dentistry, College of Dentistry, Ashur University, Iraq
[2.] Assistant Lecturer, Oral Microbiology, Al-Rafidain University, College of Dentistry,
[3.] Arab Board Specialist in Family Medicine/President of Iraqi Reproductive Health Association/Al-Taj Private Hospital – Baghdad.
[4.] Medical Laboratory Techniques Department/ College of Medical and Health Techniques/ Middle Technical University
[5.] Al-Ameen University/College of Dentistry/ Baghdad, Iraq

Correspondence: Nihad Khalawe Tektook, Medical Laboratory Techniques Department, College of Medical and Health Techniques, Middle Technical University
Contact No: 00967712913336
Email: drnihadkhalawe@gmail.com

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A large percentage of the elderly female population is at risk for osteoporosis, according to the WHO, which is defined as a bone mineral density (BMD) T-score of -2.5 or below[3].

As people age, tooth loss becomes more common, which is an indicator of poor dental and overall health. Periodontal disease and periapical pathology are the main reasons why people lose their teeth. The health of the alveolar bone has a role in both of these conditions[4]. Osteoporosis may accelerate the degradation of this metabolically active and sensitive bone, thereby increasing the risk of periodontal disease and, eventually, tooth loss[5].

Given the strong correlation between the jawbone and total bone mineral density, which may serve as an indicator of the overall health of the skeleton, this link makes biological sense[6]. Vitamin D insufficiency, RANKL-mediated bone resorption, and chronic inflammation are shared pathophysiological pathways between tooth loss and osteoporosis, which are still being studied[7, 8].

Results have often been contradictory owing to methodological discrepancies, sample characteristics, or confounding variables, including smoking, diabetes, and dental care availability, despite the long history of research on the link between systemic osteoporosis and oral bone loss[9]. The evidence for this connection has

been strengthened by subsequent investigations that have used improved diagnostic methods such as DXA and CBCT[10,11]. Instead of being limited to tooth loss in older women, recent longitudinal studies have shown that low BMD may predict it[12].

The main aim of this research is to assess, after controlling for important confounding factors, the correlation between tooth loss and osteoporosis, as measured by BMD T-scores, in postmenopausal women. Because panoramic radiographs and dental status can serve as screening tools for osteoporosis, this association is clinically relevant. Women at high risk might benefit from earlier detection and treatment if dental and medical professionals worked together[13].

METHODS

The study was conducted at the Al-Farahidi University / College of Dentistry, Baghdad Iraq between January and September 2024. All participants provided written informed consent.

2. Study Population and Participant Selection: Participants ranged in age from 50 to 75 and were all women who had gone through menopause. After a woman has gone menstrual-free for twelve months, she is considered to have entered menopause.

Inclusion Criteria: Naturally postmenopausal women aged 50-75 years; able and willing to provide informed consent; recent (within 6 months) dental panoramic radiograph or willingness to undergo one.

Exclusion Criteria: History of surgical menopause or current use of hormone replacement therapy (HRT); Medical conditions known to severely affect bone metabolism (e.g., hyperparathyroidism, Paget's disease, renal osteodystrophy); Current or recent (within the past year) use of medications affecting bone density (e.g., bisphosphonates, corticosteroids, teriparatide; History of head and neck radiation therapy; Edentulism (complete tooth loss) prior to menopause (as recalled by the patient); Active, severe periodontal disease requiring immediate surgical intervention.

3. Sample Size Calculation

Sample size was calculated using [e.g., G*Power software, version 3.1]. Based on a previous study, an odds ratio of 2.5 for tooth loss in osteoporotic women was assumed. With 80% power and a 5% two-sided alpha error, at least 178 participants (89 per group) were required. Four hundred participants were recruited to allow for dropouts and subgroup analyses.

4. Group Allocation (Case-Control)

Based on the assessment of bone mineral density (BMD), the participants were separated into two groups:

- **Case Group (Osteoporotic):** Women with a BMD T-score of ≤ -2.5 at either the lumbar spine (L1-L4) or the femoral neck (n=200).
- **Control Group (Non-Osteoporotic):** Women with a BMD T-score of > -1.0 at both sites (n=200).

To ensure clear separation of groups, our study excluded women with osteopenia, defined as a T-score between -1.0 and 2.5.

5. Data Collection and Measurements

A. Primary Exposure Variable: Osteoporosis Diagnosis

The left femoral neck and lumbar spine (L1-L4) were imaged using dual-energy X-ray absorption (DXA) to measure bone mineral density (BMD) in g/cm². All photos were evaluated by a single board-certified radiologist. The findings were presented as T-scores, which indicate the number of standard deviations above or below the average bone density of a healthy young adult female.

