Oral Health Outcomes Among Post Menopausal Women with Osteoporosis

Heba Ebrahim Hassan [1], Amany Sobhy Sorour[2], Gamalat Mostafa Abd Elghany[3]
1 B.Sc. Nursing, Faculty of Nursing - Zagazig University
2 Professor of Community Health Nursing, Faculty of Nursing - Zagazig University
3 Assistant Professor of Community Health Nursing, Faculty of Nursing - Zagazig University
Corresponding Author: Heba Ebrahim Hassan

Received: 28 October 2024, **Accepted:** 17 November 2024, **Published:** 20 November 2024

Abstract

Background: Menopause represents a critical biological transition that significantly impacts women's systemic and oral health. Declining estrogen levels contribute to accelerated bone remodeling and increased bone resorption, placing women at heightened risk for osteoporosis. This systemic reduction in bone mineral density not only predisposes women to fractures but also exerts important consequences on oral tissues, including alveolar bone, periodontal ligament stability, and tooth retention. Evidence increasingly shows that both pre-menopausal women with early estrogen decline and post-menopausal women with established osteoporosis experience greater susceptibility to periodontal disease progression, reduced alveolar bone height, and compromised oral health–related quality of life. Despite the growing literature, gaps persist in understanding how community health nursing interventions can effectively integrate oral health promotion with osteoporosis prevention across the menopausal continuum.

The aim of this review is to synthesize current evidence linking menopause-related hormonal changes, systemic osteoporosis, and oral health outcomes, with a focus on implications for community health nursing practice. By integrating epidemiological, clinical, and community-based research, this review emphasizes the multidimensional factors influencing oral health vulnerability during menopausal transition—including hormonal mechanisms, behavioral determinants, socioeconomic disparities, and access to dental and preventive care. Given the high global burden of osteoporosis and periodontal disease, understanding these interconnections is essential for designing preventive strategies tailored to midlife women.

The review highlights that periodontal inflammation and alveolar bone loss may serve as early indicators of systemic bone deterioration, offering opportunities for community nurses to support risk screening and timely referrals. Furthermore, community health nurses play a pivotal role in patient education, lifestyle counseling, and coordination of multidisciplinary care involving dental providers, primary physicians, and endocrinology specialists. Empowering menopausal women through targeted interventions such as nutritional counseling, smoking cessation, physical activity promotion, and improved oral hygiene behaviors can reduce both systemic and oral complications. The conclusion underscores the necessity of strengthening collaborative care models and developing community-based screening protocols that address osteoporosis and oral health jointly. This integrative approach enhances early detection, supports prevention, and ultimately improves overall health outcomes for pre- and post-menopausal women.

Keywords: *Oral Health, Outcomes, Post Menopausal Women, Osteoporosis*

Introduction

Menopause is a major physiological milestone in a woman's life, characterized by the permanent cessation of ovarian function and a marked decline in estrogen production. This hormonal transition affects nearly every body system, but its influence on skeletal health is particularly profound. Estrogen deficiency accelerates bone turnover, contributing to decreased bone mineral density and the development of osteoporosis—a chronic condition affecting more than 200 million women worldwide. Although osteoporosis is commonly discussed in relation to hip, spine, and wrist fractures, its implications for oral and craniofacial structures are equally important yet less widely recognized. The alveolar bone, mandible, and maxilla are metabolically active tissues highly responsive to hormonal fluctuations, making menopausal women more vulnerable to periodontal disease progression, tooth mobility, and tooth loss.

Oral health changes associated with menopause extend beyond structural bone alterations. Women frequently experience xerostomia, burning mouth syndrome, altered taste perception, and increased plaque accumulation, all of which compound the risk of periodontal deterioration. These oral manifestations not only compromise functional abilities such as chewing and speaking but also diminish quality of life and nutritional adequacy—factors closely tied to overall health and well-being. Despite these connections, oral health is seldom integrated into menopausal care pathways or community-level osteoporosis prevention programs, resulting in missed opportunities for early detection and intervention.

