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Evaluation of Oral Health-Related Quality of Life in Older Adults with Osteoporosis, Osteopenia, and Normal Bone Density: Results from the Amirkola Cohort Study

ME. Ghaffari (DDS)[1], S. R. Hosseini (MD, PhD)[2], A. Shirzad (DDS, MS)[*3], A. Bijani (MD, PhD)[2], M. Motalebnejad (DDS, MS)[3], E. Mahmoodi (DDS, MS)[4], Z. S. Madani (DDS, MS)[4], F. Baladi (DDS, MS)[3], F. Sayadi (DDS, MS)[3]

1.Student Research Committee, Babol University of Medical Sciences, Babol, I.R.Iran.
2.Social Determinants of Health Research Centre, Health Research Institute, Babol University of Medical Sciences, Babol, I.R.Iran.
3.Oral Health Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, I.R.Iran.
4.Dental Materials Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, I.R.Iran.

*Corresponding Author: A. Shirzad (DDS, MS)
Address: Oral Health Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, I.R.Iran.
Tel: +98 (11) 32291093. **E-mail:** ats60dent@gmail.com

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ABSTRACT

Background and Objective: Osteoporosis represents one of the most frequently encountered chronic bone diseases during the aging process, and it is associated with decreased bone mineral density. Due to the recognized impact of osteoporosis on oral health, the present study was conducted with the aim of evaluating oral health-related quality of life among older adults diagnosed with osteoporosis residing in Amirkola, Babol, northern Iran.

Methods: This cross-sectional study was conducted as part of the second phase of the Amirkola Health and Aging Cohort Study. A total of 400 older adults were assessed and categorized into three groups: normal bone mineral density (n=100), osteoporosis (n=214), and osteopenia (n=86). All participants completed the Geriatric Oral Health Assessment Index (GOHAI) questionnaire and xerostomia questionnaire. The number of remaining teeth was determined via intraoral examination. Bone mineral density (BMD) was measured and compared using dual-energy X-ray absorptiometry (DEXA).

Findings: No significant difference was observed in the mean oral health-related quality of life scores between individuals with normal bone mineral density (52.49±7.36), those with osteopenia (50.92 ±7.22), and those with osteoporosis (50.82±7.93). In contrast, the number of remaining teeth demonstrated a statistically significant difference between the three groups when analyzed within the female subpopulation ($p<0.05$).

Conclusion: The results of the present study revealed that neither osteopenia nor osteoporosis has a significant effect on oral health-related quality of life.

Keywords: *Osteoporosis, Oral Health-Related Quality of Life, Bone Mineral Density, Older Adults.*

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Introduction

Osteoporosis represents one of the most frequently encountered metabolic bone diseases and is widely recognized as a significant public health concern worldwide (1). In recent years, due to increased life expectancy and the subsequent growth of the elderly population, the prevalence of this disease has been rising among both men and women; however, it remains considerably more common among women. According to statistics reported by the Rheumatology Research Center at Tehran University of Medical Sciences, 50% of men and 70% of women over the age of 40 years in Iran are affected by osteoporosis or reduced bone mineral density (2). The World Health Organization defines osteoporosis as a bone mineral density value that is 2.5 standard deviations or more below the average peak bone density observed in healthy young adults (3).

The most significant problems experienced by individuals diagnosed with osteoporosis include an increased risk of bone fractures, chronic pain, and mobility limitations. Patients with osteoporosis may sometimes develop depression as a result of the complications associated with the disease, and these complications can adversely affect the social and psychological dimensions of the individual's life, thereby impacting their overall quality of life (1).

Emerging evidence suggests that osteoporosis may be associated with oral health status, including periodontal diseases, reduced bone density of the jaw, and tooth loss (4). According to existing research, postmenopausal women with normal bone mineral density lose an average of 6.8 teeth, whereas women with osteopenia lose 10.5 teeth, and women with osteoporosis lose 16.5 teeth (5). Izadi et al. conducted an evaluation of the relationship between osteoporosis and xerostomia (dry mouth) as well as the number of remaining teeth. Their findings revealed no significant association between osteoporosis and dry mouth; however, the relationship between osteoporosis and the number of remaining teeth was statistically significant (6). In a separate study by Rezazadeh et al., a significant association was observed between the decayed, missing, and filled teeth (DMFT) index and periodontal health indices with bone mineral density in both the spinal and femoral regions (7).

