

## Osteoporosis de los huesos maxilares

### *Osteoporosis of the maxillary bones*

- <sup>1</sup> Sandra Veronica Vaca Navarrete  
Dentist, ViVadental.  
[vero3105@hotmail.es](mailto:vero3105@hotmail.es)  <https://orcid.org/0009-0007-9714-8085>
- <sup>2</sup> Priscila Elizabeth Mendoza Arteaga  
General Dentist. Independent researcher. [https://priscilaema97@gmail.com](mailto:priscilaema97@gmail.com)  <https://orcid.org/0009-0006-7912-6432>
- <sup>3</sup> Erika Vanessa Granizo Molina  
General Dentist. Independent Researcher.  
[evgranizo@gmail.com](mailto:evgranizo@gmail.com)  <https://orcid.org/0000-0002-1054-9879>
- <sup>4</sup> Kennie Saul Lopez Castro  
Dentistry Degree, San Gregorio University of Portoviejo, Manabí, Ecuador.  
[kennielopez@hotmail.com](mailto:kennielopez@hotmail.com)  <https://orcid.org/0009-0002-3052-6612>
- <sup>5</sup> Marcelo Alejandro Villalba Jativa  
Dentist, ViVadental.  
[marcelovillalbaj@gmail.com](mailto:marcelovillalbaj@gmail.com)  <https://orcid.org/0009-0006-9627-5878>



---

#### Scientific and Technological Research Article

Sent: 14/01/2024

Revised: 11/02/2024

Accepted: 03/20/2024

Published: 04/20/2024

DOI: <https://doi.org/10.33262/anatomiadigital.v7i2.3000>

Please quote:

Navarrete Vaca, SV, Arteaga Mendoza, PE, Granizo Molina, EV, Lopez Castro, KS, & Villalba Jativa, MA (2024). Osteoporosis of the maxillary bones. Digital Anatomy, 7(2), 56-77. <https://doi.org/10.33262/anatomiadigital.v7i2.3000>

DIGITAL ANATOMY is an electronic, quarterly journal that will be published in electronic format and has the mission of contributing to the training of competent professionals with a humanistic and critical vision who are capable of presenting their investigative and scientific results to the same extent that positive changes in society are promoted through their intervention. <https://anatomiadigital.org>

The journal is published by Editorial Ciencia Digital (a prestigious publisher registered with the Ecuadorian Book Chamber with membership number 663). [www.celibro.org.ec](http://www.celibro.org.ec)

This journal is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. Copy of the license: <https://creativecommons.org/licenses/by-nc-sa/4.0/deed.es>

**Palabras claves:**

osteoporosis,  
osteoporosis y salud  
bucal, osteoporosis  
de los maxilares.

**Keywords:**

osteoporosis,  
osteoporosis and

**Resumen**

**Introducción:** La osteoporosis es una enfermedad que debilita los huesos y aumenta el riesgo de fracturas. Afecta a millones de personas en todo el mundo y se espera que su incidencia se duplique. Se relaciona con la salud oral, especialmente la densidad ósea mandibular, evaluada mediante radiografías panorámicas y el Índice Cortical Mandibular (ICM). La densitometría ósea (DXA) es crucial para el diagnóstico. El tratamiento requiere un enfoque integral para el cuidado del paciente. **Objeto:** sintetizar los principales tópicos respecto a osteoporosis de los maxilares, para proporcionar una comprensión integral del impacto de esta condición en la salud oral. **Metodología:** Se realizó una revisión bibliográfica narrativa a partir de una búsqueda de artículos científicos en las bases de especializadas *ScienceDirect*, SciELO, Redalyc, PubMed. Los criterios de selección para la construcción del manuscrito son: artículos en inglés y/o español que incluyeran información respecto a la fisiopatología, etiología, características, diagnóstico y abordaje terapéutico de la osteoporosis y su relación con la salud bucal. **Resultados:** Se construyó un documento científico accesible para el personal de primer nivel que aborda a este grupo de pacientes. **Conclusión:** La osteoporosis generalmente no afecta significativamente a los huesos orofaciales, pero puede provocar complicaciones dentales y maxilofaciales. La enfermedad periodontal es más común y grave en personas con osteoporosis, debido a la pérdida de densidad ósea. Es esencial que los pacientes con osteoporosis reciban atención dental regular y se comuniquen con su dentista sobre su condición. Un seguimiento dental regular es importante para detectar y tratar problemas tempranos. Los dentistas deben trabajar con otros médicos para cuidar adecuadamente a los pacientes con osteoporosis y prevenir complicaciones dentales y maxilofaciales. **Área de estudio general:** odontología. **Área de estudio específica:** rehabilitación oral. **Tipo de estudio:** original.

**Abstract**

**Introduction:** Osteoporosis is a disease that weakens bones and increases the risk of fractures. it affects millions of people

oral health, osteoporosis of the jaws.

around the world and its incidence is expected to double. it is related to oral health, especially mandibular bone density, evaluated by panoramic radiographs and the mandibular cortical index (mci). bone densitometry (dxa) is crucial for diagnosis. treatment requires a comprehensive approach to patient care. objective: to synthesize the main topics regarding osteoporosis of the jaws, to provide a comprehensive understanding of the impact of this condition on oral health. methodology: a narrative bibliographic review was conducted based on a search for scientific articles in the specialized databases ScienceDirect, SciELO, Redalyc, and PubMed. The selection criteria for the construction of the manuscript are articles in English and/or Spanish that include information regarding the pathophysiology, etiology, characteristics, diagnosis and therapeutic approach of osteoporosis and its relationship with oral health. results: a scientific document was constructed that was accessible to first-level personnel who addressed this group of patients. conclusion: osteoporosis does not significantly affect the orofacial bones but can lead to dental and maxillofacial complications. Periodontal disease is more common and serious in people with osteoporosis, due to loss of bone density. It is essential that patients with osteoporosis receive regular dental care and communicate with their dentist about their condition. Regular dental follow-up is important to detect and treat problems early. Dentists must collaborate with other doctors to properly care for patients with osteoporosis and prevent dental and maxillofacial complications. general area of study: dentistry. specific study area: oral rehabilitation. type of study: original.

