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REVIEW

Disparities in Osteoporosis Prevention and Care: Understanding Gender, Racial, and Ethnic Dynamics

Naoko Onizuka[1,2] · Takeshi Onizuka[3]

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Abstract

Purpose Osteoporosis, the most prevalent metabolic bone disease, significantly impacts global public health by increasing fracture risks, particularly among post-menopausal women and the elderly. Osteoporosis is characterized by decreased bone mineral density (BMD) and deterioration of bone tissue, which leads to enhanced fragility. The disease is predominantly diagnosed using dual X-ray absorptiometry (DXA) and is significantly influenced by demographic factors such as age and hormonal changes. This chapter delves into the condition's complex nature, emphasizing the pervasive gender and racial disparities in its screening, diagnosis, and treatment.

Recent Findings Recent findings highlight a substantial gap in the management of osteoporosis, with many individuals remaining under-screened and under-treated. Factors contributing to this include the asymptomatic early stages of the disease, lack of awareness, economic barriers, and inconsistent screening practices, especially in under-resourced areas. These challenges are compounded by disparities that affect different genders and races unevenly, influencing both the prevalence of the disease and the likelihood of receiving adequate healthcare services.

Summary The summary of this chapter underscores the urgent need for targeted strategies to overcome these barriers and improve health equity in osteoporosis care. Proposed strategies include enhancing public and healthcare provider awareness of osteoporosis, broadening access to diagnostic screenings, and integrating personalized treatment approaches. These efforts aim to align with global health objectives to mitigate the impacts of osteoporosis and ensure equitable health outcomes across all demographic groups.

Keywords Osteoporosis · Gender differences · Racial disparities · Ethnic disparities · Osteoporosis screening and treatment · Healthcare inequality

Introduction

Osteoporosis, the most common metabolic bone disease, is characterized by decreased bone density and increased fracture risk, poses a significant public health challenge globally. Although osteoporosis affects diverse demographic groups, gender and racial disparities persist in its screening, diagnosis, and treatment [1, 2]. This review explores the multifaceted nature of these disparities, highlighting key factors contributing to differential outcomes and proposing strategies for achieving health equity in osteoporosis care.

Osteoporosis

Osteoporosis is a multifaceted systemic skeletal ailment. It involves reduced bone mineral density (BMD) and deterioration in the micro-architecture of bone tissue, resulting in heightened bone fragility [3]. Diagnosis typically relies on dual X-ray absorptiometry (DXA), which measures BMD. According to World Health Organization (WHO) standards, osteoporosis is identified by a T-score of -2.5 or lower, while osteopenia falls between -1.0 and -2.5 [4]. Evaluation often

✉ Naoko Onizuka
onizu002@umn.edu

Takeshi Onizuka
onizu001@umn.edu

[1] Department of Orthopaedic Surgery, University of Minnesota, Minneapolis, MN, USA

[2] TRIA Orthopedics Park Nicollet Methodist Hospital, St. Louis Park, MN, USA

[3] St. Luke's Hospital, Duluth, MN, USA

focuses on the femoral neck and lumbar spine. Age-related BMD decline contributes to primary osteoporosis, especially affecting post-menopausal women. Tools like the Fracture Risk Assessment Tool (FRAX) aid in predicting fracture risk by considering clinical factors and optional BMD measurements [5]. As populations age, osteoporosis and its associated fractures pose growing public health challenges and impose significant economic burdens on healthcare systems [6].

Screening Recommendations

Osteoporosis predominantly affects women, particularly those who are postmenopausal. Hormonal shifts during menopause accelerate bone loss, making women more susceptible to this condition [5]. WHO defines natural menopause as the absence of menstruation for at least 12 consecutive months, unrelated to physiological or pathological factors [7]. In industrialized nations, menopause typically occurs around age 51, compared to age 48 in developing countries [8]. As life expectancy increases, women now spend more than a third of their lives beyond menopause, making the prevalence of osteoporosis higher.

WHO recommends DXA screening for specific age groups and clinical risk factors as multiple studies show that drug therapies reduce fractures in patients with osteoporosis [9]. For women, DXA screening is recommended for those aged 65 and older or aged 50–64 with risk factors. Men aged 70 and older or aged 50–69 with risk factors should also undergo DXA screening. Additionally, anyone who has experienced a fracture after age 50 should be screened [10]. Risk factors include parental history of hip fracture, excessive alcohol consumption, smoking and low body weight [9]. Despite this, osteoporosis often remains under-screened, underdiagnosed, and undertreated until multiple fractures have occurred. Studies indicate that less than 25% of patients in the United States who are recommended for osteoporosis screening actually receive it [11]. Furthermore, more than 90% of patients do not receive DXA or start treatment for osteoporosis a year after experiencing a fragility fracture [12].