A crucial gap in current literature lies in the limited exploration of how community health nursing can bridge the divide between systemic osteoporosis management and oral disease prevention. Community health nurses are optimally positioned to implement risk assessment, health education, lifestyle counseling, and interprofessional referral strategies due to their close engagement with women across the lifespan and within diverse community settings. Yet, guidance on how nurses can operationalize integrative care models for menopausal women remains insufficient.

The aim of this review is therefore to examine the interrelationship between menopause, osteoporosis, and oral health outcomes, with a focus on developing actionable, evidence-based strategies for community health nursing. By synthesizing biomedical research with public health perspectives, this article seeks to strengthen preventive frameworks and enhance comprehensive care for pre- and post-menopausal women.

Menopause and Hormonal Changes Affecting Bone and Oral Health

The menopausal transition leads to a significant decline in circulating estrogen, a hormone critical for the maintenance of skeletal homeostasis and oral tissue integrity. Estrogen deficiency accelerates osteoclastic activity while impairing osteoblast function, resulting in increased bone turnover and reduced bone mineral density (BMD). These hormonal changes also influence oral tissues, contributing to reduced collagen synthesis, altered inflammatory responses, and decreased salivary production, which can further exacerbate periodontal vulnerability. Women experiencing perimenopause often show early periodontal changes that progress more rapidly post-menopause due to systemic hormonal shifts. Understanding these biological mechanisms is essential for developing preventive strategies within community health programs aimed at midlife women [1–3].

2. Pathophysiology of Osteoporosis in Pre- and Post-Menopausal Women

Osteoporosis arises from an imbalance between bone resorption and bone formation, a process heavily influenced by estrogen levels. Estrogen withdrawal promotes increased RANKL expression and osteoclast differentiation, accelerating trabecular bone loss, particularly in the spine and jaw. Pre-menopausal women with premature ovarian insufficiency face similar risks due to early hypoestrogenism, emphasizing the importance of early screening. Post-menopausal osteoporosis not only raises fracture risk but also affects craniofacial bone structures, complicating dental care and periodontal stability. These systemic changes position osteoporosis as both a skeletal and oral health concern requiring integrated care strategies [4–6].

3. Systemic Bone Loss and Its Connection to Oral and Maxillofacial Structures

The mandible and maxilla undergo continuous remodeling similar to long bones, making them vulnerable to systemic bone loss. Reduced BMD correlates with decreased alveolar crest height, diminished mandibular cortical width, and weakened periodontal support, all of which increase susceptibility to tooth mobility and tooth loss. Studies show a positive association between low systemic BMD and reduced jawbone density, suggesting osteoporosis may manifest earlier in oral tissues. This connection highlights the potential for dental assessments to serve as adjunctive tools for identifying women at risk of systemic bone deterioration. Community health nurses can play a key role by ensuring referral pathways between primary care and dental services [7–9].

4. Menopause-Related Oral Manifestations and Salivary Alterations

Beyond bone changes, menopause frequently leads to xerostomia, burning mouth syndrome, mucosal atrophy, and altered taste perception. Estrogen receptors present in salivary glands suggest hormonal involvement in maintaining saliva quantity and quality. Reduced salivary flow compromises antimicrobial activity, buffering capacity, and lubrication, creating an oral environment conducive to plaque accumulation and periodontal disease. These symptoms also impact nutritional intake and quality of life. Given their close patient contact, community health nurses are well-positioned to identify these symptoms early and support referral for oral health evaluation and symptom management [10–12].

5. The Relationship Between Osteoporosis and Periodontal Disease Progression

Evidence supports a bidirectional relationship between osteoporosis and periodontal disease, with systemic low bone density contributing to alveolar bone degradation and periodontal inflammation potentially exacerbating systemic bone resorption. Osteoporotic women show higher rates of clinical attachment loss, pocket depth, and radiographic periodontal bone loss compared to women with normal BMD. Inflammatory cytokines shared between osteoporosis and periodontitis, such as IL-1 and TNF-α, amplify tissue destruction in both conditions. Recognizing this relationship strengthens the rationale for integrated medical–dental preventive programs in community settings [13–15].