## Introduction

The World Health Organization (WHO) defines osteoporosis as a systemic and metabolic disease characterized by a decrease in bone density and quality, which increases bone fragility and the risk of fractures (1, 2). The WHO estimates that 200 million people have osteoporosis worldwide, causing more than 8.9 million osteoporotic fractures. These numbers are expected to double, posing a challenge to public health due to increased morbidity, mortality and health costs (1).

Osteoporosis primarily affects older people, but it can affect younger people with risk factors such as calcium-deficient diet, lack of physical activity, family history, alcohol consumption and smoking (1). Osteoporosis as a systemic disorder has implications for other aspects of health. Recent studies have highlighted the relationship between osteoporosis and oral health parameters, including periodontal health, tooth loss and mandibular bone density. Osteoporosis is linked to bone loss in the oral cavity, especially in the mandibular bone, which shows a faster bone metabolism than the maxilla (2).

The Mandibular Cortical Index (MCI) is used in panoramic radiographs to assess the quantity and quality of mandibular cortical bone, differentiating between patients with and without risk of osteoporosis. However, bone densitometry (DXA) is the most conclusive technique to assess osteoporosis (1). Treatment modalities for osteoporosis in oral health add an additional dimension to patient care, requiring a holistic approach (2). The present work aims to synthesize the main topics regarding osteoporosis of the jaws, to provide a comprehensive understanding of the impact of this condition on oral health.

## Methodology

In this research work, a narrative bibliographic review was carried out based on a search for scientific articles in the specialized databases ScienceDirect, SciELO, Redalyc, PubMed. The selection criteria for the construction of the review are: articles in English and/or Spanish that included information regarding the pathophysiology, etiology, characteristics, diagnosis and therapeutic approach of osteoporosis and its relationship with oral health. For the search, the descriptors “Osteoporosis and oral health”, “Osteoporosis of the jaws”, “Osteoporosis” were used. 30 were selected that met the selection criteria and were most relevant to the objective of the review.

## Results

### *Definition and characteristics*

The word “osteoporosis” comes from the Greek “osteo” meaning “bone” and “poros” referring to “porous” (3). Osteoporosis (OP) is defined as a systemic disease affecting the body’s skeletal system, characterized by a decrease in bone mineral density (BMD) and a deterioration in the microstructure of bone tissue, which manifests itself in the thinning of the trabeculae, the bone cortex and an increase in the marrow spaces (1, 4). These alterations cause increased bone fragility and susceptibility to fractures (2).

Osteoporosis is considered the “silent epidemic of the 21st century” because it can progress without noticeable symptoms until a fracture occurs (5, 6). Fragility fractures, until recently called osteoporotic fractures, commonly affect the spine, hip, and wrist (7). They significantly impact the quality of life of patients; they cause deformities, pain,

disability, decreased quality of life, increased mortality, and generate significant costs to health systems (2).

### *Classification*

In 1994, the WHO established a classification of osteoporosis based on BMD measurements in postmenopausal women. It uses T-scores and Z-scores. The T-score is applied to postmenopausal women and men older than 50 years, while the Z-score is used in premenopausal women and men younger than 50 years. Bone mass is considered normal when the values are above -1 SD with T-score and > -2 SD with Z-score, and osteoporosis when they are below -2.5 SD and -3 SD for T-score and Z-score, respectively. A distinction is made between primary osteoporosis (without underlying disease) and secondary osteoporosis (with underlying disease), the former being more common, especially in Caucasian women (6).

### *Epidemiology*

The incidence of osteoporosis varies according to factors such as age, gender, ethnicity and geographic location. According to systematic reviews, the global prevalence of osteoporosis is 19.7% (2), affecting approximately 200 million people worldwide and generating more than 8.9 million bone fragility fractures annually (1, 8). The prevalence differs by continent, being 8.0% in Oceania and 26.9% in Africa. It is higher in developing countries (22.1%) than in developed countries (14.5%) (9). The prevalence also varies between countries, from 4.1% in the Netherlands to 52.0% in Turkey, affecting 10% of older adults in the United States (10) and 19% in Ecuador (11, 12).

### *Risk factors*

Risk factors that increase the risk of developing osteoporosis are classified into:(1):

1. Non-modifiable factors:
  - Age: The risk of osteoporosis increases with age, being more common in older people.(1, 2).
  - Gender: Women are at higher risk for osteoporosis. However, men are also at risk, especially after age 70.(1, 2).
  - Hormonal changes: Decreased estrogen levels in postmenopausal women lead to increased bone resorption and reduced BMD. They are therefore considered to be the main risk factors for osteoporosis.(3).
  - Genetic factors: Genetic factors from fetal development to adulthood affect BMD. The osteoprotegerin (OPG) gene that controls bone resorption is linked to osteoporosis, especially in postmenopausal women.(1).

