



## Osteoporosis: A Silent Disease Underdiagnosed

Bruce E Heck<sup>1,2</sup>, Serena Maag<sup>3</sup>, Holly C Heck<sup>4</sup>, Bryce Pember<sup>5</sup>, Connor Spera<sup>5\*</sup>, Steven Franks<sup>6</sup>, Vanessa C Heck<sup>7</sup> and Dong Hyun Kim<sup>1,8</sup>

<sup>1</sup>Northwest Ohio Orthopedics and Sports Medicine, Findlay, OH, USA

<sup>2</sup>Department of Orthopedics, University of Toledo Medical Center, Toledo, OH, USA

<sup>3</sup>University of Toledo College of Medicine, Toledo, OH, USA

<sup>4</sup>College of Natural Science and Mathematics, University of Toledo, Toledo, OH, USA

<sup>5</sup>Northeast Ohio Medical University, Rootstown, OH, USA

<sup>6</sup>College of Arts and Sciences, Bowling Green State University, Bowling Green, OH, USA

<sup>7</sup>College of Health and Human Services, University of Toledo, Toledo, OH, USA

<sup>8</sup>Department of Pediatric Hematology/Oncology, Samsung Medical Center,

Sungkyunkwan University School of Medicine, Korea

\*Corresponding Author: Connor Spera, Northeast Ohio Medical University, Rootstown, OH, USA.

Received: October 28, 2024

Published: November 18, 2024

© All rights are reserved by Bedjaoui Hind., et al.

### Abstract

**Purpose/Objective:** Osteoporosis is a diagnostic and treatment dilemma because it is a silent disease to the patient or physician until a fragility fracture occurs. Once osteoporotic fracture occurs osteoporosis becomes a silent killer if not recognized and treated, as many patients will develop additional fractures that lead to increased cost to the healthcare system, morbidity, and mortality. Osteoporosis is a diagnostic dilemma because even after an osteoporotic fracture occurs the diagnosis and treatment remain alarmingly low with decreasing rates of treatment over the years. Rural settings with decreased access to healthcare and specialists as well as multiple co-morbidities these patients have in addition to their age, frailty, difficulty mobilizing, and complications occurring with a hip fracture make diagnosis and treatment even more difficult in rural outpatient clinics. Osteoporosis is a complex disease with many underlying etiologies and requires a team approach with multiple specialists including primary care physicians, endocrinologists, rheumatologists, gastroenterologists, orthopedic surgeons, and other specialists to treat. Although these specialties are often absent in a rural setting, if needed, referral can be made to a tertiary care setting once treatment is initiated, as it often takes months for access.

**Methods:** A retrospective study was performed using a single orthopedic practice cohort of all hip fractures from fall-from-standing-height treated by surgeons of the group from 2013-2022 from 4 rural hospitals. Treatment initiation rates in a rural setting of patients with hip fractures despite primary care requesting to diagnose and treat for osteoporosis remained very low.

**Results:** Initiation treatment rates for osteoporotic hip fractures were low (3.8%) despite primary care requesting to treat these individuals. Treatment rate doubled when the patient was given the diagnosis of osteoporosis and nearly tripled when dual x-ray absorptiometry (DXA) was ordered.

**Conclusions:** Initiation and individualization of treatment for osteoporosis were twice as likely when the patient was labeled with osteoporosis in the medical record and nearly tripled when the diagnosis was substantiated by dual x-ray absorptiometry (DXA) which also served as a baseline reference for treatment.

Our team has already implemented changes collaborating with health systems and entering a co-management with 2 of the 4 hospitals that expressed interest in our region to ensure every hip fracture over the age of 50 from a fall-from-standing-height receives a diagnosis and treatment at the time of hospital admission for osteoporotic hip fractures. Future studies will compare rates of diagnosis and treatment with this team-based hospital system approach.

**Level of Evidence:** Level III.

**Keywords:** Dual X-Ray Absorptiometry (DXA); Osteoporosis; Mortality

## Introduction

Osteoporosis is a diagnostic and treatment dilemma for physicians as it is a silent disease often ongoing for years until a fragility fracture occurs. Osteoporosis is a disease resulting in significant bone loss and reduced strength. Osteoporosis has no clinical manifestations until there is a fracture and affects people all over the world [12,21]. According to the International Osteoporosis Foundation, 1 in 3 women and 1 in 5 men will experience an osteoporotic fracture in their lifetime worldwide. All osteoporotic fractures increase morbidity, the risk of another fracture, and mortality [16]. The mortality rate for hip fractures is highest in the first year after hip fracture, ranging from 20-40% [10]. Hip fractures are the most serious outcome of osteoporosis, and the frequency of hip fractures is increasing by 1-3% per year in most areas of the world [5]. Early diagnosis and treatment after the initial presenting osteoporotic fracture is of paramount importance to minimize cost to the healthcare system, additional fractures, complications, and death.