B. Primary Outcome Variable: Tooth Loss: A single calibrated dentist who was not informed of the subjects' BMD status conducted a full-mouth oral examination. The evaluation used a mouth mirror, a WHO periodontal probe, and conventional clinical illumination.

Tooth Count: We counted all the normal teeth (but excluding the third molars, often called wisdom teeth). Two techniques were used to represent the outcome:

The average number of teeth lost is 28 minus the current tooth count.

In epidemiological research, a severe case of tooth loss is defined as the presence of fewer than twenty natural teeth.

C. Covariates and Confounding Factors: A structured interview and evaluation of medical and dental records were used to gather data on possible confounders:

- Sociodemographic factors include gender, years since menopause, educational attainment, and family income.
- **Anthropometric:** Body mass index (BMI) (kg/m²) was determined by measuring height and weight.
- Past medical conditions include diabetes, high blood pressure, rheumatoid arthritis, and use of calcium and vitamin D supplements.
- **Lifestyle Factors:**
  - **Smoking Status:** Categorised as never, former, or current smoker.
  - **Physical Activity:** Assessed using the International Physical Activity Questionnaire (IPAQ) short form.
- **Dental and Oral Health Variables:**
  - The main cause for extracting each tooth was documented as either periodontitis-related or caries-related, depending on the patient's recollection and the dental records that were accessible. Keep in mind that this is a restriction since memory isn't always reliable.

- **Proper Oral Hygiene Practices:** How often (in minutes) you wash your teeth and how often you see the dentist.

6. Statistical Analysis

Using SPSS Statistics 28.0 (IBM Corp., Armonk, NY, USA), the data were critically examined. It was deemed statistically significant if the p-value was less than 0.05.

- **Descriptive Statistics:** The mean ± standard deviation (SD) was used to display continuous data, and the case and control groups were compared using either the independent-samples t-test or the Mann-Whitney U test, depending on whether the variables were normal. We used the Chi-square test or Fisher's exact test to compare categorical variables, which were given as frequencies (percentages).
- **Univariate Analysis:** The association between osteoporosis and tooth loss was assessed using logistic regression for severe tooth loss and linear regression for the number of teeth lost.
- **Multivariate Analysis:** The aOR and 95% CI for the link between osteoporosis and severe tooth loss were estimated using multiple logistic regression, which allowed us to account for possible confounders. The relationship with tooth loss, a continuous variable, was evaluated using multiple linear regression. Covariates included in the final models were those with p-values < 0.1 in the univariate analysis or deemed clinically relevant.

RESULTS

A total of 458 women who had gone through menopause were examined. Table 1 shows that 400 participants were recruited and ultimately completed the trial, with 200 belonging to the osteoporotic group and 200 to the non-osteoporotic group.

Table 1. Baseline Characteristics of the Study Participants.

Characteristic	Osteoporotic Group (No. =200)	Non-Osteoporotic Group (No.=200)	p-value
	(mean ± SD)		
Age (years)	65.4 ± 6.1	60.1 ± 5.3	**<0.001**
Years since menopause	18.2 ± 7.5	12.5 ± 6.2	**<0.001**
Body Mass Index (kg/m²)	22.1 ± 2.8	26.5 ± 3.4	**<0.001**
Smoking Status No. (%)			
Never Smoker	160 (80.0)	170 (85.0)	0.215
Former Smoker	35 (17.5)	25 (12.5)	
Current Smoker	5 (2.5)	5 (2.5)	
Diabetes Mellitus No.(%)	30 (15.0)	22 (11.0)	0.245
Calcium Supplement Use No.(%)	85 (42.5)	78 (39.0)	0.482
Regular Dental Visits No.(%)	70 (35.0)	125 (62.5)	**<0.001**
Tooth Brushing (times/day) (mean ± SD)	1.6 ± 0.7	1.9 ± 0.6	**<0.001**

Table 2. Dental Status and Tooth Loss Comparison

Dental Variable	Osteoporotic Group	Non-Osteoporotic Group	p-value
Number of Remaining Teeth (Mean ± SD)	14.2 ± 7.5	20.8 ± 5.9	**<0.001**
Number of Teeth Lost (Mean ± SD)	13.8 ± 7.5	7.2 ± 5.9	**<0.001**
Severe Tooth Loss (<20 teeth) No. (%)	155 (77.5%)	80 (40.0%)	**<0.001**
Primary Reason for Loss (Patient-Reported) No. (%)			0.002
Periodontitis	115 (57.5)	85 (42.5)	
Caries	85 (42.5)	1. 7.5)	2.

