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OSTEOPOROSIS IN MEN – A CONTEMPORARY PERSPECTIVE ON DIAGNOSIS, TREATMENT AND FRACTURE PREVENTION STRATEGIES

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ABSTRACT

Introduction: Osteoporosis in men is an increasingly acknowledged but underdiagnosed public health issue. Despite accounting for 20% of osteoporosis cases, male patients are frequently overlooked due to lower awareness, stereotypical associations with female aging, and subtler clinical presentation. Mortality following hip fractures in men reaches up to 37%. This review summarizes current knowledge and highlights emerging concepts in male osteoporosis.
Material and Methods: A narrative review based on a PubMed literature search and analysis of international osteoporosis guidelines (2017–2025). Included were high-quality reviews, randomized trials, and position statements focused on osteoporosis in men.
Results: Male osteoporosis is mainly secondary, linked to hypogonadism, androgen deprivation therapy, glucocorticoids, chronic disease, and poor lifestyle factors such as alcohol, smoking, low activity, and vitamin D deficiency. Diagnosis remains challenging due to female-based T-score thresholds and limitations of FRAX in male populations. Bone turnover markers and HR-pQCT imaging improve risk stratification. Treatment combines antiresorptive agents (bisphosphonates, denosumab) and anabolic therapies (romosozumab), often sequenced under treat-to-target (T2T) models. New approaches include the role of gut microbiota, osteosarcopenia, and personalized digital tools.
Conclusions: Male osteoporosis requires earlier recognition, individualized therapy, and public awareness. Advancing care involves closing diagnostic gaps, integrating male-focused strategies into clinical guidelines, and embracing novel therapeutic targets and technologies.

KEYWORDS

Osteoporosis, Male Osteoporosis, Secondary Osteoporosis, Romosozumab, Bone Remodeling, Osteoporotic Fractures

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Introduction

Osteoporosis is a chronic skeletal disease that requires long-term treatment, sequential pharmacologic therapy, and regular monitoring. It is defined by a decrease in bone mineral density and structural deterioration of bone tissue, which significantly increases the risk of fracture. Osteoporosis in men represents a growing health burden. It is predicted that the number of osteoporotic fractures worldwide will increase by over 310% between 1990 and 2050, mainly due to demographic aging. It is estimated that approximately 20% of men over the age of 50 are affected, although the actual prevalence is likely to be underestimated due to low diagnosis rates[4].

Compared to women, men have a higher mortality rate following a fracture. For example, one-year mortality after a hip fracture in men can be as high as 37%, most likely due to a higher rate of comorbidities and infections [5]. Despite this, awareness of the condition among healthcare professionals and patients remains poor, leading to delays in diagnosis and initiation of treatment [6, 7].

Epidemiology and risk factors

Osteoporosis in men is still underdiagnosed, although it is associated with serious health and social consequences. Unlike in women, where the disease usually develops as primary osteoporosis after the menopause, in men it usually occurs secondary to other underlying diseases. The most important risk factors include advanced age, low testosterone levels (hypogonadism), androgen deprivation therapy (ADT) for prostate cancer, long-term glucocorticoid therapy, alcohol abuse, smoking, low body weight and vitamin D deficiency [8–10]. Secondary osteoporosis in men is also frequently associated with renal disease, gastrointestinal disorders (e.g. celiac disease), endocrine dysfunction and malignancies. In clinical practice, it is important to identify the underlying cause and eliminate modifiable secondary risk factors to improve therapeutic efficacy [11–14].

Diagnostics and risk assessment

According to the current IOF and ESCEO guidelines, the gold standard for the diagnosis of osteoporosis in men is dual-energy X-ray absorptiometry (DXA), which measures T-values at the lumbar spine and femoral neck [13]. Although the use of female reference values in men is controversial, they continue to be used to standardize diagnostic thresholds between the sexes [14].

DXA screening is recommended for all men aged 70 years and older and for men over 50 years who have clinical risk factors for osteoporosis [15]. The FRAX tool helps to estimate 10-year fracture risk based on clinical factors, with or without DXA input. However, its predictive accuracy may be reduced in men with glucocorticoid-induced osteoporosis or hypogonadism [16, 17].