Several factors contribute to the under-screening, underdiagnosis, and under-treatment of osteoporosis. Often, the disease remains asymptomatic until a fracture occurs, which means it frequently goes unnoticed in its early stages. Additionally, there is a widespread lack of awareness about osteoporosis among both patients and healthcare providers, which undermines the perceived necessity of screening and understanding of associated risk factors. The guidelines for screening can be unclear, leading to inconsistent practices among healthcare professionals. Furthermore, osteoporosis is commonly perceived as a condition that primarily affects older individuals, which can cause younger at-risk populations to neglect necessary screenings and preventive measures. Economic barriers and limited accessibility further discourage individuals from undergoing bone density tests and adhering to treatment plans, particularly in under-resourced areas. The complexity of treatment options and fear of side effects also deter adherence to treatments. These challenges are further compounded by disparities related to gender, race, and ethnicity. This review will explore these disparities in greater detail, focusing on the differences in osteoporosis screening and care.

Gender Disparity in Osteoporosis Screening and Care

Although osteoporosis is commonly associated with postmenopausal women, it also affects men. A prevalence of osteoporosis in men is lower being about 12% worldwide, compared to 25–30% of women [13–15]. Secondary osteoporosis is more prevalent in men than women. The most prevalent causes for secondary osteoporosis include hypogonadism, excessive alcohol intake, and prolonged use of glucocorticoids [16]. Generally, men have larger and denser bones and experience less bone loss and less fractures over their lifetimes. In the United States, it is estimated that the annual incidence of hip fractures per 100,000 individuals ranges from 197 to 201 for men and 511 to 553 for women [17, 18]. Although men fracture less frequently than women, they have higher mortality rates following fractures [19]. For men, screening for osteoporosis using DXA is advised for those aged 70 and above, or earlier if there is a significant risk of fractures [20]. Unfortunately, men often have lower rates of screening, are therefore underdiagnosed, and receive undertreatment for the condition. For example, Lim et al. reported only 11% had undergone the screening among men aged 70 or over in the United States, and the majority of them were aged between 80 and 89 years [21]. Others reported only 8–16% of men with osteoporosis receive adequate treatment, compared to 27% of women received adequate treatment for osteoporosis even after a hip fracture [21–25].

Male patients often perceive themselves as being at lower risk of osteoporosis, and similarly, healthcare providers do not view them as high-risk candidates for the condition. Educating both patients and healthcare professionals is essential to increase awareness, mitigate biases, and promote sufficient screening and treatment practices.

Global Epidemiology and Race/Ethnic Disparities in Osteoporosis Prevalence and Fracture Risk

Globally, osteoporosis affects approximately 200 million females [13]. The prevalence of osteoporosis varies among different countries worldwide. A review encompassing 40

studies (31 from Asia, 5 from Europe, and 4 from America), with a combined sample size of 79,127 individuals aged between 50 and 85 years, indicated a worldwide prevalence of osteoporosis among the elderly at 21.7% (95% confidence interval: 18.8–25%). The prevalence of osteoporosis among older men was reported at 12.5%, while among older women, it stood at 35.3% [26]. After conducting subgroup analysis, it was found that the prevalence of osteoporosis in Asia, Europe, and the United States stood at 24.3%, 16.7%, and 11.5%, respectively, with Asia exhibiting the highest prevalence [26]. Wade et al. provided country-specific prevalence figures, with Japan exhibiting a prevalence of 26.3%, whereas rates in the Unites States, Germany, France, and Italy range from 9.7% to 21% [27]. Overall, the prevalence of osteoporosis is reported higher in developing countries (22.1%) than in developed countries (14.5%) [28]. The higher incidence of osteoporosis reported in developing countries compared to developed ones is influenced by multiple factors. One significant factor is the earlier age of menopause observed in developing nations [8]. Additionally, nutritional deficits, especially in calcium and vitamin D, are more prevalent in these regions due to limited access to varied and nutritious diets, which are vital for maintaining bone density and reducing osteoporosis risk [29]. The scarcity of healthcare resources also contributes to the underdiagnosis and undertreatment of osteoporosis during its initial stages [30]. Consequently, individuals in developing countries often have reduced access to osteoporosis screening and treatment, leading to more severe cases and a higher reported prevalence. Moreover, there is generally a lower level of awareness about osteoporosis, including its risk factors and prevention methods, which may lead to the neglect of bone health until serious complications or fractures arise. Lifestyle factors also significantly impact bone health; in some developing regions, there might be a lack of regular physical activity, which is crucial for bone strength, while in rural areas, excessive physical labor from a young age, combined with poor nutrition, can adversely affect bone health.