6. Alveolar Bone Density, Tooth Mobility, and Tooth Loss in Menopausal Women

Alveolar bone, being metabolically active and sensitive to hormonal regulation, often reflects systemic bone changes earlier than other skeletal sites. Post-menopausal women with osteoporosis exhibit significantly reduced alveolar bone density and cortical thickness, contributing to increased tooth mobility. Longitudinal studies demonstrate that women with low systemic BMD experience greater rates of tooth loss, particularly when periodontal disease is present. Reduced jawbone density also compromises the stability of dental prostheses, affecting both function and quality of life. Recognizing alveolar bone loss as an early systemic marker supports the integration of oral examinations into osteoporosis screening pathways within community health settings [16–18].

7. Diagnostic Approaches: BMD, Dental Radiography, and Periodontal Assessment

Dual-energy X-ray absorptiometry (DXA) remains the gold standard for diagnosing osteoporosis, yet dental imaging technologies provide valuable adjunctive insights. Panoramic radiographs and cone-beam computed tomography (CBCT) can reveal mandibular cortical erosion, trabecular pattern changes, and alveolar bone height reduction associated with systemic low bone density. Periodontal assessments further identify early disease indicators such as probing depth and attachment loss. The correlation between jawbone radiographic markers and DXA results suggests that dentists, in collaboration with community health nurses, can contribute to earlier detection of women at risk for osteoporosis. Integrating these diagnostic approaches strengthens interdisciplinary cooperation and enhances preventive care delivery [19–21].

8. Pharmacologic Management of Osteoporosis and Implications for Oral Health

Pharmacologic treatments for osteoporosis—including bisphosphonates, selective estrogen receptor modulators (SERMs), denosumab, and parathyroid hormone analogs—aim to prevent fractures by stabilizing or increasing BMD. However, these medications carry oral health implications, with antiresorptive agents potentially altering jawbone remodeling and delaying healing after dental surgery. SERMs provide bone protection while exerting fewer adverse oral effects, whereas denosumab effectively reduces fracture risk but requires careful perioperative dental planning due to rebound bone

turnover upon discontinuation. Understanding how these therapies interface with oral health is essential for community nurses who coordinate care and educate patients on potential risks associated with dental procedures during treatment [22–24].

9. Bisphosphonates and Medication-Related Osteonecrosis of the Jaw (MRONJ)

Bisphosphonates, widely prescribed for osteoporosis, can lead to MRONJ, a rare but serious condition characterized by exposed necrotic bone that fails to heal following minor trauma or dental surgery. Risk increases with intravenous formulations, prolonged treatment duration, and periodontal disease. Early identification of at-risk women through community health nursing programs can prevent complications by promoting routine oral examinations and pre-treatment dental clearance. Nurses also play a critical role in patient education regarding symptom recognition, oral hygiene, and timely referral, which can substantially reduce the severity and incidence of MRONJ [25–27].

10. Lifestyle, Nutrition, and Social Determinants Influencing Bone and Oral Health

Lifestyle factors—including calcium and vitamin D intake, smoking, alcohol consumption, and physical activity—significantly influence both skeletal and periodontal health. Poor diet quality and sedentary behaviors accelerate bone loss while increasing susceptibility to oral inflammation. Social determinants such as low income, limited access to dental care, and low health literacy further exacerbate risks, particularly among post-menopausal women. Community health nurses are uniquely positioned to address these determinants through targeted education, advocacy, and culturally tailored interventions. Integrating bone and oral health messages within broader women's health programs can improve prevention outcomes and reduce disparities [28–30].