Osteoporosis is a diagnostic and treatment dilemma not only because it is silent before a fracture occurs, but even after an osteoporotic fracture occurs, many of these patients are not diagnosed. Medical providers, especially in rural communities with limited resources and subspecialists, are often focused on treating the more acute comorbidities [17] these patients have, but also the multiple complications that occur with the incident fracture such as constipation, stroke, and pneumonia [15]. David, *et al.* [6] found that the prevalence of osteoporosis was not only increased with comorbidities, but the osteoporosis severity was increased by confounding comorbid conditions with autoimmune diseases, such as inflammatory bowel and joint diseases with or without glucocorticoid therapy, breast cancer, prostate cancer with chemotherapy or hormone therapy, diabetes (chiefly type 1), and celiac disease. A prospective cohort study by Ensurd, *et al.* [8] found women over 80 have a 5-year hip fracture probability that is over 3-fold higher among women with osteoporosis, especially in women with a greater number of comorbidities or poorer prognosis, compared to women without osteoporosis but at high fracture risk. More comorbidities increase the likelihood of osteoporotic hip fracture and death [8] and hence it is especially important to diagnose these patients when presenting with an osteoporotic fracture.

Although osteoporosis can be diagnosed based on low trauma hip fracture regardless of BMD [20], it is our opinion that in a rural

setting, initiation and individualization of treatment will be more likely if additional workup with BMD testing, preferably dual x-ray absorptiometry (DXA), is performed which also serves as a baseline reference for treatment. We recommend a more aggressive, team approach to the diagnostic and treatment dilemma of osteoporotic hip fractures with the ordering of a DXA while the patient is hospitalized so the clinician can review results, initiate appropriate treatment, and monitoring from baseline can begin.

## Methods

A retrospective study was performed using a single orthopedic practice cohort of all hip fractures from fall-from-standing-height treated by surgeons of the group from 2013-2022. A retrospective cohort of 801 patients was retrieved through Athenahealth electronic health record software (Watertown, MA, USA) with the following filters applied to the analytics report: active visit (not canceled or voided), service date equal or greater than 01/01/2013, and current procedural terminology code 27230, 27232, 27235, 27236, 27238, 27240, 27244, 27245, 27246, 27248, 27254, 27267, 27268, 27269. Locations of care included four rural hospitals in Northwest Ohio. The records analyzed were limited to include hip fractures with fall-from-standing-height to capture postmenopausal women and men at risk due to age and secondary osteoporosis. Records matching these terms were analyzed to determine the percentage of the patient population that had been diagnosed with either osteopenia or osteoporosis along with the percentage that was receiving treatment for the diagnosis of osteopenia or osteoporosis within 1 year of fracture or until death. Both patients with prior use of osteoporosis medications before hip fracture and those never treated for osteopenia or osteoporosis were included. Both hospital records and office records were reviewed to minimize missing data. Although we meticulously searched through local hospital and office records as well as asked patients if they had a bone density during their follow-up, it is possible that a diagnosis or bone density was performed at an outlying hospital or facility, and we did not receive the results and/or the patient did not recall (recall bias).

Patients already diagnosed or treated for osteopenia or osteoporosis were subtracted from the total hip fracture cohort to determine rates of new diagnosis and treatment for the population. The institutional review board of Northwest Ohio Orthopedics and Sports Medicine approved this study protocol and review. Patient

consent was waived because the data used in this study were fully.

**Results**

An age-specific search of all hip fractures between 2013-2022 established a retrospective cohort of 801 patients with fall-from-standing-height, 585 of which were women and 216 were men. The patient’s age when the hip fracture occurred ranged from 50 to 102 years old. The average age of the patient was 79 years old. The number of patients with greater than 3 comorbidities was

Variables	Number of Patients
Gender	
Male	216
Female	585
Age	
<75	226
75-85	319
>85	256
Number of comorbidities	
<3	152
≥3	649

**Table 1:** Demographics Associated with Hip Fracture.

over 80%, indicating a complicated patient population (Table 1).