Variations in fracture risk across ethnic and regional groups are evident. Northern European countries such as Norway, Sweden, Iceland, and Ireland have the highest incidence of hip fractures [31]. For instance, the annual age-standardized incidence per 100,000 women is 574 in Denmark, 563 in Norway, 539 in Sweden, and 501 in Austria [31]. Following closely are Central European nations like Denmark, Belgium, Germany, Switzerland, and Austria, as well as Eastern European countries (Czech Republic, Slovakia, Hungary) and the Middle East (Oman, Iran). The lowest rates of hip fractures are found in Nigeria (2 per 100,000), South Africa (20), Tunisia (58), and Ecuador (73) [17, 31, 32]. Additionally, Argentina and Taiwan are noted as other high-risk areas. Asian nations such as Kuwait, Iran, China, and Hong Kong show moderate rates of hip fractures [17]. Globally, men have approximately half the risk of hip fractures compared to women.

These disparities underscore the complex interplay of biological, social, and environmental factors influencing osteoporosis and fracture risk worldwide.

Global Disparities in Osteoporosis Screening and Treatment

Differences in osteoporosis screening and treatment prevalence persist globally, reflecting varying access to healthcare, screening and treatment guidelines, disease awareness and perception, insurance systems, risk factors, and societal attitudes [33].

In developed countries with strong healthcare systems, the rates of screening and treatment for osteoporosis are generally higher compared to developing nations, where resources are more limited. Nevertheless, even in these advanced nations, the rates of screening and treatment remain lower than ideal. At a major hospital in Sweden, Axelsson and colleagues discovered that only 8% of patients underwent a DXA scan and merely 13% were prescribed osteoporosis medication within the year following a fragility fracture [34]. Countries where screening is publicly funded and accessible to all citizens tend to have more standardized access to osteoporosis screening [35]. Similarly, patients in countries with universal healthcare may have better access to DXA [36].

The screening and treatment rates are lower in developing countries with limited access to healthcare resources, however, literature data is scarce regarding the actual rate of osteoporosis screening and treatment in developing countries. Recent analyses have highlighted the shortcomings of healthcare systems in low- and middle-income countries [30]. In low- and middle-income countries, where healthcare resources are scarce and competing health priorities abound, osteoporosis screening may be overlooked, resulting in underdiagnosis and undertreatment of the condition. Limited access to bone density scanning technology, shortage of trained healthcare professionals, and inadequate public health infrastructure further exacerbate disparities in screening rates in these regions [37, 38].

Osteoporosis screening and treatment varies significantly between countries due to several factors, including the availability of treatments, healthcare systems, and economic conditions. It necessitates tailored approaches to overcome systemic barriers and ensure equitable access to care. Efforts to improve access to healthcare services, build capacity for osteoporosis screening in low-resource settings, and raise awareness about the importance of bone health are paramount. For example, CT scans is clinically feasible to assess osteoporosis and are relevant tool when DXA availability is limited [39, 40].

Epidemiology in the United States and Disparities in Osteoporosis and Fracture Risk among Different Race and Ethnic Group

In the United States, the age-adjusted prevalence of osteoporosis among adults aged 50 and over at either the femur neck or lumbar spine (or both) was reported as 12.6%, with women experiencing a significantly higher prevalence (19.6%) compared to men (4.4%) [41]. Notably, in 2017–2018, 27.1% of women aged 65 and above had osteoporosis, compared to 13.1% of women aged 50–64. Over the decade from 2007–2008 through 2017–2018, osteoporosis prevalence increased among women, with the overall age-adjusted prevalence among adults aged 50 and over rising from 9.4% to 12.6% [41].

In the United States, there is a variance in BMD among different races and ethnicities. Black adults exhibit higher BMD and lower osteoporosis rates compared to Hispanic, White, and Asian adults [42]. Information on BMD in Asian adults is conflicting, with some studies suggesting lower BMD and higher prevalence of osteoporosis, and others indicating similar BMD to White and Black adults [43–46]. BMD and the prevalence of osteoporosis among Hispanic have been reported to vary among studies with some showing higher, similar, or lower, compared to Whites [2].

Fracture rates vary by race and ethnicity as well. Caucasian women are at highest risk of fragility fracture. The United States sees the highest annual hip fracture rates among white women (140.7 per 100,000), followed by Asian women (85.4 per 100,000), Black women (57.3 per 100,000), and Hispanic women (49.7 per 100,000) [47]. Similarly, Bao et al. reported that individuals from other racial and ethnic groups in the United States demonstrated a notably reduced risk of fractures. When compared to white individuals as the reference group, black individuals had a pooled relative risk (RR) of 0.46 (95% confidence interval (CI): 0.43–0.48, $p < 0.0001$), Hispanic individuals had a pooled RR of 0.66 (95% CI: 0.55–0.79, $p < 0.0001$), and Asian Americans had a pooled RR of 0.55 (95% CI: 0.45–0.66, $p < 0.0001$) [48].