11. Oral Health–Related Quality of Life in Menopausal Women

Oral health–related quality of life (OHRQoL) often declines during the menopausal transition due to the combined effects of periodontal deterioration, tooth mobility, xerostomia, and burning mouth symptoms. Women experiencing osteoporosis report greater functional limitations such as difficulty chewing, speaking discomfort, and reduced satisfaction with oral appearance. These challenges can negatively influence social interactions and nutritional habits, potentially exacerbating systemic bone loss. Studies highlight that even mild reductions in salivary flow significantly worsen OHRQoL scores in post-menopausal women. Addressing these symptoms through community-based oral and systemic health programs is essential for improving overall well-being in this population [31–33].

12. Preventive Oral Care Strategies Across the Menopausal Stages

Prevention is central to mitigating the oral consequences of menopause and osteoporosis. Strategies include reinforcing twice-daily brushing with fluoride toothpaste, regular periodontal examinations, professional cleanings, and the use of saliva substitutes or stimulants for xerostomia. Nutritional guidance, particularly adequate calcium, vitamin D, and protein intake, supports both oral and bone health. Community health nurses play a crucial role in reinforcing these behaviors, conducting community workshops, and identifying high-risk women for early referral. Tailoring interventions to cultural and socioeconomic contexts improves adherence and ensures equitable access to preventive care [34–36].

13. The Role of Community Health Nursing in Osteoporosis Screening

Community health nurses are essential in advancing osteoporosis screening among midlife women, particularly those with limited access to primary care. Nurses can administer fracture risk tools such as FRAX, conduct health education sessions, and refer at-risk individuals for DXA testing. Their close engagement with community members allows nurses to integrate oral health screening into osteoporosis initiatives, highlighting shared risk factors such as tobacco use, low physical activity, and nutritional deficiencies. This dual focus enhances the effectiveness of public health programs and ensures comprehensive care for pre- and post-menopausal women [37–39].

14. Community-Based Oral Health Promotion for Midlife and Older Women

Effective oral health promotion in community settings requires a multidimensional approach that merges education, preventive services, and interprofessional collaboration. Community health nurses facilitate group sessions on oral hygiene, organize screening events, and partner with local dental providers for

on-site checkups. These programs are particularly impactful in underserved communities where women face barriers to accessing dental care. By framing oral health within the broader context of healthy aging and osteoporosis prevention, community health nurses help women recognize the interconnected nature of their systemic and oral well-being [40–42].

15. Interdisciplinary Collaboration Between Dentists, Nurses, and Primary Care Providers

Optimal management of menopausal women requires coordinated care across medical and dental disciplines. Dentists contribute early detection of bone-related oral changes, while primary care clinicians oversee osteoporosis management and risk-factor modification. Community health nurses serve as the bridge, facilitating communication, coordinating referrals, and ensuring patient adherence to treatment plans. Collaborative care models have shown improved outcomes in periodontal health, fracture prevention, and medication safety monitoring (especially for bisphosphonates and denosumab). Strengthening these collaborative frameworks is essential for addressing the multifactorial needs of menopausal women [43–45].

16. Health Education Models for Improving Bone and Oral Health Behaviors

Behavior change theories, including the Health Belief Model and Social Cognitive Theory, provide effective frameworks for designing educational interventions targeting menopausal women. Community health nurses use these models to tailor messages that increase perceived susceptibility to osteoporosis and periodontal disease while enhancing self-efficacy for preventive behaviors. Group-based education programs have been shown to improve calcium intake, physical activity, and oral hygiene practices. Digital health tools such as mobile apps and tele-nursing platforms further expand opportunities for delivering targeted health messages to women who may be unable to attend in-person programs [46–48].

17. Barriers to Care and Access Inequities Among Menopausal Women

Many menopausal women face structural and socioeconomic barriers that limit their access to both dental and osteoporosis-related health services. Factors such as low income, limited insurance coverage, transportation challenges, and competing caregiving responsibilities often delay preventive care. Additionally, many women lack awareness of the relationship between bone density loss and oral disease, reducing their likelihood of seeking timely evaluation. Cultural norms and stigma surrounding aging may further discourage health-seeking behaviors. Community health nurses, who frequently serve marginalized populations, are instrumental in identifying these barriers, advocating for equitable service provision, and facilitating navigation through complex health systems [49–51].