70 of the 801 (8.7%) patients had a preexisting diagnosis of osteoporosis/osteopenia prior to hip fracture. Only 28/731 (3.8%) of at-risk patients had a diagnosis of osteoporosis after hip fracture in a rural setting where the primary care physicians requested to diagnose and treat for osteoporosis. Although only 189/731(25.9%) of at-risk patients with osteoporotic hip fracture were treated, once diagnosed with osteoporosis 15/28 (53.5%) of patients with a hip fracture were treated. The initiation percentage of treatment increased to 6/9(66.7%) when the DXA was obtained (Table 2). 189/731 (26%) of patients were treated with an anti-resorptive (bisphosphonate or RANKL inhibitor, calcitriol (Validus Pharmaceuticals, Parsippany, NJ, USA), or supplements (Vitamin D or calcium). No patients were treated with an anabolic bone-forming medication [teriparatide (Eli Lilly and Company, Indianapolis, Indiana, USA), abaloparatide (Radius Health, Inc, Boston, MA, USA), or romosozumab (Amgen, Inc, Thousand Oaks, CA, USA)].

**Discussion**

A retrospective study of hip fractures in rural communities of Northwest Ohio in four rural hospitals revealed the rates of diagnosed and treated osteopenia/osteoporosis in patients with hip fractures after fall-from-standing-height pre- and post-hip frac-

Timing and Method of Diagnosis of Osteopenia/Osteoporosis	Count of Patients Diagnosed with Disease	% of Fractures with Diagnosis After Hip Fracture	Count of Treated Patients	% of Fractures Treated After Hip Fracture
Diagnosis Before Fracture	70	N/A	50	N/A
Diagnosis After Fracture	28	3.8% (28/731)	15	53.6% (15/28)
Clinical	19	2.6% (19/731)	9	47.4% (9/19)
DXA	9	1.2% (9/731)	6	66.7% (6/9)
No Diagnosis After Fracture	703	N/A	174	24.8% (174/703)
Total	98	3.8%	238	25.9% (189/731)

**Table 2:** Percentage of Diagnosis and Treatment of Hip Fracture Cohort.

ture. The results show that 8.7% of patients were being actively treated for their osteopenia/osteoporosis at the time of hip fracture and only 3.8% of patients were diagnosed with osteopenia or osteoporosis post hip fracture within 1 year or until death.

Our results are supported by numerous other studies indicating that osteoporosis has a low diagnosis and an even lower treatment rate. One such study completed by Gleason., *et al.* [9] found that 40% of their high-risk cohort of 1070 patients had been diagnosed with osteoporosis before their hip fracture occurred. Of the 40% diagnosed with osteoporosis, only 27.4% had been taking calcium and vitamin D supplementation prior to their fracture, and only

11% were taking osteoporosis medications like bisphosphonates, SERMs, calcitonin, and teriparatide [9]. In another study conducted by Naik-Panvelkar., *et al.* [23] a diagnosis of osteoporosis was recorded in 12.4% of patients over 50, but almost a quarter of that population was not prescribed medication. In our study, 8.7% of patients were diagnosed with osteopenia or osteoporosis prior to fracture with only 6.24% receiving some form of treatment (calcium, vitamin D, or osteoporosis medications). None of the patients in our study received an anabolic agent (teriparatide, abaloparatide, romosozumab). Perhaps, the even lower rates of patients being treated for osteoporosis prior to hip fractures were due to a

rural location with only the primary care physician overseeing diagnosis and treatment versus the larger community teaching hospitals affiliated with a university medical center in Gleason's study.

While diagnosis rates were low pre-fracture, they remained low post-fracture. Hooven., *et al.* [11] came to this same conclusion in their study. They observed a 7% increase in the number of patients diagnosed with osteoporosis post-hip or wrist fracture, but that percentage was still only 29% of the total cohort. A similar pattern was observed in the treatment post-fracture with an 8% increase in prescriptions for osteoporosis medication or recommended calcium and vitamin D supplementation, but that percentage was still only 60% of the total cohort [11]. Preventative treatment with calcium and vitamin D plays a large role in decreasing fracture risk [3], therefore increasing supplementation numbers alone could help decrease the personal and economic burden of hip fractures on the aging population. Our findings are alarming and consistent with declining rates of diagnosis and treatment as reported by Desai., *et al.* [7]. In a large US population, previously untreated patients with a hip fracture had rates of effective drug treatment in the first 180 days (about 6 months) following hip fracture decline from 9.8% in 2004 to 3.3% in 2015. Unfortunately, this finding of 3.3% in 2015 from Desai's study is similar to the low rates of diagnosis and effective treatment in previously untreated patients after hip fracture in our rural population [2.1% (15/731)].