The variations in BMD and fracture rates across different racial and ethnic groups in the United States underscore the complex interplay of biological, social, and environmental factors influencing osteoporosis risk and fracture susceptibility within diverse populations.

The Disparities in Screening and Treatment among Different Race and Ethnic Group in the United States

The process of identifying and caring for osteoporosis patients starts with primary prevention, which involves screening asymptomatic individuals. Despite well-established clinical guidelines recommending DXA for screening and diagnosis, significant disparities persist, particularly among racial and ethnic minorities [49, 50]. Black, Hispanic, and Native American populations, among others, experience disproportionately lower rates of screening compared to White individuals. In a study which investigated if women had undergone the appropriate screening for osteoporosis recommended by the US Preventive Services Task Force, it was discovered that Black women were 40% less likely than their White counterparts to undergo an incident screening DXA [51]. Even after experiencing a hip fracture, Black women were also less inclined to undergo a DXA study [52]. Multiple studies indicate that Black women are less apt to receive treatment for osteoporosis compared to White women, both generally and even after experiencing a fragility fracture [53–55]. The National Osteoporosis Risk Assessment (NORA), a study focusing on osteoporosis in postmenopausal women, revealed a greater prevalence of undiagnosed osteoporosis among Black postmenopausal women compared to their White counterparts [56]. Similarly, referral rates for DXA screening among Hispanic women by primary care providers are lower compared to White women [52]. Hispanic men and women were discovered to have elevated rates of fragility fractures attributed to undiagnosed osteoporosis, particularly in comparison to their White counterparts [57]. Gyftopoulos et al. reported among Medicare beneficiaries, White individuals had the highest overall screening rate (17.5%), followed by North American Native (13.0%), Black (11.8%), and Hispanic (11.1%) individuals. Asian Americans exhibited notably lower DXA rates even after adjusting for years of Medicare eligibility, patient age, sex, location, and mean income ($p < 0.001$) [58].

It is worth noting a recent publication that delves into the inclusion of race or ethnicity in assessment algorithms. The FRAX tool is a globally utilized algorithm for estimating the 10-year risk of major osteoporotic fractures as well as the 10-year risk of a hip fracture specifically. It requires inputs such as age, gender, height, weight, and answers to seven clinical risk factor questions—covering previous fractures, a parental history of hip fractures, current smoking habits, long-term glucocorticoid use, rheumatoid arthritis, secondary osteoporosis, and daily alcohol intake of three or more units. FRAX is integral to clinical practice guidelines in various countries and is the most widely adopted fracture risk assessment tool worldwide. In the U.S., FRAX calculations necessitate the selection of one of four racial or ethnic categories: White, Black, Hispanic, or Asian [59–61]. Vyas et al. highlighted discrepancies in fracture risk estimation by the US FRAX calculator across various racial and ethnic groups of women. The study raised questions about whether these disparities contribute to delays in initiating osteoporosis therapy for minority groups [62]. However, the inclusion of self-designated rate in the use of FRAX USA is

considered to be crucial due to substantial evidence of differing fracture risks among these groups, even when bone mineral density (BMD) levels are similar [61]. Thus, utilizing FRAX calculator remains essential for healthcare providers to stratify patients based on fracture risk and optimize treatment allocation for those who stand to benefit the most.

Racial variations may influence the side effects of osteoporosis treatments. Research within a large healthcare system in northern California tracked 48,390 women (65.3% White, 17.1% Asian) who began bisphosphonate therapy over an average period of 7.7 years [63]. The study found that Asian women experienced atypical femur fractures (AFF) at a rate eight times higher than White women. This significant disparity could stem from differences in femur shape, medication adherence, and dosage levels. Notably, most participants received a standard dose of alendronate, typically 10 mg daily. However, in Japan, where a reduced dose of 5 mg daily is common for osteoporosis treatment, the incidence of AFF among Japanese patients aligns more closely with that of Whites. A deeper understanding of these racial disparities in treatment response could enhance the tailoring of osteoporosis therapies to individual needs.

The persistence of disparities in osteoporosis screening and treatment among racial and ethnic minorities underscores the urgent need for equitable healthcare practices. Despite established clinical guidelines recommending DXA screening, significant gaps remain, with Black, Hispanic, and Native American populations experiencing disproportionately lower rates of screening and treatment compared to their White counterparts.