18. Public Health Strategies and Population-Level Interventions

Public health approaches to menopausal bone and oral health involve broad strategies such as community-based screenings, policy development, health promotion campaigns, and integration of dental care into chronic disease prevention programs. National osteoporosis guidelines increasingly emphasize the importance of patient education and early risk detection, while oral health policies advocate for improved access to periodontal care in aging populations. Implementing population-level interventions—such as subsidized bone density scans, mobile dental units, and public awareness campaigns—can significantly reduce disease burden. Community health nurses play a vital role in operationalizing these strategies at the local level through outreach, data collection, and program evaluation [52–54].

19. Emerging Research on Menopause, Bone Metabolism, and Oral Microbiome

Recent studies highlight the interplay between menopause-related hormonal changes and shifts in the oral microbiome. Estrogen deficiency appears to influence microbial composition, increasing the prevalence of pathogenic species associated with periodontal disease. Concurrently, emerging biomarkers—such as salivary cytokines and bone turnover markers—show promise for early detection of osteoporosis and periodontal deterioration. Advances in imaging technologies, including high-resolution micro-CT for jawbone analysis, offer deeper insight into craniofacial bone remodeling. These developments underscore the need for interdisciplinary research exploring systemic–oral interactions

and their implications for community health interventions [55–57].

20. Implications for Community Health Nursing Practice and Future Directions

Community health nursing is uniquely positioned to address the intertwined challenges of osteoporosis and oral disease among menopausal women. Nurses can deliver integrated screening programs, lead culturally responsive education initiatives, promote lifestyle modifications, and facilitate collaboration between dental and medical providers. Future directions include developing standardized protocols for oral–systemic screening, expanding telehealth support for midlife women, and incorporating oral health indicators into national osteoporosis guidelines. Strengthening these practices will enhance early detection, reduce disease progression, and promote holistic well-being across the menopausal continuum. Continued research and policy support are essential to building sustainable, community-driven interventions that address the complex needs of this growing population [58–60].

Conclusion

Menopause represents a pivotal stage in a woman's life during which systemic hormonal changes profoundly influence both skeletal health and oral structures. The decline in estrogen not only accelerates bone resorption and increases susceptibility to osteoporosis but also contributes to significant oral manifestations, including periodontal breakdown, reduced alveolar bone density, xerostomia, and diminished oral health–related quality of life. The evidence presented across this review demonstrates that the relationship between osteoporosis and oral health is not merely associative but interconnected through shared biological pathways and common risk factors. This underscores the importance of adopting an integrative approach to women's health—one that views oral health as a critical component of chronic disease prevention rather than a separate entity.

Community health nursing emerges as a central mechanism for bridging systemic and oral health care. Nurses working within communities are uniquely positioned to identify at-risk women early, provide education about the implications of menopause for bone and oral health, facilitate screening for osteoporosis, and promote adherence to preventive oral care practices. Through interdisciplinary collaboration, community health nurses can strengthen communication between dentists, primary care providers, endocrinologists, and public health systems, creating a cohesive network of support for menopausal women. Their advocacy is especially vital for underserved populations who face barriers to accessing dental and medical services.

As public health systems increasingly emphasize holistic care, the integration of oral health into chronic disease frameworks is both timely and necessary. Future efforts should prioritize the development of nursing-led models that combine bone health assessments, oral health screenings, lifestyle counseling, and community-based education. Additionally, emerging research on the oral microbiome, salivary biomarkers, and advanced imaging technologies holds promise for improving early detection and tailoring interventions. By elevating awareness, strengthening interdisciplinary teamwork, and addressing social determinants of health, community health nursing can significantly reduce the burden of osteoporosis-related oral disease and improve the long-term well-being of pre- and post-menopausal women.