Tooth loss leads to difficulties in chewing food and speaking, which may subsequently result in gastrointestinal problems and ultimately reduce oral health-related quality of life (1). Oral health status can exert significant effects on both the physical and psychological dimensions of an individual's quality of life. Furthermore, given the important role that oral conditions play in a person's ability to speak, chew, taste, and swallow food, as well as the social aspects such as appearance and self-confidence, oral health can profoundly influence the level of enjoyment an individual experiences in life (8).

A variety of questionnaires are available for the assessment of oral health-related quality of life. One such instrument is the GOHAI (Geriatric Oral Health Assessment Index) questionnaire, which contains 12 items and was specifically designed to evaluate the impact of oral health status on quality of life in older adults. The domains assessed by this questionnaire include three areas: physical function, social-psychological function, and pain or discomfort (9).

Given that complications associated with osteoporosis, including tooth loss and periodontal problems, may potentially affect oral health-related quality of life, and considering that studies specifically evaluating oral health-related quality of life in osteoporotic older adults remain very limited, the present study was conducted with the aim of assessing oral health-related quality of life in osteoporotic older adults living in Amirkola.

Methods

This cross-sectional study is a part of the second phase of the Amirkola Health and Aging Project, a longitudinal study that was initiated in 2011 and encompasses all elderly residents of Amirkola, a city in northern Iran (9). The present study received ethical approval from the Ethics Committee of Babol University of Medical Sciences under the ethics code IR.MUBABOL.HRI.REC.1400.135. The sample size was estimated with a 95% confidence level and 80% statistical power, assuming a correlation coefficient of r=0.15 between bone mineral density and tooth count. Based on this calculation, a sample size of 350 individuals was initially estimated. A total of 400 older adults were ultimately enrolled in this study, selected through random sampling method, and were subsequently classified into three distinct groups according to their bone mineral density measurements: individuals with normal bone mineral density (n=100), individuals with osteopenia (n=214), and individuals with osteoporosis (n=86). The inclusion criterion for the study was age 60 years or older. The exclusion criteria included the following: incomplete medical records, fewer than 10 remaining teeth, severe periodontal status (defined as a Periodontal Disease Index (PDI) greater than 4 on the Ramfjord Index), use of corticosteroid medications or chemotherapy, use of hormonal supplements or vitamin D and calcium supplementation, and diagnosis of cancer.

Initially, baseline and demographic information was recorded for all study participants. This included age, sex, level of education, smoking history, and history of diabetes mellitus. All participants subsequently underwent a clinical oral examination, and the total number of remaining teeth was recorded for each individual. Additionally, all participants were assessed for the presence or absence of xerostomia using a standardized xerostomia questionnaire. This questionnaire consists of 9 items, each answered with either "yes" or "no." The presence of xerostomia was confirmed when a participant provided positive responses to 5 or more of the 9 questions (10). For the determination of bone mineral density (BMD), measurements were carried out using dual-energy X-ray absorptiometry (DEXA) densitometry using a Horizon Wl device (Hologic company, USA). BMD was measured at the left femoral neck and the lumbar vertebrae (L2-L4). Based on the World Health Organization classification according to T-score, participants were categorized into three groups: T-score≥ -2.5 as osteoporosis, T-score between -2.5 and -1.0 as osteopenia, and T-score> -1.0 as normal (3).

To evaluate oral health-related quality of life, the Persian version of the GOHAI questionnaire was employed. The validity and reliability of this Persian version had previously been confirmed by Motallebnejad et al. (11). The questionnaire was completed via interviews with the participants and was designed to evaluate three distinct domains: physical function, psychological-social function, and pain or discomfort, with reference to the past three months. The scoring system was as follows: responses to each of the 12 questions were recorded based on a 5-point Likert scale with the following options: "never" (assigned a score of 5), "rarely" (score 4), "sometimes" (score 3), "often" (score 2), and "always" (score 1). The total score for each participant thus ranged between a minimum of 12 and a maximum of 60. Lower total scores indicated a poorer level of oral health-related quality of life, whereas higher total scores reflected a better oral health-related quality of life for the individual.

The collected data were analyzed statistically using the Statistical Package for the Social Sciences (SPSS) software, version 17. The analytical methods included analysis of variance (ANOVA), independent sample t-tests, Pearson correlation analysis, and multiple linear regression. A p-value of less than 0.05 was considered to indicate statistical significance.