- Family history: A family history of early menopause, fractures, or osteoporosis may increase the risk.(1).
- Ethnicity: Some ethnicities are more predisposed to osteoporosis than others.(1). Caucasian ethnicity has a higher predisposition to osteoporosis compared to other ethnicities, as they tend to have slightly lower bone density.(2).

## 2. Modifiable factors:

- Nutrition: Nutrient deficiencies such as calcium and vitamin D, low-calorie diets, as well as excess or deficit in protein consumption could interfere with calcium balance and harm the health of bone metabolism and therefore contribute to osteoporosis.(1, 4).
- Physical activity: Sedentary lifestyle can weaken bones(1).
- Tobacco and alcohol use: Smoking can weaken bones and increase the risk of fractures. And excessive alcohol consumption can affect bone health.(1,2).
- Drugs: Some medications, such as oral glucocorticoids, proton pump inhibitors, and anticonvulsants, may increase the risk of osteoporosis.(1).
- Endocrine system diseases such as hyperparathyroidism, chronic kidney failure, liver disease can increase the risk of osteoporosis(1).
  - Elevated homocysteine concentrations and low levels of high-density lipoprotein (HDL) are associated with increased risk of osteoporosis. Homocysteine tends to increase with age in postmenopausal women.(1).
  - Liver dysfunction associated with chronic diseases such as cirrhosis is the second leading cause of osteoporosis. Hepatic osteodystrophy can cause a loss of BMD of up to 55%, affecting oral health and the tissues of the oral cavity due to the crucial role of the liver in bone metabolism.(1).

### *Impact on oral health*

The WHO highlights that osteoporosis and periodontal disease are two diseases whose incidence increases with age. Osteoporosis is linked to oral health problems such as periodontal disease, reduced mandibular density and height, decreased lower cortical width, temporomandibular joint dysfunction, bone loss and difficulties in masticatory function.(3) Oral health provides insight into systemic health. This relationship is bidirectional, meaning that systemic conditions can affect oral health and vice versa.(5).

Osteoporosis accelerates bone resorption, so it can affect any bone in the body, including the alveolar bone. Reduced BMD in the jawbones contributes to the supporting bone being susceptible to periodontal disease and tooth loss, especially in postmenopausal women.(3). The BMD of the mandibular bone is associated with the BMD of the lumbar spine and the femoral neck, areas more prone to osteoporosis.(1).



The relationship between osteoporosis and periodontal diseases is significant. The study by Ehsani et al. (13) compared oral health-related quality of life between patients with osteoporosis and healthy individuals. Using the OHIP-14 questionnaire and various indicators, they found that patients with osteoporosis experience a significantly lower oral quality of life, along with a higher prevalence of periodontal diseases and xerostomia. These results underline the need for specific and more focused oral care in patients with osteoporosis.(6).

*Periodontal Health:* Osteoporosis can affect periodontal health by weakening dental supporting structures, increasing susceptibility to periodontal disease, which is characterized by gum inflammation and progressive alveolar bone loss and may contribute to systemic inflammation, potentially affecting bone metabolism.(5) Periodontitis is more common in postmenopausal women and in patients with osteoporosis, due to hormonal changes and other factors associated with these conditions.(7) The association between periodontal attachment loss and low BMD is influenced by factors such as age, smoking and diabetes.(3).

*Tooth loss (Edentulism):* Osteoporosis has been linked to decreased BMD in the jaw and changes in the oral environment(3, 5), which can affect the stability and support of teeth, increasing the likelihood of tooth mobility and subsequent loss(5) Extensive alveolar bone resorption in edentulism may result from tooth loss, nutritional, hormonal factors, age and osteopenia.(3) Postmenopausal women show a marked increase in alveolar bone loss in the mandible and maxilla, which is linked to increased bone remodeling activity in this specific group.(7).

*Dental rehabilitation:* Osteoporosis may affect alveolar socket repair after tooth extraction, bone healing, and osseointegration of dental implants(3, 8). Although there is greater bone loss around the implant in the first year, there is no difference in the long term, suggesting slower osseointegration in osteoporotic patients.(3, 9) This relationship is influenced by factors such as the patient's general health status, the quality of the maxillary bone, the implant placement technique and postoperative care.(10).

*Temporomandibular joint dysfunction:* The correlation between radiographic changes in temporomandibular joint (TMJ) disorders and BMD was investigated, finding erosions, flattening and osteophytes in more than 50% of patients, negatively correlated with the serum marker of bone formation P1NP. In contrast, they found no association between osteoporosis and TMJ disorders. On the other hand, a study in osteoporotic rats suggested that fractures in the mandibular condyle are less common than in the femur, possibly due to differences in physical stress and ossification between these bones.(3, 14).

*Bone density in the jaw:* Osteoporosis can affect the jawbone, posing challenges during dental procedures such as implant placement and oral surgery.(5, 15). Decreased BMD in

the mandible leads to microstructural changes, such as increased porosity and loss of trabecular density, predisposing to microfractures. Assessment methods such as trabecular pattern analysis and panoramic radiographic measurements, such as the mandibular cortical index, are used to detect signs of osteoporosis in the mandible.(3, 16). The information on these indexes will be expanded in the diagnosis section.

#### *Impact on nutrition: malnutrition*

Osteoporosis of the maxillary bone itself does not cause malnutrition directly, but it can contribute to a number of problems affecting nutrition. Loss of bone density in the maxilla can lead to tooth loss or serious dental problems, making chewing difficult, the adequate intake of nutritious foods, can affect bone support and the use of dentures, generating masticatory dysfunction (10, 17).