Biochemical bone turnover markers (BTM) such as the N-terminal propeptide of procollagen type I in serum (P1NP) and the C-terminal telopeptide of collagen type I (CTX) are increasingly used to assess the dynamics of bone remodeling. They support early risk stratification, monitoring of treatment efficacy and can serve as targets in treat-to-target strategies [18–20].

Bone-muscle crosstalk and the concept of osteosarcopenia in men

Bone and muscle tissues are intricately connected through mechanical, endocrine, and biochemical pathways, a relationship collectively known as bone-muscle crosstalk. This interaction is particularly significant in older men with osteoporosis, who frequently also suffer from muscle loss, weakness, and impaired mobility. The term osteosarcopenia describes the coexistence of low bone mass and reduced muscle function, an emerging syndrome increasingly recognised as a strong predictor of falls, fractures, and poor rehabilitation outcomes [5, 32].

Osteosarcopenia reflects a shared pathophysiological background involving age-related hormonal decline—including testosterone and IGF-1—chronic inflammation, physical inactivity, and oxidative stress. Cytokines such as irisin and myostatin, alongside molecules like osteocalcin and sclerostin, act as mediators of this crosstalk. For instance, irisin, released during exercise, stimulates osteoblast activity, while osteocalcin influences muscle metabolism and energy use [36]. Disruption of this regulatory network accelerates musculoskeletal degeneration, further compounding fracture risk. Clinically, men with osteosarcopenia demonstrate a higher risk of falls and fractures than those affected by either osteoporosis or sarcopenia alone. Diagnosis typically involves DXA scanning, alongside assessments of grip strength and gait speed. Effective interventions target both bone and muscle health through resistance and balance training, high-protein diets with adequate vitamin D and calcium intake, and, when indicated, pharmacological treatments that exert dual anabolic effects on bone and muscle. Emerging therapies targeting shared pathways such as Wnt signalling or irisin analogues may eventually provide combined musculoskeletal benefits. Recognising osteosarcopenia as a distinct clinical phenotype is consistent with the principles of personalised and preventive medicine and underscores the importance of integrated geriatric care.

Pharmacotherapy

The treatment of osteoporosis in men generally follows the same principles as in women, although there are still few high-quality randomized clinical trials.

Antiresorptive therapies, including bisphosphonates (alendronate, risedronate, ibandronate and zoledronate), are considered first-line treatment. They are effective in reducing the risk of vertebral and other fractures and are well tolerated in oral or intravenous form [21, 22]. Bisphosphonates are particularly indicated in men with glucocorticoid-induced osteoporosis or a history of cancer treatment [23].

Denosumab, a monoclonal antibody that inhibits RANKL, is recommended for men at high risk of fracture, for men with impaired renal function or for men who cannot tolerate bisphosphonates. It is also effective in preventing bone loss associated with androgen deprivation therapy (ADT) for prostate cancer [24].

Romosozumab is a novel anabolic agent that simultaneously stimulates bone formation and inhibits bone resorption by blocking sclerostin. In the FRAME and ARCH studies, romosozumab significantly reduced the incidence of vertebral fractures by over 50% within 12 months [25, 26].

Sequential therapy is recommended: 12 months of treatment with romosozumab should be followed by maintenance anti-resorptive therapy (e.g. with denosumab or bisphosphonates) in order to consolidate the BMD increase and sustainably reduce the fracture risk [27].

Treat-to-Target (T2T) srategy

The Treat-to-Target (T2T) strategy, which is well established in rheumatology, is increasingly being used in the treatment of osteoporosis. This approach focuses on setting individual, measurable treatment goals, such as reducing fracture risk, improving bone mineral density (BMD) and normalizing bone turnover markers [28].

In 2024, international experts proposed a T2T framework specifically for osteoporosis that includes regular reassessment by DXA, monitoring of BTMs and treatment adjustment based on response to treatment [29]. This model promotes sequential treatment planning, starting with potent anabolic agents (e.g. romosozumab) followed by long-term antiresorptive therapy to maintain bone formation.

T2T also requires active patient involvement and consistent follow-up to ensure treatment adherence and optimize outcomes. Studies suggest that this approach leads to a significant reduction in both vertebral and non-vertebral fractures in high-risk populations [30].