There are many potential explanations for why diagnosis and treatment rates are low both pre- and post-fracture. One such explanation is a lack of awareness surrounding osteoporosis in the patient population. In a survey conducted by Lewiecki., *et al.* [14], they found that 35% of postmenopausal women with an osteoporotic fracture had no idea that osteoporosis could be the cause of their fracture before a physician made them aware. As far as treatment goes, there's still a shocking lack of awareness surrounding treatment options for osteoporosis. In that same survey of postmenopausal women, 24% of them thought that new bone could not be built at their age, and 21% believed that nothing could be done to reduce the risk of fracture at their age [14]. However, the blame cannot be solely placed on the patient's lack of education surrounding osteoporosis as some of that responsibility falls on their physician. When surveyed, only 61% of at-risk postmenopausal women reported that their physician was the one who brought up the topic of osteoporosis [14]. As much as this percentage needs to improve to 100%, talking about osteoporosis is not enough as osteoporosis needs to be properly diagnosed through BMD [19], fragility fracture [20], or FRAX [20] and then treated. Of the women surveyed with self-reported osteoporosis, 50% of them said they were never given a prescription for osteoporosis medica-

tion [14]. In a study by De Martinis., *et al.* [26], they observed their patient population in an outpatient service for the diagnosis of osteoporosis over three years. They found that men only made up only 5.4% of their patient population. This shows an underdiagnosis in men, despite secondary osteoporosis being more prevalent in men. Osteoporosis is a silent disease and often goes unrecognized until a fragility fracture occurs. In our patient population, only 8.7% of patients were being treated for the diagnosis of osteopenia or osteoporosis at the time of hip fracture. Because of the indolent nature of the disease until a fracture occurs, many patients and their physicians are simply not thinking about osteoporosis, and future efforts surrounding osteoporosis need to be done by both patients and physicians in awareness, diagnoses and treatment-based follow-through. This will cause a lower mortality rate. This is supported by Ramachandran., *et al.* [25] showing a hazard risk ratio of 0.57 for lower hazard of all-cause mortality in patients who have received testing and/or treatment for osteoporosis.

Another explanation for why diagnosis and treatment rates for osteoporosis are low could be due to limitations on a physician level. Particularly in rural settings, access to healthcare is more difficult. There are fewer physicians and medical providers which leads to less time available to spend with a patient. Also complicating the situation is the fact that patients with underlying osteoporosis have multiple comorbidities, often which take precedence at the time of a visit such as coronary heart disease, heart failure, hypertension, diabetes [17], and cognitive impairment [4] which is associated with worse outcomes following hip fracture. To support this theory, a study conducted by Choski., *et al.* [24] in which 359 physicians completed a survey about barriers for the diagnosis of osteoporosis, 45% of the physicians indicated that osteoporosis was low on their priority list. Bauer states that although there is a clear clinical mandate to treat individuals with a history of hip fracture (regardless of bone mass measurements), early reports of low rates of treatment were disappointing but perhaps understandable given the comorbidities and frailty that often accompany a hip fracture [2]. Unfortunately, it is increasingly clear that having a hip fracture alone is not enough to have high initiation treatment rates for osteoporosis, and perhaps having a DXA ordered at the time of admission for a hip fracture will provide objective testing for the diagnosis of osteoporosis associated with hip fracture and initiate treatment. In our study, initiation treatment rates were highest when the patient was labeled in the medical record with the diagnosis of osteoporosis and a DXA was ordered.

Despite that primary care medical doctors were engaged and actively requesting to diagnose, treat, and evaluate their patients