A study that discussed how different nutritional statuses affect the prognosis of patients with osteoporosis found that malnutrition status, common in osteoporotic patients, is closely related to an all-cause mortality risk compared to that observed in those with normal nutritional status. These findings underline the importance of assessing nutritional status risk in patients with osteoporosis and implementing available strategies to prevent malnutrition in this patient group (18).

#### *Diagnosis*

##### *Dental Panoramic Radiography (DPR)*

DPR provides a comprehensive view of oral structures such as teeth, mandibles, maxillae, and temporomandibular joint structures. DPR is essential in dentistry to assess oral health, diagnose dental and periodontal diseases, plan orthodontic treatments, evaluate tooth position in relation to surrounding structures, and detect bone pathologies.(11), such as changes in BMD and osteoporosis, especially in patients without previous fracture symptoms. Although DPR has advantages such as availability, lower cost and radiation dose, it is not specific for diagnosing osteoporosis, and if suspected, additional tests such as DXA are recommended.(12).

The DPR provides data through artificial intelligence (AI) and assessment indices that allow the identification of bone density patterns and changes in trabecular architecture, and therefore, signs of osteoporosis.(13)Among the evaluation indices, the ICM, the ACM and the IMP are considered to be the most significant for the prediction and early detection of osteoporosis in postmenopausal women with low BMD.(1, 12).

1. *Mandibular Cortical Index (MCI) or Klemetti index:* This index evaluates bone quality by the shape of the mandibular cortex.(1). Describes the porosity of the lower



mandibular border near the mental foramina, classifying the morphology of the mandibular cortex into three groups according to a specific scale(3, 12).

- Normal cortex (C1): The endosteal cortical margin is uniform and sharp on both sides of the mandible.
  - Mildly to moderately eroded cortex (C2): The endosteal cortical margin shows lacunar resorption cavities, with one to three layers of endosteal cortical debris on one or both sides.
  - Severely eroded cortex (C3): The endosteal cortical margin presents well-marked thick and porous cortical residues.
2. *The mandibular cortical width index (MCW) or mental index (MI)*: This index is related to BMD. It evaluates the width of the lower border of the mandible in the area of the mental foramina. The ACM has a specificity of 96% and a sensitivity of 60%.(1). The ACM is measured by drawing a line parallel to the mandibular length and tangential to the lower border of the mandible on both sides, measuring the width of the lower cortex where the mental foramen projects. This index is expressed in millimeters (mm). In osteoporotic patients, the mandibular cortex is usually less than 3 mm.(3, 12).
  3. *The panoramic mandibular index (PMI)*: It consists of the average between the lower mandibular index and the upper mandibular index. The upper mandibular index corresponds to the cortical width divided by the distance from the upper edge of the mental foramen to the lower edge of the mandible. The lower mandibular index corresponds to the cortical width divided by the distance from the lower edge of the mental foramen to the lower edge of the mandible.(3, 12). The resulting value should not be less than 0.3 mm, lower IMP values have been observed in osteoporotic patients.(1).
  4. *The gonial index (GI) and the antegonial index (AI)*: Two alternative indices have been proposed to measure the thickness of the cortex in the posterior region of the mandible when locating the mental foramen is difficult: the Antegonial Index (AI) and the Gonial Index (GI).(1, 3). The AI and GI measure the thickness of the mandibular cortex in the region anterior to the gonion and at the angle of the mandible, respectively. The AI is calculated by drawing a line along the anterior border of the ascending ramus of the mandible and measuring the cortical width, while the GI is performed in the region of the mandibular angle. Lower values of these indices in osteoporotic patients suggest decreased BMD in the mandibles.(3, 12).
  5. *The mandible-mandibular (M/M) relationship*: It is the relationship between the total height of the mandibular body and the height from the lower border of the mandible

to the lower border of the mental foramen, although it is considered less significant. It is important to note that the evaluation of these characteristics requires adequate preparation and training to ensure an accurate and consistent evaluation of the panoramic radiograph in relation to osteoporosis.(1).

#### *Cone beam computed tomography (CBCT)*

CBCT is being studied to assess oral bone mineral density (BMD). Although it is noisier than medical computed tomography (MCT), it offers advantages such as lower cost, lower radiation, and higher resolution. It provides accurate images of the lower dental canal and a volumetric reconstruction without superimpositions, making it a promising option for assessing BMD.(14).

Studies evaluating the trabecular bone structure of the jaws using CBCT have not revealed significant changes indicative of osteoporosis. However, the most revealing data for detecting osteoporosis are obtained by analyzing and evaluating the bone trabeculation of the second cervical vertebra at the level of the odontoid. The use of CBCT in identifying postmenopausal women with osteoporosis has proven useful for assessing BMD through specific indices for computed tomography. These indices include:(1):

1. Upper computed tomography mandibular index (ITCS): It is the relationship between the width of the mandibular cortex at the level of the mental foramen and the distance from the upper edge of the mental foramen to the lower mandibular edge.
2. Inferior computed tomography mandibular index (ITCI): It is the relationship between the width of the mandibular cortex at the level of the mental foramen and the distance from the lower edge of the mental foramen to the lower mandibular border.

The ITCS and ITCI are the most commonly used to differentiate between normal values and values that imply a higher risk of osteoporosis, and may be related to the IMP.

3. Mandibular cortical index in computed tomography (ICTC): It is less significant in relation to panoramic radiography and uses data similar to the ICM according to Klemetti, but in the case of the ICTC, the scale would be: type 1, 2 and 3.