Personalised medicine in male osteoporosis

Osteoporosis in men exhibits significant clinical heterogeneity, necessitating a personalized approach rather than a one-size-fits-all strategy. Clinical phenotyping, which classifies patients based on underlying causes, fracture patterns, and bone turnover characteristics, offers a promising route toward individualized care. Common male phenotypes include hypogonadism-related osteoporosis, characterized by low testosterone and reduced trabecular bone mineral density (BMD), which often responds well to anabolic agents or, in specific cases, testosterone supplementation [9, 12]. Glucocorticoid-induced osteoporosis (GIO) is associated with reduced bone formation and increased resorption and requires early intervention with bisphosphonates or anabolic agents [10, 23]. ADT-related osteoporosis in prostate cancer is characterized by rapid bone loss and increased fracture risk and necessitates antiresorptive treatment, particularly with denosumab or zoledronic acid [24]. Another important phenotype includes men at high risk of fractures despite near-normal BMD, often seen in those with impaired bone quality or increased cortical porosity. This condition is best assessed using high-resolution peripheral quantitative computed tomography (HR-pQCT) and biochemical bone turnover markers (BTMs) [19, 22].

These phenotypes differ not only in pathophysiology but also in treatment response, disease progression, and prognosis. Phenotype-guided treatment selection—based on biomarkers, fracture history, and imaging—may significantly improve outcomes. BTMs such as P1NP and CTX are particularly valuable for real-time assessment of bone turnover, allowing stratification into high-turnover groups (suitable for anabolic therapy) or low-turnover groups (better managed with antiresorptive therapy) [19, 20].

The emergence of precision medicine, including genetic profiling and AI-assisted risk prediction tools, may further refine treatment strategies, although these technologies remain largely investigational. Machine learning models trained on clinical, densitometric, and biochemical data can help predict fracture risk and suggest optimal therapeutic sequences, aligning well with the principles of treat-to-target (T2T) therapy [2, 28]. Implementing a phenotype-personalized framework represents the future of male osteoporosis care, enabling more accurate diagnoses, rational therapeutic choices, and improved long-term outcomes, particularly in atypical cases or among patients who respond poorly to standard treatment regimens.

Gut microbiome and bone health in men

Emerging evidence highlights the significant role of the gut microbiome in regulating bone metabolism and influencing osteoporosis risk. Dysbiosis—an imbalance in microbial composition—has been implicated in systemic inflammation, impaired calcium absorption, and altered bone remodeling dynamics, all of which may contribute to skeletal fragility [10, 12, 19].

Specific bacterial strains influence the immune environment through the production of short-chain fatty acids (SCFAs), such as butyrate, which exhibit anti-inflammatory properties and stimulate osteoblast differentiation. Conversely, dysbiosis can promote the release of pro-inflammatory cytokines like TNF-α and IL-6, known to enhance osteoclastogenesis and bone resorption [19, 20].

In men, factors such as chronic alcohol consumption, frequent use of proton pump inhibitors (PPIs), nonsteroidal anti-inflammatory drugs (NSAIDs), or antibiotics may significantly alter gut microbiota composition, potentially increasing the risk of osteoporosis [9, 10]. Moreover, conditions like inflammatory bowel disease (IBD) or celiac disease, which occur in certain male populations, are directly linked to secondary osteoporosis through malabsorption and microbiome alterations [12].

Future therapeutic avenues may include probiotics, prebiotics, or postbiotics aimed at restoring microbial balance and improving bone health. Although clinical trials in male osteoporosis remain limited,

animal models have shown promising results for microbiome-targeted interventions as adjunctive strategies to traditional pharmacotherapy [20].

Integrating microbiome assessment into personalized osteoporosis care could offer novel diagnostic and therapeutic tools, aligning with the precision medicine paradigm and further differentiating phenotypic subgroups of patients at risk

Multidisciplinary management and public health implications

Osteoporosis in men should no longer be seen as a localized skeletal disease, but as a chronic, multifactorial condition that requires multidisciplinary coordination. Effective long-term treatment must integrate the expertise of various specialists such as rheumatologists, endocrinologists, geriatricians, general practitioners, urologists, nutritionists and physiotherapists. This collaborative model allows for comprehensive assessment and treatment of the various clinical dimensions that typically coexist in male patients with osteoporosis.

Men often present with secondary forms of osteoporosis due to chronic disease, pharmacotherapy or hormonal imbalances — factors that significantly influence treatment planning [9, 10, 12]. High-risk groups such as men undergoing androgen deprivation therapy (ADT) for prostate cancer, long-term glucocorticoid users or those with chronic kidney or gastrointestinal disease require specialized follow-up and tailored pharmacological therapies [11, 24].