Barriers to Osteoporosis Awareness and Screening and Addressing those Barriers

Despite advances in osteoporosis detection and treatment, underdiagnosis and undertreatment persist, particularly among men and individuals from minority communities. These disparities are multifactorial, stemming from structural inequities such as unequal access to healthcare, socioeconomic factors, biases, and cultural beliefs. Minority communities are more likely to experience barriers such as lack of health insurance, transportation issues, and linguistic and cultural barriers that hinder access to healthcare services, including osteoporosis screening and treatment. Moreover, cultural beliefs and perceptions surrounding health and illness can influence screening behavior within racial and ethnic minority groups. Misconceptions about osteoporosis, fear of diagnosis, fear of medication side effects, and distrust of the healthcare system may contribute to low screening and treatment rates in these communities. These disparities result in suboptimal screening rates, leading to undiagnosed osteoporosis and increased morbidity and mortality from fractures, especially among minority populations [64].

On the patient side, factors such as disease awareness, perception of risk, education levels, access to primary care physicians, and affordability of treatment all play significant roles. Additionally, barriers like language and cultural differences can hinder effective communication and access to care [65, 66]. Educating patients about osteoporosis should take into account factors like race, culture, language, and health literacy levels. Educational materials need to be linguistically accessible, easy to understand, and tailored to the educational and health literacy levels of patients. Visual aids such as graphs, charts, or videos can be particularly beneficial for those who are illiterate or have limited reading abilities. Additionally, men and people from minority groups often do not see themselves as being at risk for osteoporosis, which can result in less frequent screening, fewer diagnoses, and inadequate treatment. Socioeconomic status also significantly impacts access to preventive services and treatment options for osteoporosis [67]. Individuals from low-income backgrounds or lacking adequate health insurance may face challenges in affording bone density testing, prescription medications, and essential preventive measures like calcium and vitamin D supplementation. Additionally, disparities in accessing nutritious foods, safe exercise opportunities, and culturally competent healthcare providers contribute to divergent outcomes in bone health.

On providers side, biases, and language and cultural barriers can contribute to disparities in screening and treatment. Racial biases and assumptions about risk levels among patients of color, could affect patient engagement and shared decision-making, potentially leading to fewer discussions about osteoporosis screening, particularly among racial and ethnic minority patients.

Efforts to improve the quality of care must address these disparities. Community education and outreach efforts are vital for increasing awareness of osteoporosis among men and minority communities, facilitating appropriate screening and treatment. Initiatives such as community-based education programs, culturally tailored outreach initiatives, and collaborations with local organizations play a crucial role in disseminating accurate information and encouraging preventive behaviors. Additionally, healthcare providers must undergo training in culturally sensitive approaches to osteoporosis screening, diagnosis, and management to address cultural beliefs, language barriers, and mistrust of the healthcare system, thereby enhancing patient-provider communication and treatment adherence. Policymakers also have a pivotal role in tackling structural inequities contributing to osteoporosis disparities by implementing policies to expand access to affordable healthcare services,

reduce socioeconomic barriers to preventive care, and promote health equity in underserved communities. This can include initiatives like Medicaid expansion, reimbursement for osteoporosis screening and treatment, and incentives for healthcare providers to deliver culturally competent care.

Conclusion

Gender and racial disparities in osteoporosis prevention and care are complex and multifaceted, stemming from a combination of biological, social, and structural factors. By acknowledging the intersectionality of global and domestic disparities in osteoporosis screening, policymakers, healthcare professionals, and advocates can work collaboratively to implement effective strategies that ensure equitable access to screening services and ultimately reduce the burden of osteoporotic fractures among all populations, both within the United States and around the world.

Addressing these disparities requires a comprehensive approach that encompasses community education, provider training, and policy interventions aimed at achieving health equity. By prioritizing awareness, access, and cultural competence, we can work towards ensuring that all individuals, regardless of gender or race, receive equitable care for osteoporosis, ultimately reducing the burden of this debilitating condition on society.