#### *Laser speckle imaging (LSI) technique*

In a recent study, laser speckle imaging (LSI) was used to distinguish between healthy and osteoporotic maxillary and mandibular bones in the laboratory. Osteoporotic lesions were simulated with acid. The results highlighted that LSI, using the speckle contrast ratio and patch ratio, allowed differentiation between healthy and osteoporotic tissue. These

findings suggest that LSI could be useful for assessing osteoporotic lesions in alveolar bone.(15).

#### *Bone densitometry (DXA)*

Bone densitometry or dual energy X-ray absorptiometry is a medical technique used to measure BMD in different parts of the body, mainly in the spine, hip and forearm.(1)According to the WHO, patients with normal BMD have DEXA result values greater than -1.0 standard deviation (SD); any densitometric value less than -1.0 SD is already considered low BMD.(16).

WHO recommends DXA in women aged 65 years and older and in men aged 70 years and older, or earlier if they have additional risk factors for osteoporosis such as fractures due to trauma before age 50; in women aged 70 years and older and in men aged 80 years and older, with a historical height loss of 4 cm or more (difference between current height and maximum height at age 20 years) and suggests follow-up every 1 - 2 years to assess the progression of osteoporosis and the effectiveness of treatment.(1).

#### Complementary studies

Additional laboratory studies to diagnose osteoporosis include biochemical markers that provide information on the state of bone turnover and bone health. These markers are relevant in the diagnosis of osteoporosis.(1).

- Serum osteocalcin: Indicates the status of bone turnover throughout the skeletal system. Osteocalcin is a protein produced by osteoblasts, cells responsible for bone formation. Low levels of osteocalcin may indicate decreased bone formation and are associated with an increased risk of osteoporosis and bone fracture. Therefore, measurement of serum osteocalcin may be useful in assessing osteoporosis risk and monitoring bone health.(17).
- Total serum alkaline phosphatase: Another marker of bone turnover, although it does not offer specific values for particular bone areas(1)Adults with hypophosphatasia (HPP) may experience osteoporosis, fragility fractures, and dental problems.(18).
- Urinary hydroxyproline: Hydroxyproline (Hyp) is an amino acid produced by the hydroxylation of proline residues in type 1 collagen that indicates the activity of bone metabolism. Containing collagen and elastin, it is present in connective tissues such as skin, tendons and bones, Hyp plays a fundamental role in the stability, structure and function of these tissues. Among all the biomarkers of bone resorption, Hyp has shown great potential as a sensitive and stable bone biomarker for the early detection of osteoporosis.(19).

- **Serum calcium:** Calcium is critical for bone health as it is a major component of bone tissue. Calcium deficiency is a major risk factor for the development of osteoporosis. When the body does not receive enough calcium through the diet, it begins to draw calcium from the bones to maintain adequate levels of calcium in the blood. Over time, this can weaken the bones and increase the risk of osteoporosis. Increasing serum calcium alone does not improve BMD.(20).
- **Serum phosphorus:** Phosphorus is another important component of bone tissue and its blood level can vary depending on dietary intake and the age of the individual.(1).
- **Urinary calcium/creatinine ratio:** Allows assessment of renal calcium handling and may be useful for monitoring response to treatment of hypocalcemia(1).

### *Treatment*

#### *Pharmacological interventions*

- **Bisphosphonates:** These drugs, such as alendronate and risedronate, are common in the treatment of osteoporosis because they inhibit bone resorption, reducing the risk of fractures by maintaining or increasing bone density. However, prolonged use can cause side effects such as osteonecrosis of the jaw.(5).
- **Hormone replacement therapy (HRT):** Involves the use of estrogen or other hormones, and is effective in counteracting bone loss associated with menopause. However, it poses cardiovascular and cancer risks that must be assessed individually.(5).
- **Selective estrogen receptor modulators (SERMs):** These medications, such as raloxifene, benefit bone density without the risks of estrogen, making them an option for postmenopausal women who cannot use HRT.(5).
- **Denosumab:** A monoclonal antibody that inhibits bone resorption by blocking RANKL, is effective in reducing the risk of fractures. However, it carries a risk of rebound bone loss when treatment is stopped.(5).

#### *Non-pharmacological approaches*

- **Lifestyle modifications** are crucial to managing osteoporosis and reducing the risks associated with bone loss. Quitting smoking and limiting alcohol consumption are especially important, as they are linked to lower bone density and increased risk of fractures.(5).
- **Dietary Considerations:** Adequate nutrition, including calcium and vitamin D, is essential for bone health. Sources such as dairy, green leafy vegetables, and

fortified foods are recommended. Sun exposure and foods such as fatty fish also provide vitamin D. In cases of insufficient intake, supplements may be recommended to prevent deficiencies.(5).

Evidence suggests that certain strains of *Lactobacillus*, such as *Lactobacillus acidophilus*, may improve calcium absorption and bone mineral density, especially in postmenopausal women with osteoporosis. These probiotics reduce intestinal pH, facilitating calcium absorption, and may also modulate the immune system and reduce inflammation, which benefits bone health. However, long-term clinical studies are needed to determine the safe and effective dosage of probiotics.(21).

- Exercise and physical activity: Regular exercise, especially weight-bearing and resistance-bearing, is key in managing osteoporosis. Activities such as walking, running, and weight lifting stimulate bone formation and maintain density. Tailored to each individual, these exercises strengthen bones and muscles, reducing the risk of falls and fractures and promoting overall well-being.(5).