Results

A total of 400 participants were enrolled in the present study and were subsequently categorized into three groups based on their bone mineral density status: the normal bone density group comprised 100 individuals, the osteoporosis group comprised 86 individuals, and the osteopenia group comprised 214 individuals. Various demographic and clinical qualitative variables, including sex, smoking history, level of education, presence of diabetes mellitus, and the presence of xerostomia (dry mouth), were compared across the three groups. The analysis revealed that smoking history, level of education, and xerostomia did not demonstrate any statistically significant differences between the three groups (Table 1).

Comparison of the mean values of quantitative variables between the three groups of older adults, categorized according to bone mineral density as normal, osteopenia, and osteoporosis, did not demonstrate any statistically significant differences (Table 2).

Table 1. Comparison of demographic and clinical parameters between the three study groups (normal, osteopenia, and osteoporosis)

Parameter	Normal n(%)	Osteopenia n(%)	Osteoporosis n(%)	p-value
Sex				
Male	59(29.9)	109(50.9)	29(33.7)	0.002*
Female	41(20.2)	105(49.1)	57(66.3)	
Smoking history				
No	88(88)	189(88.3)	81(94.2)	0.227*
Yes	12(12)	25(11.7)	5(5.8)	
Education level				
Illiterate	40(40)	81(37.9)	42(48.8)	0.134*
Elementary	22(22)	58(27.1)	26(30.2)	
Diploma	27(27)	45(21)	13(15.1)	
University education	11(11)	30(14)	5(5.8)	
Diabetes				
Yes	39(39)	68(31.8)	17(19.8)	0.017*
No	61(61)	146(68.2)	69(80.2)	
Xerostomia (dry mouth)				
Yes	9(9)	24(11.2)	12(14)	0.580*
No	91(91)	190(88.8)	74(86)	

*Chi-Square Tests

Table 2. Comparison of quantitative demographic and clinical parameters between the three study groups

Parameter	Normal Mean±SD	Osteopenia Mean±SD	Osteoporosis Mean±SD	p-value***
Age (years)	66.66±5.46	66.72±5.34	67.83±6.35	0.788
BMI*	29.98±4.33	29.25±4.38	27.82±5.09	0.974
OHI**	2.12±1.53	2.07±1.55	2.09±1.36	0.976
Number of remaining teeth	21.21±5.50	20.70±5.48	20.09±5.10	0.375

*BMI: Body Mass Index, **OHI: Oral Hygiene Index, ***ANOVA test

The overall mean GOHAI score was 51.25±7.66. Furthermore, comparison of the mean total GOHAI score as well as the mean scores of its three domains (physical function, psychosocial function, and pain/discomfort) across the three study groups revealed no statistically significant differences (Table 3).

Table 3. Comparison of mean oral health-related quality of life scores between the three study groups stratified by bone mineral density status

Parameter	Normal Mean±SD	Osteopenia Mean±SD	Osteoporosis Mean±SD	p-value*
Physical domain	26.06±3.84	25.19±4.45	25.31±4.18	0.238
Social-psychological domain	17.56±2.91	16.91±3.02	17.23±2.82	0.188
Pain domain	8.75±1.69	8.72±1.71	8.37±1.71	0.218
Total	52.49±7.36	50.82±7.93	50.92±7.22	0.187

*ANOVA test

No significant correlation was observed between GOHAI scores and femoral or spinal bone mineral density (Figure 1). The mean number of missing teeth in elderly women with normal bone density was greater than that in women with osteopenia and osteoporosis (Table 4). Multiple linear regression analysis was performed to identify factors influencing oral health-related quality of life. The analysis revealed that xerostomia, number of remaining teeth, and diabetes mellitus had more substantial predictive roles for oral health-related quality of life in the regression model (Table 5).