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Declarations

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References

1. Anam AK, Insogna K. Update on osteoporosis screening and management. Med Clin N Am. 2021;105(6):1117–34.
2. Noel SE, Santos MP, Wright NC. Racial and ethnic disparities in bone health and outcomes in the United States. J Bone Miner Res. 2021;36(10):1881–905.
3. Sandhu SK, Hampson G. The pathogenesis, diagnosis, investigation and management of osteoporosis. J Clin Pathol. 2011;64:1042–50.
4. World Health Organisation. Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. Geneva: WHO; 1994.
5. Kanis JA, Johansson H, Harvey NC, McCloskey EV. A brief history of FRAX. Arch Osteoporos. 2018;13(1):118. **This article provides insights into the development and utilization of the FRAX tool, which is an algorithm used globally to evaluate fracture risk.**
6. Adami G, Fassio A, Gatti D, et al. Osteoporosis in 10 years time: a glimpse into the future of osteoporosis. Ther Adv Musculoskelet Dis. 2022;14:1759720X221083541.
7. World Health Organization. Research on the menopause in the 1990s (report of a WHO scientific group, WHO Technical Report Series, 886). Geneva: World Health Organization; 1996.
8. Sapre S, Thakur R. Lifestyle and dietary factors determine age at natural menopause. J Midlife Health. 2014;5(1):3–5.
9. US Preventive Services Task Force, Curry SJ, Krist AH, et al. Screening for Osteoporosis to Prevent Fractures: US Preventive Services Task Force Recommendation Statement. JAMA. 2018;319(24):2521–31. https://doi.org/10.1001/jama.2018.7498. **This reference is critical because it outlines the current recommendations for osteoporosis screening by the US Preventive Services Task Force**.
10. World Health Organization. WHO Scientific Group on the Assessment of Osteoporosis at Primary Health Care Level: Summary Meeting Report. World Health Organization; 2015.
11. Gillespie CW, Morin PE. Trends and disparities in osteoporosis screening among women in the United States, 2008–2014. Am J Med. 2017;130(3):306–16.
12. Barton DW, Behrend CJ, Carmouche JJ. Rates of osteoporosis screening and treatment following vertebral fracture. The Spine Journal. 2019;19(3):411–7.
13 Zamani M, Zamani V, Heidari B, Parsian H, Esmaeilnejad-Ganji SM. Prevalence of osteoporosis with the World Health Organization diagnostic criteria in the Eastern Mediterranean Region: a systematic review and meta-analysis. Arch Osteoporos. 2018;13(1):129.
14. Vilaca T, Eastell R, Schini M. Osteoporosis in men. Lancet Diabetes Endocrinol. 2022;10(4):273–83.
15 Salari N, Ghasemi H, Mohammadi L, et al. The global prevalence of osteoporosis in the world: a comprehensive systematic review and meta-analysis. J Orthop Surg Res. 2021;16(1):609.
16. Bandeira L, Silva BC, Bilezikian JP. Male osteoporosis. Arch Endocrinol Metab. 2022;66(5):739–47.
17. Dhanwal DK, Dennison EM, Harvey NC, Cooper C. Epidemiology of hip fracture: Worldwide geographic variation. Indian J Orthop. 2011;45(1):15–22.
18. Schuit SCE, van der Klift M, Weel AE, de Laet CEDH, Burger H, Seeman E, Hofman A, Uitterlinden AG, van Leeuwen JPTM, Pols HAP. Fracture incidence and association with bone mineral density in elderly men and women: the Rotterdam Study. Bone. 2004;34:195–202.
19 Guzon-Illescas O, Perez Fernandez E, CrespíVillarias N, et al. Mortality after osteoporotic hip fracture: incidence, trends, and associated factors. J Orthop Surg Res. 2019;14(1):203.
20. Watts NB, Adler RA, Bilezikian JP, Drake MT, Eastell R, Orwoll ES, et al. Osteoporosis in men: an Endocrine Society clinical practice guideline. J Clin Endocrinol Metab. 2012;97(6):1802–22.
21. Lim SY, Lim JH, Nguyen D, Okamura R, Amiri HM, Calmes M, Nugent K. Screening for osteoporosis in men aged 70 years and older in a primary care setting in the United States. Am J Mens Health. 2013;7:350–4.
22. Antonelli M, Einstadter D, Magrey M. Screening and treatment of osteoporosis after hip fracture: comparison of sex and race. J Clin Densitom. 2014;17:479–83.
23. Kiebzak GM, Beinart GA, Perser K, Ambrose CG, Siff SJ, Heggeness MH. Undertreatment of osteoporosis in men with hip fracture. Arch Intern Med. 2002;162:2217–22.