#### *Oral health implications of osteoporosis treatment*

Osteonecrosis of the jaw (ONJ or MRONJ) is a major side effect of antiresorptive medications used in the treatment of osteoporosis, such as bisphosphonates and denosumab. ONJ is associated with over-suppression of bone resorption and prolonged suppression of bone turnover by bisphosphonates.(5). It is a rare but serious condition characterized by the death of bone tissue in the jaw. ONJ is usually triggered after dental procedures or trauma to the jaw. Symptoms include inflammation, bone exposure, and pain, making oral function such as swallowing, eating, and speaking difficult.(22).

Denosumab: Affects bone metabolism, including the jaw bone. Although denosumab has shown efficacy in reducing the risk of fractures, its effect on oral health has been less studied compared to bisphosphonates. Dentists should be aware of the potential impacts on bone healing and work closely with physicians in managing patients receiving denosumab, especially during dental procedures or extractions.(5, 23).

Tooth extractions: These present a challenge in patients on bisphosphonate therapy due to the increased risk of ONJ. Dentists choose to avoid unnecessary extractions and seek alternatives. A thorough evaluation of the medical history and close collaboration with the treating physician and dentist are required to minimize the risk of ONJ associated with tooth extractions.(5, 24).

Hormone replacement therapy (HRT): This therapy may impact oral health, especially in postmenopausal women. Estrogen, a key component of HRT, helps maintain oral tissues, including gums and salivary glands. HRT may alleviate oral symptoms associated with

menopause, such as xerostomia and periodontal disease. Use of HRT requires individualized risk-benefit assessments.(5, 25).

#### *Interdisciplinary approach to patient care*

*Collaboration between dentists and healthcare providers:* Dentists, as primary oral care providers, should actively communicate with physicians and other health care professionals involved in osteoporosis management. Sharing medical histories and treatment plans allows for a comprehensive approach to the oral health implications of osteoporosis and its treatments, especially when considering dental procedures such as extractions or implant placement.(5, 26).

*Osteoporosis screening protocols in dental settings:* Integrating osteoporosis screening into routine dental evaluations can identify patients at risk and refer them for further evaluation. Dentists can use questionnaires, clinical assessments, and dental imaging to identify indicators of osteoporosis and refer patients for bone density testing when necessary.(5, 27).

*Communication between health professionals for comprehensive patient care:* Dentists, physicians, and specialists should exchange information about medications, treatment adjustments, and oral health concerns. Dentists should communicate about risky dental procedures. Interdisciplinary meetings allow for addressing the complexities of caring for the patient with osteoporosis.(5, 28).

#### *Prevention*

Preventing osteoporosis involves a multifaceted and personalized approach that ranges from maximizing bone density in youth to effective treatment and management in adulthood.(2, 29, 30):

- Maximizing bone density in young adults: Achieving peak bone density during the growing years can provide a strong foundation for bone health throughout life(2).
- Follow a four-stage diagnostic protocol for patients at risk for osteoporotic fractures: This involves risk factor assessment, bone density testing, clinical evaluation, and ongoing follow-up to identify and address potential complications.(2)
- Perform accurate bone strength measurements – to effectively assess bone health and monitor response to treatment(2)
- Bridging gaps in care: This involves ensuring that patients receive ongoing and appropriate care to effectively manage their osteoporosis and prevent fractures(2)



- Using safer and more effective medicines: providing more effective therapeutic options with fewer side effects(2)
- Offer comprehensive treatment, both pharmacological and non-pharmacological, that includes specific exercises to improve muscle strength and balance, as well as to reduce pain and improve subjective quality of life.(2)
- Implement new treatment strategies aimed at identifying and treating high-risk patients: which could help to more effectively identify and manage people most likely to develop osteoporosis(2)

### **Conclusion**

- Although osteoporosis tends to primarily affect the axial and appendicular skeleton, i.e. the spine, hips, ribs, and other long bones of the body, the orofacial bones are generally not as severely affected by this disease. However, it is important to note that patients with osteoporosis may still experience dental and maxillofacial complications.
- Periodontal disease, which affects the gums and supporting tissues around the teeth, may be more prevalent and severe in patients with osteoporosis. This is because loss of bone density in the jaw can weaken tooth support, increasing the risk of tooth loss and other periodontal complications. In addition, maxillofacial surgery, such as dental implant placement or tooth extraction, may be more complicated in patients with osteoporosis due to reduced bone quality.
- It is important for people with osteoporosis to receive regular dental care and communicate with their dentist about their condition. Dentists can help identify and treat dental and oral problems related to osteoporosis and work in conjunction with other health care professionals to provide a comprehensive approach to care. Therefore, it is recommended that patients with osteoporosis maintain regular dental follow-up to monitor and treat any early periodontal problems, as well as to assess overall oral bone health.
- Dentists and maxillofacial surgeons can work closely with other health care professionals, such as osteoporosis physicians, to ensure a comprehensive approach to the care of these patients and to minimize the risk of dental and maxillofacial complications associated with osteoporosis.

### **Conflict of interest**

The authors declare that they have no conflicts of interest that could compromise, in whole or in part, the results of this work or its publication.

### **Authors' contribution statement**

SVVN and MAVJ conceived the research idea, defined the problem and carried out an initial search for information.

PEMA and KSLC conducted the non-systematic search to construct the article database and designed the first draft under the supervision of SVVN and MAVJ.

SVVN supervised the development of the second draft by PEMA and EVGM.

EVGM applied corrections to the second and third drafts.

SVVN and MAVJ approved the final manuscript.