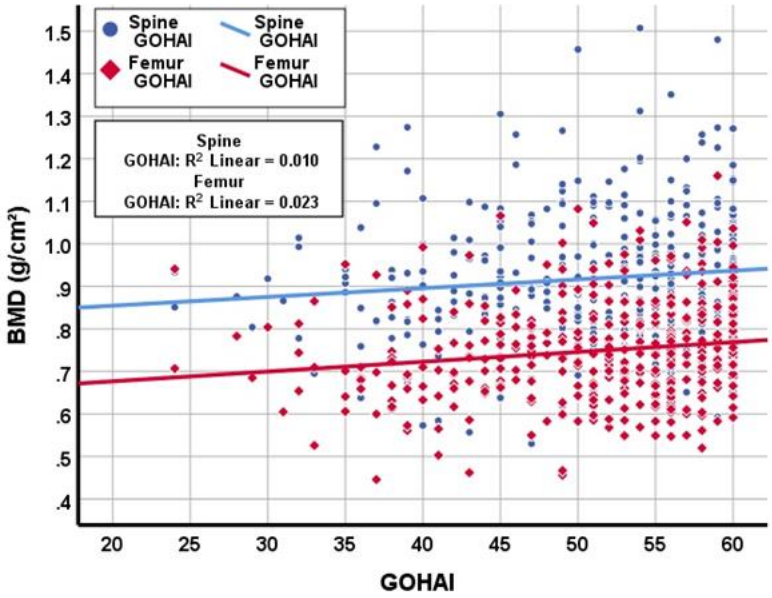


Figure 1. Correlation between oral health-related quality of life (GOHAI) and bone mineral density measured at the femur and spine

Table 4. Comparison of mean scores for xerostomia indices, number of remaining teeth, and GOHAI across the three groups, stratified by sex

Sex	Density			p-value
	Normal Mean±SD	Osteopenia Mean±SD	Osteoporosis Mean±SD	
Male				
Xerostomia	1.42±1.97	1.24±1.90	1.06±1.48	0.688
Number of remaining teeth	20.27±5.69	21.00±4.97	20.37±5.67	0.658
GOHAI	53.03±7.00	52.59±6.88	51.72±6.00	0.701
Female				
Xerostomia	1.82±2.26	2.06±2.27	2.08±2.57	0.835
Number of remaining teeth	22.56±4.97	20.40±5.98	19.94±4.84	0.050
GOHAI	51.75±7.87	48.98±8.54	50.50±7.78	0.160

Table 5. Multiple linear regression analysis to identify variables predicting oral health-related quality of life

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta coefficient		
Constant	59.118	5.511		10.726	0.000
Age	-0.040	0.077	-0.032	-0.522	0.602
Sex	-1.181	0.905	-0.083	-1.305	0.193
Xerostomia (dry mouth)	-1.174	0.224	-0.341	-5.243	0.000
Diabetes	-2.451	0.999	-0.159	-2.453	0.015
Bone density	-0.552	1.110	-0.031	-0.497	0.620
Number of remaining teeth	0.353	0.081	0.268	0.381	0.000

Discussion

In modern dentistry, in addition to focusing on the physical dimensions and pathological aspects of diseases related to oral and dental health, increasing attention has been directed toward socioeconomic outcomes, psychological and mental health aspects, patient satisfaction, and ultimately the patient's oral health-related quality of life. The findings from a number of studies have indicated that osteoporosis exerts a significant negative impact on both the quality of life and the oral and dental health status of affected patients (12-15).

In the present study, although the prevalence of xerostomia was observed to be higher among patients diagnosed with osteoporosis when compared to those with osteopenia or normal bone mineral density, this difference did not reach statistical significance. This finding is consistent with the results reported by Izadi et al. (6). Conversely, Arbabi-Kalati et al. concluded in their investigation that salivary flow rate in postmenopausal women with osteoporosis was significantly elevated compared to normal postmenopausal women (16), a finding that does not align with the results of our study. The discrepancy between the studies may be attributable to differences in the study populations and the methods employed for data collection. In the study by Arbabi-Kalati et al., the reduction in salivary flow was measured objectively, and the study sample consisted exclusively of women. In contrast, the present study assessed the subjective sensation of dry mouth using a questionnaire, included both male and female participants, and stratified individuals into

three distinct groups (normal, osteopenia, and osteoporosis) based on their bone mineral density measurements. It is important to note that including individuals with osteopenia in such studies is of particular significance, as this population constitutes the majority of the older adults.

In the present study, the number of remaining teeth did not demonstrate any statistically significant difference when compared across individuals with osteoporosis, osteopenia, and normal bone density. However, it was observed that individuals with normal bone density possessed a greater number of remaining teeth in comparison to those with either osteoporosis or osteopenia. These findings are consistent with studies conducted by Nicopoulou-Karayianni et al. (17) and Bollen et al. (18), both of which investigated risk factors for tooth loss and similarly reported no observable association between tooth loss and osteoporosis.