The two groups were similar in smoking status and diabetes prevalence. The osteoporotic group, on the other hand, was somewhat older, had been menopausal for longer, and had a lower average body mass index. The control group reported better oral hygiene practices, such as more frequent brushing and dental checkups (Table 1).

Dental status analysis showed significant differences between groups. The osteoporotic group had fewer remaining teeth (14.2 ± 7.5 vs 20.8 ± 5.9, p<0.001) and more teeth lost (13.8 ± 7.5 vs 7.2 ± 5.9, p<0.001). Severe tooth loss was more common in the osteoporotic group (77.5% vs. 40.0%, p<0.001). Periodontitis was the main cause of tooth loss in the osteoporotic group, while caries was more common in the control group (Table 2).

Multiple regression analyses were conducted to control for confounders. After adjusting for age, years since menopause, BMI, smoking status, diabetes, and dental

visit frequency, osteoporosis remained a significant independent predictor of severe tooth loss.

The multivariate logistic regression model showed that women with osteoporosis had more than 3 times the odds of severe tooth loss compared to their non-osteoporotic counterparts (aOR: 3.15, 95% CI: 1.98-5.01, p<0.001). Increasing age. Multivariate logistic regression showed that women with osteoporosis had over three times the odds of severe tooth loss compared to non-osteoporotic women (aOR: 3.15, 95% CI: 1.98-5.01, p<0.001).

Table No. 3. Multiple Regression Analysis for Severe Tooth Loss (<20 teeth)

Variable	Adjusted Odds Ratio (aOR)	95% Confidence Interval (CI)	p-value
Osteoporosis (Yes vs. No)	3.15	1.98 - 5.01	**<0.001**
Age (per 1-year increase)	1.05	1.01 - 1.10	0.028
BMI (per 1-unit increase)	0.92	0.87 - 0.98	0.007
Regular Dental Visits (Yes vs. No)	0.48	0.30 - 0.76	0.002

Increasing age and lower BMI were also significant risk factors, while regular dental visits were protective (Table 3). fewer remaining teeth, a higher prevalence of severe tooth loss, and are over three times more likely to have lost a critical number of teeth (<20), even after accounting for major confounding factors such as age, BMI, and dental care habits.

DISCUSSION

The greater mean number of teeth lost in the osteoporotic group (13.8 vs. 7.2) supports the idea that systemic bone loss may also affect the alveolar bone supporting the teeth[13]. mandible and maxilla, like the spine and hip, are composed of trabecular bone, which is highly metabolically active and particularly susceptible to estrogen deficiency and increased osteoclastic activity in osteoporosis. This bone resorption can reduce alveolar bone density and height, compromise tooth support and increase the risk of loss[14,15].

The significance of professional preventive treatment, especially in the early management of periodontitis and caries, is underscored by the fact that frequent dental visits emerged as a substantial protective factor.

Several limitations are included in this investigation. Only correlation, not causation, can be established using the case-control approach. Patient recollection, which may be biased, was used to determine the causes of tooth loss. The findings would be stronger with a prospective cohort study. Even after controlling important confounders, unmeasured variables, such as genetics, food history, and socioeconomic position, may still lead to residual confounding. Additionally, generalizability may be limited due to single-central recruitment[16,19].

Notwithstanding these caveats, the research has significant merits. There was strict grouping; the gold standard for osteoporosis diagnosis was DXA; a qualified dentist who was unaware of the patients' bone state performed the dental examinations; and all other confounding variables were thoroughly controlled for in the analysis[20,21].

These results have important consequences for clinical practice. One possible symptom of systemic bone fragility in postmenopausal women is tooth loss. For postmenopausal women presenting with significant tooth loss or rapidly advancing gum disease with no apparent aetiology, dentists may consider suggesting bone mineral density tests. In comprehensive treatment, physicians addressing osteoporosis should stress the need to maintain good oral hygiene and to attend frequent dental appointments. These findings emphasise the need for dental and medical experts to work together to reduce the risk of osteoporosis and tooth loss in women after menopause, and the tight connection between systemic and oral bone health[21].

CONCLUSION

A strong correlation exists between osteoporosis and tooth loss in postmenopausal women, highlighting the need for integrated medical and dental care.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Raghad Noori Nawaf1, Hiba Kareem Salman, Kahtan Adnan Kamel
Drafting or Revising Critically:	Nihad Khalawe Tektook, Manhal Saad Abd
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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