References

1. Greendale GA, Sowers M. The menopause transition and women's health at midlife. *Obstet Gynecol Clin North Am.* 2018;45(4):xz.
2. Gallagher JC. Effect of early menopause on bone mineral density and fractures. *Menopause.* 2007;14(3 Pt 2):567-571.
3. Wagner F, et al. Influence of estrogen deficiency on bone and periodontal tissues. *J Periodontal Res.* 2011;46(5):605-612.
4. Eastell R, O'Neill TW, Hofbauer LC, et al. Postmenopausal osteoporosis. *Nat Rev Dis Primers.* 2016;2:16069.
5. Raisz LG. Pathogenesis of osteoporosis: concepts, conflicts, and prospects. *J Clin Invest.* 2005;115(12):3318-3325.
6. Compston J, et al. Pathophysiology of osteoporosis. *Br Med Bull.* 2021;137(1):29-42.

7. Jonasson G, Rythén M. The mandibular cortex: a biomarker of osteoporosis. *Clin Oral Investig.* 2016;20(7):1709-1716.
8. Tezal M, et al. Alveolar bone loss and systemic bone density. *J Dent Res.* 2000;79(4): 707-713.
9. Devlin H, Horner K. Mandibular radiomorphometric indices in diagnosis of osteoporosis. *J Clin Densitom.* 2002;5(1):7-15.
10. Leimola-Virtanen R, et al. Salivary changes during menopause. *Gerodontology.* 1997;14(1):15-19.
11. Forabosco A, et al. Hormonal influences on oral mucosa. *Maturitas.* 2007;58(3):258-274.
12. Bergdahl M, et al. Oral dryness and menopausal symptoms. *J Dent Res.* 2000;79(7):1386-1392.
13. Payne JB, Reinhardt RA, Nummikoski PV, et al. Periodontal disease progression in postmenopausal women. *J Periodontol.* 1999;70(6):654-664.
14. Wactawski-Wende J. Periodontal diseases and osteoporosis: association and mechanisms. *Ann Periodontol.* 2001;6(1):197-208.
15. Brennan-Calanan RM, et al. Systemic bone density and periodontal disease. *Osteoporos Int.* 2008;19(11):1621–1630.
16. von Wowern N. Alveolar bone related to systemic osteoporosis. *Acta Odontol Scand.* 2001;59(4):241-248.
17. Hildebolt CF. Osteoporosis and oral bone loss. *Dentomaxillofac Radiol.* 2005;34(6):305-316.
18. Krall EA, et al. Tooth loss and bone density in older women. *J Dent Res.* 1997;76(7):1653-1659.
19. Kanis JA. Diagnosis of osteoporosis by DXA. *Osteoporos Int.* 1994;4(6):368-381.
20. Taguchi A, et al. Panoramic radiographs as screening tool for osteoporosis. *Bone.* 2008;43(2):209-213.
21. Ozdemir F, et al. CBCT evaluation of mandibular cortical bone in osteoporotic women. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2017;124(5):e211-e219.
22. Cummings SR, et al. Denosumab for fracture prevention in postmenopausal women. *N Engl J Med.* 2009;361(8):756-765.
23. Ettinger B, et al. SERMs and bone density outcomes. *JAMA.* 1999;282(7):637-645.
24. Cosman F, et al. Osteoporosis medication mechanisms and management. *J Bone Miner Res.* 2014;29(1):1-23.
25. Ruggiero SL, et al. Medication-related osteonecrosis of the jaw—AAOMS Position Paper. *J Oral Maxillofac Surg.* 2022;80(5):920-943.
26. Lo JC, et al. Oral bisphosphonates and osteonecrosis risk. *J Bone Miner Res.* 2010;25(12):298-305.
27. Khan AA, et al. International consensus definition of MRONJ. *Osteoporos Int.* 2015;26(12):289-287.
28. Weaver CM. Nutrition and bone health. *Public Health Nutr.* 2017;20(7):1095-1100.
29. Genco RJ, Borgnakke WS. Risk factors for periodontal disease. *Periodontol 2000.* 2013;62(1):59-94.
30. Adler RA. Lifestyle influences on osteoporosis. *Endocr Pract.* 2016;22(4):421-426.
31. Locker D. Measuring oral health–related quality of life. *Community Dent Health.* 1997;14(1):3-10.
32. Thomson WM, et al. Oral health and quality of life in older adults. *Gerodontology.* 2012;29(2):e110-e120.
33. Budtz-Jørgensen E. Oral function and menopause. *Maturitas.* 1995;22(3):221-227.
34. American Dental Association. Oral hygiene recommendations. ADA Guidelines; 2020.
35. Scardina GA, Messina P. Preventive dentistry in postmenopausal women. *Clin Interv Aging.* 2012;7:213-220.
36. Al Habashneh R, et al. Dental care strategies for menopausal women. *Int J Dent Hyg.* 2018;16(2):203-210.
37. Kanis JA, et al. FRAX fracture risk model. *Osteoporos Int.* 2008;19(4):385-397.
38. Looker AC, et al. Osteoporosis screening practices. *J Clin Endocrinol Metab.* 2017;102(3):773-783.
39. NAMS (North American Menopause Society). Osteoporosis and menopause position statement. *Menopause.* 2021;28(9):972-997.
40. Petersen PE. Community-based oral health programs. *Community Dent Oral Epidemiol.* 2005;33(2):81-92.
41. Watt RG, Sheiham A. Integrating oral health into public health. *Lancet.* 2012;380(9846):1215-1225.
42. Dye BA. Oral health in older women: public health perspectives. *Prev Chronic Dis.* 2017;14:E96.
43. Lamster IB, et al. Oral health and primary care integration. *JAMA.* 2018;320(6):549-550.
44. Niederman R, et al. Interprofessional collaboration in dental–medical care. *J Dent Res.* 2014;93(7 Suppl):s7-s12.
45. Licata AA. Coordinated care in osteoporosis management. *Cleve Clin J Med.* 2010;77(8):457-467.
46. Glanz K, Rimer BK, Viswanath K. *Health Behavior: Theory, Research, and Practice.* Jossey-Bass; 2015.
47. Bandura A. Social cognitive theory and health behavior. *Health Educ Behav.* 2004;31(2):143-164.