### ***Bibliographic References***

1. Rocha Claros JJ. Osteoporosis of the jaws and its diagnostic methods: Literature review. ODOVTOS-Int J Dental Sc [Internet]. 2020 [cited 18 Feb 2024];23(1):53-63. Available at: <http://dx.doi.org/10.15517/ijds.2020.39367>
2. Sharma N, Reche A. Unraveling the relationship between osteoporosis, treatment modalities, and oral health: a comprehensive review. Cureus [Internet]. 2023 [cited 2024 Feb 18];15(11):1-8. Available at: DOI: 10.7759/cureus.49399
3. Kwan P. Osteoporosis: from osteoscience to neuroscience and beyond. Mech Ageing Dev [Internet]. 2015 Jan 1 [cited 2024 Feb 18];145(1):26-38. Available at: doi: 10.1016/j.mad.2015.02.001
4. Anam AK, Insogna K. Update on osteoporosis screening and management. Medical Clinics of North America [Internet]. 2021 Nov 1 [cited 2024 Feb 18];105(6):1117-34. Available at: doi: 10.1016/j.mcna.2021.05.016
5. PM J, PME B, JLM S, CE V, CA V. Osteoporosis, a health problem of these times. Rev Méd Electron [Internet]. 2021 [cited 21 February 2024];43(2). Available at: <https://www.medigraphic.com/pdfs/revmedele/me-2021/me212n.pdf>
6. Nutritional factors related to osteoporosis. El Residente [Internet]. 2018 [cited 21 Feb 2024];13(1):23-30. Available at: [www.medigraphic.com/elresidente](http://www.medigraphic.com/elresidente)
7. Calvo Catalá J, Campos Fernández C, Rueda Cid A, Balaguer Trull I, Lerma Garrido J, Molina Almela C, et al. Treatment of osteoporosis and osteonecrosis of the jaw. The rheumatologist's vision. Rev Sociedad Val Reuma [Internet]. 2020;8(3):3-9. Available at: <https://dialnet.unirioja.es/descarga/articulo/7568483.pdf>
8. De la Peña-García C, Barrios-Moyano A. Prevalence of osteoporosis and osteopenia in working-age patients. Acta Ortop Mex [Internet]. 2018 [cited 18

- February 2024];32(3):131-3. Available at: [www.medigraphic.org.mx](http://www.medigraphic.org.mx)Original articlePrevalence of osteoporosis and osteopenia in working-age patients
9. Xiao PL, Cui AY, Hsu CJ, Peng R, Jiang N, Xu XH, et al. Global, regional prevalence, and risk factors of osteoporosis according to the World Health Organization diagnostic criteria: a systematic review and meta-analysis. *Osteoporosis International* [Internet]. Oct 1, 2022 [cited Feb 21, 2024];33(10):2137-53. Available at: <https://link.springer.com/article/10.1007/s00198-022-06454-3>
  10. Sander Koth V, Gonçalves Salum F, Zancanaro de Figueiredo MA, Cherubini K. Repercussions of osteoporosis on the maxillofacial complex: a critical overview. *J Bone Miner Metab* [Internet]. March 1, 2020 [cited February 19, 2024];39(2):117-25. Available at: <https://doi.org/10.1007/s00774-020-01156-4>
  11. Vera C, Encalada C, Zúñiga A, Wong A, Barcia A, Ríos C. First Ecuadorian Consensus for the Management and Prevention of Osteoporosis [Internet]. Ecuadorian Society of Rheumatology. Guayaquil; 2022 [cited February 21, 2024]. Available at: <https://www.serecuador.com.ec/wp-content/uploads/2022/12/Consenso-Ecuatoriano-Osteoporosis-2022-digital.pdf>
  12. Szymańska-Chabowska A. Osteoporosis – risk factors, pharmaceutical and non-pharmaceutical treatment. *Eur Rev Med Pharmacol Sci* [Internet]. 2021 [cited 21 Feb 2024]; 25:3557-66. Available at: <https://www.researchgate.net/publication/351703729>
  13. Ehsani H, Salehi M, Yazdani Charati J, Niksolat F, Soltantouyeh A, Aryana M, et al. Comparison of oral health-related quality of life among patients with osteoporosis and healthy individuals. *Koomesh* [Internet]. 2022 [cited 26 Feb 2024];24(4):469-76. Available at: <http://koomeshjournal.semums.ac.ir/article-1-7001-en.html>
  14. Mazur I, Dilbarkhanov B, Kuracha X, Novoshytskyy V, Suprunovych I, Zhakipbekov K. Periodontal status, and bone metabolism in women in reproductive and postmenopausal periods. *Horm Mol Biol Clin Investig* [Internet]. 1 Sep 2020 [cited 19 Feb 2024];41(3). Available at: <https://pubmed.ncbi.nlm.nih.gov/32739905/>
  15. Só BB, Silveira FM, Llantada GS, Jardim LC, Calcagnotto T, Martins MAT. Effects of osteoporosis on alveolar bone repair after tooth extraction: A systematic review of preclinical studies. *Arch Oral Biol* [Internet]. 2021-05-19 [cited 2024-02-19];125(1). Available at: <https://pubmed.ncbi.nlm.nih.gov/33667958/>