From a public health perspective, the burden of osteoporosis in men is significantly underestimated. Fractures, particularly of the hip and vertebrae, are associated with increased hospitalization, prolonged disability, institutionalization and a 1-year mortality rate that can exceed 30–37% in older men [5, 7]. These consequences have significant socioeconomic implications, yet national prevention strategies and health resources continue to focus disproportionately on women [3, 4].

Studies have shown that Fracture Liaison Services (FLS) reduce the incidence of secondary fractures and improve survival by bridging the gap between orthopedic care and chronic disease management. However, the implementation of FLS programs for men remains limited worldwide and should be a priority for healthcare systems seeking to reduce osteoporotic complications [30].

In addition, there are few screening initiatives and prevention campaigns targeting the male population. Routine DXA scans are rarely offered to men, although guidelines recommend them for all individuals aged ≥70 years and for younger men with risk factors [13, 15]. In addition, awareness among both physicians and patients is suboptimal, often resulting in delayed diagnosis and missed opportunities for early intervention [6, 8].

Lifestyle factors such as smoking, alcohol abuse, physical inactivity and poor diet are modifiable and should be addressed through public health education programs [10, 31]. There is evidence for the effectiveness of structured, supervised physical activity in increasing bone strength, improving muscle function and preventing falls in older men [32–38]. Community initiatives that include physiotherapy, resistance training and balance exercises should be an integral part of national fracture prevention strategies.

Ultimately, the treatment of osteoporosis in men requires a systems-level change: the disease must be viewed as a chronic, systemic health problem and embedded in multidisciplinary treatment pathways while being integrated into national policies for aging and musculoskeletal health. Population-based strategies — including reimbursement policies for anabolic steroids, early screening and digital risk assessment tools — are essential for long-term impact. This broader vision is consistent with the evolving treatment model for chronic disease management and provides a realistic framework to reduce the clinical, economic and societal burden of osteoporosis in men [2, 28–30].

Osteoporosis in the context of multimorbidity and polypharmacy in older men

Osteoporosis in older men rarely occurs in isolation. Instead, it is often part of a broader clinical landscape of multimorbidity, encompassing conditions such as cardiovascular disease, diabetes, chronic kidney disease, depression, and cognitive impairment. These comorbidities complicate diagnosis and limit therapeutic options. [5, 10, 11]. Men with multiple comorbidities frequently present with atypical or non-specific symptoms, causing bone fragility to go unrecognised. Moreover, chronic conditions like chronic obstructive pulmonary disease (COPD) and type 2 diabetes independently elevate fracture risk through mechanisms involving systemic inflammation, oxidative stress, and endocrine disruption [6, 7]. Polypharmacy further complicates care in this population. Older men often take five or more chronic medications, many of which—including proton pump inhibitors, selective serotonin reuptake inhibitors (SSRIs), anticonvulsants, and ADT—adversely affect bone metabolism [9]. The presence of polypharmacy also increases the risk of

drug interactions, renal impairment, and reduced adherence. Selecting the appropriate anti-osteoporotic agent in such patients requires careful assessment of renal function, gastrointestinal tolerance, and cardiovascular status. Intravenous bisphosphonates may be preferred in patients with poor oral intake, while denosumab remains effective and safe in men with impaired glomerular filtration rate (GFR) [24]. Although romosozumab offers rapid BMD improvements, caution is warranted in men with recent myocardial infarction or stroke [25]. Effective management of osteoporosis in multimorbid patients requires close collaboration between specialists such as cardiologists, nephrologists, endocrinologists, and geriatricians. Coordinated care plans and thorough medication reviews are critical to minimising treatment burden and prioritising fracture prevention alongside management of other chronic conditions. Clinical decision-making should incorporate frailty status, functional reserve, and life expectancy. In certain cases, the primary therapeutic goal may shift from aggressive fracture prevention to preserving autonomy and quality of life, particularly in individuals with significant mobility limitations or cognitive decline [4, 32]. Overall, managing osteoporosis in older men with multimorbidity and polypharmacy demands a personalised, multidisciplinary, and risk-adapted approach. Recognising these complex interactions is essential for optimising clinical outcomes and minimising harm in this vulnerable and growing patient population.