24. Feldstein AC, Nichols G, Orwoll E, Elmer PJ, Smith DH, Herson M, Aickin M. The near absence of osteoporosis treatment in older men with fractures. Osteoporos Int. 2005;16:953–62.
25. Harper CM, Fitzpatrick SK, Zurakowski D, Rozental TD. Distal radial fractures in older men. A missed opportunity? J Bone Joint Surg Am. 2014;96:1820–7.
26 Salari N, Darvishi N, Bartina Y, et al. Global prevalence of osteoporosis among the world older adults: a comprehensive systematic review and meta-analysis. J Orthop Surg Res. 2021;16(1):669.
27. Wade SW, Strader C, Fitzpatrick LA, Anthony MS, O'Malley CD. Estimating prevalence of osteoporosis: examples from industrialized countries. Arch Osteoporos. 2014;9:182.
28. Xiao PL, Cui AY, Hsu CJ, et al. Global, regional prevalence, and risk factors of osteoporosis according to the World Health Organization diagnostic criteria: a systematic review and meta-analysis. Osteoporos Int. 2022;33:2137–53.
29. Kiani AK, Dhuli K, Donato K, et al. Main nutritional deficiencies. J Prev Med Hyg. 2022;63(2):E93–101. https://doi.org/10.15167/2421-4248/jpmh2022.63.2S3.2752.
30. Mills A. Health care systems in low- and middle-income countries. N Engl J Med. 2014;370(6):552–7. https://doi.org/10.1056/NEJMra1110897.
31. Kanis JA, Odén A, McCloskey EV, Johansson H, Wahl DA, Cooper C. A systematic review of hip fracture incidence and probability of fracture worldwide. Osteoporos Int. 2012;23(9):2239–56. **This article investigated marked variations in hip fracture rate worldwide**.
32. Brennan-Olsen SL, Zengin A, Duckham RL, Hosking SM, Talevski J, Hyde NK. Differences in fracture risk between countries, within countries and between social and ethnic groups. In: Miszkiewicz J, Brennan-Olsen S, Riancho J, editors. Bone health. Singapore: Springer; 2019.
33 Verdonck C, Willems R, Liesbeth B. Osteoporosis care through an Integrated, People-Centred Health Services framework lens: a hybrid qualitative analysis of international patient experiences. BMJ Open. 2023;13(6):e072031.
34. Axelsson KF, Jacobsson R, Lund D, Lorentzon M. Effectiveness of a minimal resource fracture liaison service. Osteoporos Int. 2016;27:3165–75.
35. Kanis JA, Norton N, Harvey NC, et al. SCOPE 2021: a new scorecard for osteoporosis in Europe. Arch Osteoporos. 2021;16(1):82.
36 Kikuchi S, Suda Y. Admission screening form and osteoporosis educational appointment: a novel fracture liaison service system for identifying osteoporosis patients and facilitating medication initiation. Arch Osteoporos. 2023;18(1):117. https://doi.org/10.1007/s11657-023-01326-7.
37 Chavda S, Chavda B, Dube R. Osteoporosis screening and fracture risk assessment tool: its scope and role in general clinical practice. Cureus. 2022;14(7):e26518.
38. Erlangga D, Suhrcke M, Ali S, Bloor K. The impact of public health insurance on health care utilisation, financial protection and health status in low- and middle-income countries: A systematic review [published correction appears in PLoS One]. 2019;14(11):e0225237.
39 Siwela L, Khan N, Mudau A. A radiological assessment of the prevalence of osteoporosis in male patients seen in a South African Hospital: a retrospective analysis. J Osteoporos. 2022;2022:1238927. https://doi.org/10.1155/2022/1238927.
40. Smith AD. Screening of bone density at CT: an overlooked opportunity. Radiology. 2019;291(2):368–9. https://doi.org/10.1148/radiol.2019190434.
41. Sarafrazi N, Wambogo EA, Shepherd JA. Osteoporosis or low bone mass in older adults: United States, 2017–2018. NCHS Data Brief. 2021;405:1–8.
42. Looker AC, Melton LJ 3rd, Borrud LG, Shepherd JA. Lumbar spine bone mineral density in US adults: demographic patterns and relationship with femur neck skeletal status. Osteoporos Int. 2012;23(4):1351–60.
43. Lo JC, Chandra M, Lee C, Darbinian JA, Ramaswamy M, Ettinger B. Bone mineral density in older U.S. Filipino, Chinese, Japanese, and White women. J Am Geriatr Soc. 2020;68(11):2656–61.
44. Looker AC, SarafraziIsfahani N, Fan B, Shepherd JA. Trends in osteoporosis and low bone mass in older US adults, 2005–2006 through 2013–2014. Osteoporos Int. 2017;28(6):1979–88.
45. Barrett-Connor E, Siris ES, Wehren LE, et al. Osteoporosis and fracture risk in women of different ethnic groups. J Bone Miner Res. 2005;20(2):185–94.
46. Danielson ME, Beck TJ, Lian Y, et al. Ethnic variability in bone geometry as assessed by hip structure analysis: findings from the hip strength across the menopausal transition study. J Bone Miner Res. 2013;28(4):771–9.
47. Silverman SL, Madison RE. Decreased incidence of hip fracture in Hispanics, Asians, and blacks: California Hospital Discharge Data. Am J Public Health. 1988;78:1482–3.
48 Bao Y, Xu Y, Li Z, Wu Q. Racial and ethnic difference in the risk of fractures in the United States: a systematic review and meta-analysis. Sci Rep. 2023;13(1):9481. **The study highlights disparities in bone health across different demographic groups**.
49. Curry SJK, Krist AH, Owens DK, et al. Screening for osteoporosis to prevent fractures: US preventive services Task Force recommendation statement. J Am Med Assoc. 2018;319(24):2521–31.
50. Morin SN, Berger C, Papaioannou A, et al. Race/ethnic differences in the prevalence of osteoporosis, falls and fractures: a cross-sectional analysis of the Canadian Longitudinal Study on Aging. Osteoporos Int. 2022;33(12):2637–48.
51. Amarnath AL, Franks P, Robbins JA, Xing G, Fenton JJ. Underuse and overuse of osteoporosis screening in a regional health system: a retrospective cohort study. J Gen Intern Med. 2015;30:1733–40.
52. Neuner JM, Zhang X, Sparapani R, Laud PW, Nattinger AB. Racial and socioeconomic disparities in bone density testing before and after hip fracture. J Gen Intern Med. 2007;22(9):1239–45. **The study highlights disparities in bone health across different demographic groups**.
53. Curtis JR, McClure LA, Delzell E, et al. Population-based fracture risk assessment and osteoporosis treatment disparities by race and gender. J Gen Intern Med. 2009;24(8):956–62.
54. Sattari M, Cauley JA, Garvan C, et al. Osteoporosis in the women's health initiative: another treatment gap? Am J Med. 2017;130(8):937–48.
55. Liu SK, Munson JC, Bell JE, et al. Quality of osteoporosis care of older Medicare recipients with fragility fractures: 2006 to 2010. J Am Geriatr Soc. 2013;61(11):1855–62.
56. Siris ES, Brenneman SK, Barrett-Connor E, et al. The effect of age and bone mineral density on the absolute, excess, and relative risk of fracture in postmenopausal women aged 50–99: results from the National Osteoporosis Risk Assessment (NORA). Osteoporos Int. 2006;17(4):565–74.
57. Leslie WD. Clinical review: Ethnic differences in bone mass–clinical implications. J Clin Endocrinol Metab. 2012;97(12):4329–40.
58. Gyftopoulos S, Pelzl CE, Da Silva Cardoso M, Xie J, Kwon SC, Chang CY. Bone density screening rates among medicare beneficiaries: an analysis with a focus on Asian Americans. Skeletal Radiol. 2024. https://doi.org/10.1007/s00256-024-04643-1.
59. Lewiecki EM, Erb SF. Racial disparities and inequalities in the management of patients with osteoporosis. Orthop Nurs. 2022;41(2):125–34. https://doi.org/10.1097/NOR.0000000000000832.
60. Kanis JA, on behalf of the World Health Organization Scientific Group (2007) Assessment of osteoporosis at the primary healthcare level. Technical Report. World Health Organization Collaborating Centre for Metabolic Bone Diseases, University of Sheffield, UK, Published at Sheffield, UK.