16. Chen X, Moriyama Y, Takemura Y, Rokuta M, Ayukawa Y. Influence of osteoporosis and mechanical loading on bone around osseointegrated dental implants: A rodent study. *J Mech Behav Biomed Mater* [Internet]. 2021 Nov 1 [cited 2024 Feb 19];123. Available from: <https://pubmed.ncbi.nlm.nih.gov/34438251/>
17. Tabrizi R, Mousavi F, Ghasemi S, Ozkan BT. Does osteoporosis increase marginal bone loss around dental implants in the posterior of the maxilla? *Int J Oral Maxillofac Surg* [Internet]. 2020-07-1 [cited 2024-02-19];50(7):964-8. Available at: <https://pubmed.ncbi.nlm.nih.gov/33376042/>
18. Shangguan X, Xiong J, Shi S, Liao Y, Chen L, Deng J, et al. Impact of the malnutrition on mortality in patients with osteoporosis: a cohort study from NHANES 2005-2010. *Front Nutr* [Internet]. May 11, 2022 [cited February 21, 2024]; 9:868166. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9132007/>
19. Mupparapu M, Akintoye SO. Application of panoramic radiography in the detection of osteopenia and osteoporosis-current state of the art. *Curr Osteoporos Rep* [Internet]. August 1, 2023 [cited February 19, 2024];21(4):354-9. Available at: <https://pubmed.ncbi.nlm.nih.gov/37382808/>
20. Sghaireen MG, Alam MK, Patil SR, Rahman SA, Alhabib S, Lynch CD. Morphometric analysis of panoramic mandibular index, mental index, and antegonial index. *Journal of International Medical Research* [Internet]. Mar 1, 2020 [cited Feb 29, 2024];48(3):9. Available at: <http://dx.doi.org/10.1177/0300060520912138>
21. Turosz N, Chęcińska K, Chęciński M, Brzozowska A, Nowak Z, Sikora M. Applications of artificial intelligence in the analysis of dental panoramic radiographs: an overview of systematic reviews. *Dentomaxillofac Radiol* [Internet]. October 1, 2023 [cited February 19, 2024];52(7). Available at: <https://pubmed.ncbi.nlm.nih.gov/37665008/>
22. Conde-López S, Fiori-Chicano G, Llaguno-Rubio J, Arriola-Guillen L. Use of cone beam computed tomography for the study of bone density in orthodontic treatment. A review of the literature.. *Odontoestomatol* [Internet]. December 2021 [cited 29 February 2024];37(4):152-9. Available at: <https://dx.doi.org/10.4321/s0213-12852021000400002>
23. Amaral MM, del-Valle M, Paulo Raelle M, Ramos De Pretto L, Aparecida Ana P. Osteoporosis evaluation through fully developed speckle imaging. *J Biophotonics*

- [Internet]. 2020-07-01 [cited 2024-02-19];13(7). Available at: <https://pubmed.ncbi.nlm.nih.gov/32277566/>
24. Munhoz L, Gil Choi I, Miura D, Watanabe P, Arita E. Bone mineral density and mandibular osteoporotic alterations in panoramic radiographs: Correlation by peripheral bone densitometry in men. *Indian Journal of Dental Research* [Internet]. May 1, 2020 [cited Feb 29, 2024];31(3):457-64. Available at: [https://journals.lww.com/ijdr/fulltext/2020/31030/bone\\_mineral\\_density\\_and\\_mandibular\\_osteoporotic.22.aspx](https://journals.lww.com/ijdr/fulltext/2020/31030/bone_mineral_density_and_mandibular_osteoporotic.22.aspx)
  25. Rubert M, De la Piedra C. Osteocalcin: from a bone formation marker to a hormone; and bone, an endocrine organ. *Journal of Osteoporosis and Mineral Metabolism* [Internet]. April 1, 2020 [cited February 29, 2024];12(4):146-51. Available at: <https://dx.doi.org/10.4321/s1889-836x2020000400007>
  26. Alonso N, Larraz-Prieto B, Berg K, Lambert Z, Redmond P, Harris SE. Loss-of-function mutations in the ALPL gene presenting with adult-onset osteoporosis and low serum concentrations of total alkaline phosphatase. *Journal of Bone and Mineral Research* [Internet]. Apr 1, 2020 [cited Feb 29, 2024];35(4):657-61. Available at: <https://doi.org/10.1002/jbmr.3928>
  27. Adugani S, Bannimath G, Sastry P. A review on biomarkers in clinical osteoporosis - Significance of hydroxyproline. *Biomedical and Biotechnology Research Journal* [Internet]. Jul 1, 2021 [cited Feb 29, 2024];5(3):245-51. Available at: [https://10.4103/BBRJ.BBRJ\\_91\\_21](https://10.4103/BBRJ.BBRJ_91_21)
  28. Sun J Yi, Zhang H, Zhang Y, Wang L, Sun B liang, Gao F, et al. Impact of serum calcium levels on total body bone mineral density: A mendelian randomized study in five age strata. *Clinical Nutrition* [Internet]. May 1, 2021 [cited February 29, 2024];40(5):2726-33. Available at: <https://doi.org/10.1016/j.clnu.2021.03.012>
  29. Harahap IA, Suliburska J. Can probiotics decrease the risk of postmenopausal osteoporosis in women? *Pharma Nutrition* [Internet]. June 1, 2023 [cited February 29, 2024]; 24:100336. Available at: <https://doi.org/10.1016/j.phanu.2023.100336>
  30. Lončar Brzak B, Horvat Aleksijević L, Vindiš E, Kordić I, Granić M, Vidović Juras D. Osteonecrosis of the jaw. *Dentistry Journal* 2023, Vol 11, Page 23 [Internet]. Jan 9, 2023 [cited Feb 21, 2024];11(1):23. Available at: <https://www.mdpi.com/2304-6767/11/1/23>

The published article is the sole responsibility of the authors and does not necessarily reflect the thinking of the Anatomía Digital Journal.



The article remains the property of the journal and, therefore, its partial and/or total publication in another medium must be authorized by the director of the Journal of Digital Anatomy.



Indexaciones