Treatment adherence and long-term management challenges in men with osteoporosis

Despite the availability of effective pharmacologic treatments, long-term adherence and persistence to osteoporosis therapy remain suboptimal— - especially in men. Studies consistently show that adherence rates are lower in men than in women, with discontinuation of therapy often occurring within the first year [3, 5]. This represents a significant obstacle to reducing fracture risk, as the benefit of most osteoporosis inhibitors depends on sustained adherence [21, 22].

Several factors contribute to poor adherence in men, including low perceived fracture risk, lack of overt symptoms, low awareness of the disease, and concern about medication side effects [6, 8]. In addition, men are less likely to participate in preventive health measures and are underrepresented in patient education programs [4]. The asymptomatic nature of osteoporosis until fractures occur further complicates treatment adherence and makes proactive follow-up and education essential.

The treat-to-target strategy provides a framework for improving long-term outcomes by defining measurable treatment goals and requiring regular reassessment [2, 28]. This structured approach not only guides pharmacologic decisions but also encourages patient engagement. Bone turnover markers (BTMs) such as P1NP and CTX can be used to confirm treatment success by providing tangible indicators of response and improving motivation to continue treatment [19, 20].

In addition, sequential treatment models — such as initial treatment with anabolic agents like romosozumab followed by maintenance antiresorptive therapy — require careful planning and continuity [26, 27]. Interruption or premature discontinuation can lead to rapid bone loss, especially after discontinuation of denosumab, which is associated with rebound effects and an increased risk of fracture [24].

Digital health technologies, including automated reminders, telemedicine monitoring and mobile apps to monitor adherence, may provide scalable solutions to support long-term management. However, these tools remain underutilized in older male populations, highlighting the need for more comprehensive and accessible platforms.

To optimize treatment outcomes in men, healthcare providers need to integrate regular adherence assessment, patient education and multidisciplinary support into follow-up visits. Incorporating Fracture Liaison Services (FLS) and pharmacist-led counseling may also improve medication persistence and reduce the risk of treatment failure [30].

In summary, maintaining adherence to treatment is an important but underestimated component of osteoporosis treatment in men. Future clinical protocols should place greater emphasis on patient-centered strategies that improve communication, enhance motivation, and provide continuous feedback on treatment effectiveness.

The role of physical activity in prevention and management

There is growing evidence that physical activity plays a crucial role in both the prevention and management of osteoporosis in men. In addition to the benefits to overall health, physical activity also has direct anabolic effects on the skeleton.

Weight-bearing and resistance exercises (e.g. walking, stair climbing, strength training, jumping exercises) stimulate bone formation by creating mechanical stresses that activate the Wnt/β-catenin signaling

pathway. This process leads to a downregulation of sclerostin and promotes osteoblast differentiation and function [31–35].

Exercise also induces the release of myokines, particularly irisin, which supports bone formation through anti-inflammatory and osteoanabolic effects [36].

In addition, regular physical training improves muscle strength, balance and proprioception, significantly reducing the risk of falls, which is a crucial component in fracture prevention in older men [37].

Clinical guidelines recommend structured, supervised programs that combine resistance, balance and impact training and are tailored to the patient's age, fitness level and comorbidities [38].

Digital tools, artificial intelligence, and the future of osteoporosis management in men

The integration of digital technologies and artificial intelligence (AI) is poised to transform the diagnosis, monitoring, and treatment of osteoporosis in men. These innovations hold particular promise for improving early detection, individualising therapy, and enhancing long-term outcomes, especially in underdiagnosed and undertreated male populations. AI algorithms trained on large datasets, incorporating DXA results, clinical histories, BTMs, and genetic information, can now identify high-risk individuals before significant bone loss or fractures occur. Such tools also assist in predicting therapeutic responses and optimising sequential treatment plans, aligning well with the treat-to-target paradigm [2, 28].

Digital fracture risk calculators that integrate real-world patient data, comorbidities, and behavioural factors are under development and may surpass traditional tools like FRAX, which can underestimate risk in certain male subgroups, including those with hypogonadism or undergoingADT[17, 30].