61. Lewiecki EM, Wright NC, Singer AJ. Racial disparities, FRAX, and the care of patients with osteoporosis. Osteoporos Int. 2020;31(11):2069–71.
62. Vyas DA, Eisenstein LG, Jones DS. Hidden in plain sight — reconsidering the use of race correction in clinical algorithms. N Engl J Med. 2020;383:874–82.
63. Lo JC, Hui RL, Grimsrud CD, et al. The association of race/ethnicity and risk of atypical femur fracture among older women receiving oral bisphosphonate therapy. Bone. 2016;85:142–7. https://doi.org/10.1016/j.bone.2016.01.002.
64. Penrod JD, Litke A, Hawkes WG, et al. The association of race, gender, and comorbidity with mortality and function after hip fracture. J Gerontol A Biol Sci Med Sci. 2008;63(8):867–72.
65. Hamrick I, Cao Q, Agbafe-Mosley D, Cummings DM. Osteoporosis healthcare disparities in postmenopausal women. J Womens Health (Larchmt). 2012;21(12):1232–6.
66. Kling JM, Clarke BL, Sandhu NP. Osteoporosis prevention, screening, and treatment: a review. J Women's Health. 2014;23(7):563–72.
67. Gough Courtney M, Roberts J, Godde K. Structural inequity and socioeconomic status link to osteoporosis diagnosis in a population-based cohort of middle-older-age Americans. Inquiry. 2023;60:469580231155719.