for osteoporosis, only 3.8% of patients with a hip fracture were diagnosed with osteopenia or osteoporosis. This number is below the reported prevalence rates of osteoporosis in men (4.2%) and women (18.8%) greater than 50 years old in 2017-2018 [18] and is even lower than reported estimated prevalence rates of osteoporosis in the general population aged 50 years and older in the United States which was 10% in 2010 [22] to 12% in 2018 [18], suggesting underdiagnosis. Medical complications following hip fractures are numerous, these extenuating conditions such as constipation, stroke, and pneumonia [15] strain the time spent by the medical provider which also limits discussion and diagnosis making it difficult for patients to get further workup and treatment in the perioperative period. Also, medical care for the patient while hospitalized is often by the hospitalist and not the primary care physician, which also delays the start of treatment if the primary care physician is requesting to diagnose and treat for the condition. Although not directly relevant to our study, as primary care physicians request to diagnose and treat for osteoporosis in our region, in a survey of orthopedic surgeons, roughly 90% of them believed osteoporosis care was very important and the other 10% believed it was moderately important. However, when faced with a minimal trauma fracture, over 35% of orthopedic surgeons surveyed never order a DXA scan, 20% never order a vitamin D level test, roughly 70% never prescribe osteoporosis medications, and 20% never refer the patient for osteoporosis assessment [1]. Why is there such an astounding lack of treatment despite an overwhelming awareness of the seriousness of osteoporosis? A couple of reasons endorsed by the surveyed physicians included a lack of experience with osteoporosis medications, and therefore increased hesitation to prescribe a medication they're not familiar enough with, along with most physicians only feeling moderately responsible for initiating osteoporosis care [1]. Certainly, a team approach with DXA measurement increases the likelihood of treatment. In one study by Khan *et al*, an ortho-geriatric team increased rates of treatment to 89% within 3 months of discharge from hip fracture [13].

Our team has already implemented changes collaborating with health systems and entering a co-management with two of the four hospitals that have expressed interest in our region to ensure every hip fracture occurring in patients 50 years of age and older from fall-from-standing-height receive a DXA at the time of hospital admission for timely diagnosis, treatment, and baseline for follow up evaluation of treatment for osteoporotic hip fractures. Unfortunately, one of the four hospitals not participating, does not have DXA available in the hospital and has the studies performed

at an outpatient setting miles away, which is not feasible or practical to transfer a patient recovering from major hip fracture surgery. This factor also likely contributed to the low rates of diagnosis and treatment in our study.

## Conclusion

Based on prevalence, economic burden, physical burden, and literature to date, osteoporosis is an increasingly important disease needing more awareness and treatment to decrease the rate of complications including osteoporotic fracture and mortality. Osteoporosis is a complex disease with many underlying diseases and requires a team approach with multiple specialists including primary care physicians, endocrinologists, rheumatologists, gastroenterologists, orthopedic surgeons, and other specialists to treat. Although osteoporosis can be diagnosed based on low trauma hip fracture regardless of BMD [20], it is our opinion that in a rural setting, initiation and individualization of treatment will be more likely if the patient is given the diagnosis of osteoporosis in the medical record and if additional workup with BMD testing, preferably DXA, is performed. This will reduce the amount of underdiagnosis and undertreatment in rural communities and decrease the fracture risks and mortality associated with osteoporosis. Future studies will compare rates of diagnosis and treatment with a team-based hospital system approach.

## Author Contributions

Conceptualization, B.E.H. and D.H.K.; methodology, B.E.H. and S.M.; funding acquisition, B.E.H.; investigation/data gathering, S.M., H.C.H., S.F., and V.C.H.; data analysis, B.P. and B.E.H.; project administration, B.E.H. and H.C.H.; resources, B.E.H. and V.C.H.; supervision, B.E.H.; writing-original draft, B.P., B.E.H., S.M., and H.C.H.; writing-review and editing, B.P., B.E.H., and S.M.. All authors have read and approved the published version of the manuscript.

## Acknowledgements

We thank Laura Wingate, MA, Northwest Ohio Orthopedics and Sports Medicine, Inc., assisting with retrieval of patient data for review and Sharon Damon, Billing Manager, Northwest Ohio Orthopedics and Sports Medicine, Inc., assisting with search and retrieval of retrospective cohort.

## Funding

The research did not receive specific funding but was performed as part of the employment of the authors, Northwest Ohio Orthopedics and Sports Medicine, Inc, Findlay, OH.