Additionally, mobile health (mHealth) applications and smartphone apps enable patients to monitor medication adherence, receive reminders for follow-up visits, and track physical activity. These digital interventions have shown promise in improving persistence with bisphosphonates and denosumab [5, 30] and could be especially valuable in engaging tech-savvy yet asymptomatic male patients. Wearable devices capable of real-time monitoring of gait, balance, and fall risk can be integrated into bone health programs, offering early alerts and enhancing fall prevention strategies. Moreover, telemedicine has significantly improved access to bone health specialists, facilitating multidisciplinary osteoporosis management even in rural or resource-limited settings. The next frontier involves digital phenotyping, combining sensor-derived movement data, muscle strength assessments, and cognitive screening to identify patients at risk of osteosarcopenia or fragility-related frailty [32, 36]. These data can feed into AI-driven clinical dashboards, allowing personalised intervention plans. In conclusion, digital tools and AI-based innovations have transformative potential in osteoporosis care for men. Their successful implementation will depend on collaboration between clinicians, data scientists, public health policymakers, and patient communities. When effectively utilised, these technologies will facilitate a shift from reactive fracture management to predictive, preventive, and personalised care consistent with modern chronic disease management principles.

Psychosocial impact and quality of life in men with osteoporosis

Beyond skeletal complications, osteoporosis in men can significantly affect mental health, emotional wellbeing, and overall quality of life. These aspects are often under-recognised and under-researched, despite their profound impact on treatment adherence, social functioning, and patient outcomes. Fractures, particularly of the hip and vertebrae, frequently result in chronic pain, functional dependence, and fear of falling, all of which contribute to loss of independence and reduced self-esteem [4, 6, 32]. In men, these consequences can be exacerbated by societal expectations of masculinity and physical strength, leading to stigma, emotional suppression, and reluctance to seek medical care [3, 5]. Studies show that men who sustain fragility fractures report significantly lower health-related quality of life (HRQoL) scores than age-matched peers, along with increased rates of depression, anxiety, and social withdrawal, especially during the months following hospitalisation [5, 7]. The psychological burden is often compounded by comorbidities such as sarcopenia, chronic pain syndromes, and erectile dysfunction associated with hypogonadism or ADT. Additionally, masculine identity, often closely linked to physical capacity, may be threatened by the experience of fragility and fracture, making men less inclined to embrace lifestyle changes or adhere to long-term therapy [6, 9]. This underscores the importance of gender-sensitive communication, empathetic counselling, and integrating mental health support into osteoporosis management. Healthcare professionals should routinely assess patient-reported outcomes, including pain, mobility, emotional distress, and fear of falling. Simple instruments like the EQ-5D, SF-36, or FRAX-Impact modules can help capture the psychosocial dimensions of osteoporosis and guide tailored interventions. Group-based education, peer support programmes, and cognitive behavioural

interventions have been shown to reduce isolation, improve resilience, and enhance adherence, particularly when embedded within fracture liaison services (FLS) or chronic disease management frameworks [30]. Addressing the psychosocial dimension of osteoporosis in men is essential to delivering holistic care that fosters therapeutic engagement, improves adherence, and ultimately enhances both clinical and humanistic outcomes in this often-overlooked population.

Awareness gaps and opportunities in educating men about osteoporosis

Despite significant advances in diagnosis and treatment, substantial gaps remain in knowledge and awareness of osteoporosis in men, both among healthcare providers and the general public. These deficits contribute to delayed diagnoses, low screening rates, and poor implementation of evidence-based treatments [6, 8]. Surveys indicate that many men—even those with prior fractures—do not perceive themselves at risk for osteoporosis. Likewise, general practitioners often fail to initiate diagnostic testing or refer male patients for DXA unless obvious risk factors are present [4, 13]. This contrasts sharply with the routine screening and intervention protocols widely established for postmenopausal women. Medical and postgraduate training curricula frequently lack comprehensive modules addressing osteoporosis in men, perpetuating clinical inertia and gaps in understanding [3, 10]. Furthermore, while clinical guidelines are gradually becoming more inclusive, they still tend to focus predominantly on female cohorts, leaving male-specific considerations underrepresented. Public health campaigns also rarely target men, leading to lower awareness, reduced treatment uptake, and lower participation in fall-prevention and exercise programmes [6, 32]. Opportunities exist at multiple levels to address these gaps. Medical education should incorporate structured, sex-inclusive training on bone health, particularly for practitioners in family medicine, endocrinology, oncology, and rheumatology. Continuing professional development programmes should emphasise male-specific risk factors such as ADT, alcohol abuse, and sarcopenia, as well as diagnostic thresholds and therapeutic nuances. Public health messaging should explicitly address men, using gender-sensitive language and personal narratives to reduce stigma and encourage engagement. Digital platforms and patient portals can serve as effective vehicles for delivering tailored education, self-assessment tools, and reminders for screening and medication adherence. Additionally, expanding male-focused clinical trials and registry data is crucial to better reflect the full spectrum of risk, treatment responses, and long-term outcomes in men. In conclusion, addressing the educational gaps surrounding male osteoporosis is fundamental for improving early detection, patient empowerment, and quality of care. With targeted and inclusive education strategies, osteoporosis can shift from a silent, overlooked disease to a preventable and manageable condition across all genders.