The findings reported by Izadi et al. in their study on postmenopausal women revealed a significant positive correlation between osteoporosis and the number of remaining teeth (6). Additionally, Rezazadeh et al., in their investigation examining the relationship between dental status and bone density among 59 women over 30 years of age, reported a significant inverse correlation between the DMFT index and T-scores measured at the femoral region (7). These findings are not consistent with the results obtained in the present study. The discrepancy between these studies and our own may be related to differences in the populations studied. Specifically, the present study included both male and female participants, whereas the aforementioned studies were conducted exclusively on postmenopausal women.

In our study, similar to previous investigations, the mean number of remaining teeth between the three bone density groups demonstrated a statistically significant difference within the female population; however, no such difference was observed among male participants. In a study by Takeda et al., an association between tooth count and bone mineral density was observed only in women, with no such association identified in men (19). Based on these collective findings, it can be concluded that the impact of reduced bone mineral density on decreasing the number of remaining teeth is more noticeable in women than in men, and this difference can be attributed to the hormonal changes that occur following menopause in women.

In women, increasing age and the subsequent onset of menopause, followed by the development of osteoporosis, result in decreased levels of sex hormones, including estrogen, progesterone, and testosterone. This hormonal decline facilitates the release of pro-inflammatory cytokines (20). Findings from laboratory studies have demonstrated that the release of inflammatory mediators such as interleukin-6 (IL-6), interleukin-17 (IL-17), and tumor necrosis factor-alpha (TNF-α) leads to the release and expression of the RANKL factor. RANKL subsequently binds to its corresponding receptor, RANK, located on osteocytes, thereby promoting their differentiation into osteoclasts. Menopause is recognized as one of the factors that triggers the release of these inflammatory substances within the body. Additionally, the release of inflammatory mediators has been shown to reduce the quality of alveolar bone in animal models. In experimentally induced menopause in animal models, menopause-associated osteoporosis has been demonstrated to reduce alveolar bone quality and contribute to the development of periodontitis (21, 22).

In the present study, oral health-related quality of life did not demonstrate any statistically significant difference when compared among individuals classified as having osteoporosis, osteopenia, or normal bone mineral density; however, it was observed that individuals with normal bone density exhibited higher quality of life scores than those with either osteoporosis or osteopenia. Furthermore, no significant correlation was found between bone mineral density measured at the femur or lumbar spine and oral health-related quality of life. Although a substantial body of research has investigated the relationship between quality of life and osteoporosis, and the majority of these studies have concluded that the quality of life of individuals with

osteoporosis is significantly lower than that of healthy individuals-as exemplified by the studies of Ciubean et al. (23), Hopman et al. (24), Palacios et al. (25), and Al-Sari et al. (26)-studies specifically examining oral health-related quality of life in individuals with osteoporosis remain very limited. Ehsani et al. demonstrated in their study that oral health-related quality of life in individuals with osteoporosis was significantly lower than in healthy individuals (13), a finding that stands in contrast to the results of the present study. In the current investigation, oral health-related quality of life was assessed using the GOHAI (Geriatric Oral Health Assessment Index) questionnaire, which is specifically designed for older adults and possesses strong validity and reliability within this age group. Some research has indicated that osteoporosis can affect oral health. The association of osteoporosis with periodontal diseases, xerostomia, and tooth loss has been demonstrated across numerous studies (23-26). These disorders may, in turn, lead to a reduction in oral health-related quality of life. On the other hand, a study by Madarina et al. demonstrated that mandibular osteoporosis is not associated with oral health-related quality of life in older adults (27). These conflicting results may arise from differences in culture and attitudes among the studied populations, which may cause oral health to be considered less important than general health. Consequently, oral and dental problems may receive less attention from individuals. Many individuals consider oral health disorders occurring in old age to be a natural phenomenon rather than a pathological condition requiring attention, and this attitude may serve as an explanatory factor for the absence of a reduction in oral health-related quality of life observed in this segment of our population.

The limitations of this study include the following: it was a cross-sectional study that only examined tooth count and xerostomia, and xerostomia was assessed using a questionnaire. Furthermore, since diabetes is very common in older adults, the prevalence of this disease was not evenly distributed among the three study groups, with diabetes being less common in osteoporotic individuals compared to the other two groups. Additionally, the male-to-female ratio was not balanced across the three groups. Therefore, it is recommended that future prospective studies with larger sample sizes be conducted, and that more comprehensive oral health indicators-such as salivary flow rate and periodontal parameters-be evaluated. Moreover, confounding factors should be evenly distributed between the groups.

Based on the findings of the present study, it can be concluded that the development of osteopenia and osteoporosis resulting from decreased bone mineral density does not have a significant impact on oral health-related quality of life.

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