## Bibliography

1. Barton DW, et al. "Orthopedic surgeons' views on the osteoporosis care gap and potential solutions: survey results". *Journal of Orthopaedic Surgery and Research* 14.1 (2019): 72.
2. Bauer DC. "Osteoporosis Treatment After Hip Fracture: Bad News and Getting Worse". *JAMA Network Open* 1.3 (2018): e180844.
3. Chapuy MC, et al. "Vitamin D3 and calcium to prevent hip fractures in elderly women". *The New England Journal of Medicine* 327.23 (1992): 1637-1642.
4. Cree M, et al. "Mortality and institutionalization following hip fracture". *Journal of the American Geriatrics Society* 48.3 (2000): 283-288.
5. Cummings SR and Melton LJ. "Epidemiology and outcomes of osteoporotic fractures". *Lancet* 359.9319 (2002): 1761-1767.
6. David C, et al. "Severity of osteoporosis: what is the impact of co-morbidities?" *Joint Bone Spine* 77 (2010): S103-106.
7. Desai RJ, et al. "Association of Osteoporosis Medication Use After Hip Fracture with Prevention of Subsequent Nonvertebral Fractures: An Instrumental Variable Analysis". *JAMA Network Open* 1.3 (2018): e180826.
8. Ensrud KE, et al. "Association of Disease Definition, Comorbidity Burden, and Prognosis With Hip Fracture Probability Among Late-Life Women". *JAMA Internal Medicine* 179.8 (2019): 1095-1103.
9. Gleason LJ, et al. "Diagnosis and treatment of osteoporosis in high-risk patients prior to hip fracture". *Geriatric Orthopaedic Surgery and Rehabilitation* 3.2 (2012): 79-83.
10. Guzon-Illescas O, et al. "Mortality after osteoporotic hip fracture: incidence, trends, and associated factors". *Journal of Orthopaedic Surgery and Research* 14.1 (2009): 203.
11. Hooven F, et al. "Follow-up treatment for osteoporosis after fracture". *Osteoporosis International* 16.3 (2005): 296-301.
12. Kadam NS, et al. "Prevalence of Osteoporosis in Apparently Healthy Adults above 40 Years of Age in Pune City, India". *Indian Journal of Endocrinology and Metabolism* 22.1 (2018): 67-73.
13. Khan AA, et al. "Osteoporosis treatment rate following hip fracture in a community hospital". *Archives of Osteoporosis* 16.1 (2021): 8.
14. Lewiecki EM, et al. "Challenges in osteoporosis awareness and management: results from a survey of US postmenopausal women". *Journal of Drug Assessment* 1 (2019): 25-31.
15. Liu R, et al. "Incidence and risk factors of medical complications and direct medical costs after osteoporotic fracture among patients in China". *Archives of Osteoporosis* 13.1 (2018): 12.
16. Nazrun AS, et al. "A systematic review of the outcomes of osteoporotic fracture patients after hospital discharge: morbidity, subsequent fractures, and mortality". *Therapeutics and Clinical Risk Management* 10 (2014): 937-948.
17. Puth MT, et al. "Prevalence and comorbidity of osteoporosis- a cross-sectional analysis on 10,660 adults aged 50 years and older in Germany". *BMC Musculoskeletal Disorder* 19.1 (2018): 144.
18. Sarafrazi N. "Osteoporosis or Low Bone Mass in Older Adults-United States, 2017-2018". In: Wambogo EA, editor. *National Health and Nutrition Survey 2017-2018* 2021.
19. Shuhart CR, et al. "Executive Summary of the 2019 ISCD Position Development Conference on Monitoring Treatment, DXA Cross-calibration and Least Significant Change, Spinal Cord Injury, Peri-prosthetic and Orthopedic Bone Health, Transgender Medicine, and Pediatrics". *Journal of Clinical Densitometry* 22.4 (2019): 453-471.
20. Siris ES, et al. "The clinical diagnosis of osteoporosis: a position statement from the National Bone Health Alliance Working Group". *Osteoporosis International* 25.5 (2014): 1439-1443.
21. Sozen T, et al. "An overview and management of osteoporosis". *European Journal of Rheumatology* 4.1 (2017): 46-56.
22. Wright NC, et al. "The recent prevalence of osteoporosis and low bone mass in the United States based on bone mineral density at the femoral neck or lumbar spine". *Journal of Bone and Mineral Research* 29.11 (2014): 2520-2526.
23. Naik-Panvelkar P, et al. "Osteoporosis management in Australian general practice: an analysis of current osteoporosis treatment patterns and gaps in practice". *BMC Family Practice* 21.1 (2020): 32.

24. Choksi P, *et al.* "Physician-Reported Barriers to Osteoporosis Screening: A Nationwide Survey". *Endocrine Practice* 29.8 (2023): 606-611.
25. Ramachandran S, *et al.* "Gender Disparities in Osteoporosis Screening and Management Among Older Adults". *Advances in Therapy* 38.7 (2021): 3872-3887.
26. De Martinis M, *et al.* "Gender Differences in Osteoporosis: A Single-Center Observational Study". *World Journal of Men's Health* 39.4 (2021): 750-759.