New paths and future therapies

Diagnostic and therapeutic innovations in osteoporosis treatment are increasing rapidly. Traditional reliance on BMD is now being supplemented by advanced imaging techniques such as high-resolution peripheral quantitative computed tomography (HR-pQCT), which assesses microarchitecture, cortical thickness and bone porosity — important determinants of skeletal fragility that are not assessed by DXA alone [22].

At the molecular level, targeted therapies are currently being developed to modulate key regulatory pathways in bone remodeling. These include the Wnt/β-catenin, RANK/RANKL and SOST/sclerostin signaling axes.

Promising agents such as DKK1 inhibitors and next-generation anti-sclerostin antibodies are currently under investigation and could expand future treatment options — particularly in severe osteoporosis, resistance to conventional therapies or persistent fracture risk despite optimal treatment.

Clinical challenges and gaps in male osteoporosis management

Despite significant advances in our understanding of male osteoporosis, several clinical challenges and gaps persist in translating scientific knowledge into routine practice. First, osteoporosis in men remains underdiagnosed due to lower disease awareness among healthcare providers and patients, compounded by cultural perceptions of osteoporosis as a predominantly female condition. As a result, men are less frequently screened, even in the presence of risk factors or after sustaining low-trauma fractures [4, 9, 11].

Secondly, diagnostic tools such as DXA and FRAX are primarily validated in female populations, leading to uncertainty in risk assessment for male patients, especially those with secondary osteoporosis or unique comorbidity profiles [13, 17]. This diagnostic ambiguity contributes to delays in treatment initiation and suboptimal therapeutic choices.

Furthermore, treatment guidelines for male osteoporosis are often extrapolated from studies in postmenopausal women, resulting in a lack of high-quality, male-specific data for many therapeutic agents. While drugs like bisphosphonates and denosumab have demonstrated efficacy in men, there is still limited evidence for optimal sequencing strategies and long-term outcomes, particularly regarding anabolic therapies such as romosozumab [25, 26, 27].

Treatment adherence represents another significant hurdle, as men frequently demonstrate lower persistence with osteoporosis medications compared to women. This may stem from insufficient patient education, fear of side effects, or the asymptomatic nature of the disease until fractures occur [5, 21].

Finally, socioeconomic disparities, limited access to specialized bone health services, and lack of male-focused public health initiatives further exacerbate the under-recognition and undertreatment of osteoporosis in men. Addressing these gaps requires dedicated research, tailored clinical guidelines, and public health campaigns designed specifically for male populations.

Conclusions

Osteoporosis in men is a chronic, progressive and significantly underdiagnosed disease with high morbidity and mortality. Although the overall prevalence is lower than in women, men have a significantly higher risk of fatal outcomes following fractures.

Most cases of osteoporosis in men are due to underlying conditions such as hypogonadism, androgen deprivation therapy, glucocorticoid use, chronic diseases and vitamin D deficiency. Accurate diagnosis based on DXA, FRAX and bone turnover markers— in combination with personalized pharmacological treatment (including sequential use of anabolic steroids and antiresorptives) is essential for effective treatment.

The treat-to-target model provides a promising framework for long-term treatment, ensuring that treatment goals are achieved through structured monitoring and adjustment.

Advances in molecular therapies and imaging techniques, as well as exercise interventions, broaden the spectrum of prevention and treatment strategies.

Ultimately, the effective treatment of male osteoporosis requires a paradigm shift from reactive treatment after the occurrence of fractures to proactive identification, risk stratification and comprehensive prevention. Increasing clinical awareness, expanding access to diagnostics and promoting physical activity should be prioritized in future public health strategies.

Disclosure

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