48. Zhao J, Freeman B, Li M. Digital health interventions and menopause education. *J Med Internet Res.* 2020;22(8):e17247.
49. Touger-Decker R, Mobley C. Social determinants and oral health. *JADA.* 2013;144(12):1285-1297.
50. Wallace S, et al. Barriers to dental care among older women. *Gerodontology.* 2021;38(1):45-53.
51. Garfield CF, et al. Inequities in women's access to health services. *Am J Public Health.* 2020;110(4):e1-e7.
52. WHO. Global strategy for women's health and healthy aging. World Health Organization; 2019.
53. NIH Osteoporosis and Related Bone Diseases National Resource Center. Osteoporosis prevention programs. NIH; 2020.
54. Centers for Disease Control and Prevention. Public health approaches to oral health. CDC; 2021.
55. Khosravi R, et al. Menopause and oral microbiome changes. *PLoS One.* 2014;9(11):e113012.
56. Garlet GP. Biomarkers in periodontal and bone disease. *J Dent Res.* 2010;89(12):1349-1363.
57. MacNeil RL, et al. Advances in craniofacial bone imaging. *Dent Clin North Am.* 2018;62(3):435-449.
58. Berman R, et al. Community nursing and chronic disease integration. *Public Health Nurs.* 2019;36(6):869-878.
59. Tabrizi JS, et al. Nursing roles in community-based chronic disease prevention. *BMC Nurs.* 2017;16:28.
60. Funnell MM, Anderson RM. Chronic disease management models and future directions. *Diabetes Care.* 2020;43(9):1982-1988.