Empowering women to combat osteoporosis: unveiling the causes, consequences, and control strategies

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Abbreviations
HRT, hormone replacement therapy; BMD, bone mineral density; RANKL, receptor activator of nuclear factor kappa-B ligand.

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Abstract
Osteoporosis is a common bone disease in women worldwide, leading to decreased bone density and an accelerated risk of fractures. The causes of osteoporosis in women include age (senile osteoporosis), menopause-associated hormonal changes, deficiencies in calcium and vitamin D, genetics, lifestyle factors, medical conditions, and some type of medications. The consequences of osteoporosis are colossal, consisting of fractures, decreased quality of life, psychological impacts, and economic burden. To effectively control the menace of osteoporosis in women, numerous strategies are advocated. Adequate calcium and vitamin D consumption through diet or supplements is vital. Regular weight-bearing activities and strength training that promote bone density. Maintaining a healthy lifestyle through avoiding smoking, limiting alcohol in-take and maintaining a wholesome body weight is essential. Hormone replacement therapy and some medications may be recommended in certain cases. Early detection through regular bone density and blood tests is crucial to lowering its impact. Creating a supportive network through educational programs and resources fosters awareness and empowerment. By engaging these strategies, women can be empowered to combat osteoporosis, reduce fracture risk, and build stronger bones for their overall well-being.

Keywords: women; aging; osteoporosis; causes; consequences; control strategies

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Introduction

Osteoporosis, a silent but dangerous condition, poses an enormous threat to the well-being and quality of life of women worldwide. It is a common incapacitating bone disease that primarily affects women, characterized with reduced bone density, deterioration of bone tissue and an accelerated risk of fractures. As women age, hormonal changes and various life factors contribute to a higher risk of this disease [1, 2].

The burden and prevalence of osteoporosis in women have far-reaching implications for public health and healthcare systems globally. According to the International Osteoporosis Foundation, osteoporosis impacts about two hundred million women globally. According to projections made by Shen et al. [2], it is anticipated that by 2050, the global prevalence of hip fractures in women will surge by 240%. Women are at a higher risk of developing osteoporosis than their male counterparts due to some factors including hormonal changes during menopause and decrease peak bone mass. Additionally, the global population is aging, leading to a projected rise in the number of individuals bedeviled by osteoporosis. The incidence of osteoporosis varies across different regions of the world, with higher rates found in North America, Europe, and parts of Asia. However, it is vital to be aware that osteoporosis is a global problem, affecting women of all ethnicities and socioeconomic backgrounds [3].

With an alarming upward thrust in the number of cases, comprehending the causes, consequences and control strategies for osteoporosis has become very important. Addressing the burden of osteoporosis globally calls for a multifaceted approach, such as prevention, early detection, and suitable management strategies. Public health initiatives focusing on promoting bone-healthy lifestyles, raising awareness, and ensuring access to diagnostic tools and treatments are important. Empowering women to take charge of their bone health through proactive measures can appreciably reduce the risk and impact of this disease. This review aims to explore the causes, consequences, and control strategies for combating osteoporosis in women. By comprehending these aspects, we can empower women with the knowledge required to combat osteoporosis and build stronger bones, permitting them to live a more healthy and productive lives [4, 5].

Causes of osteoporosis in women

It's critical to understand the underlying mechanisms of osteoporosis. Bones are living tissues that undergo a steady process of renewal, with new bone formation replacing old bone tissue. Osteoporosis occurs when the rate of bone loss exceeds the rate of bone formation, resulting in susceptible and fragile bones liable to fractures. A lot of factors have been recognized as the causes of osteoporosis in women [6, 7].

Age

Age is a major risk factor contributing to the development of osteoporosis in women. Advancing age will increase a woman's susceptibility to developing senile osteoporosis. Women are more commonly prone to suffer from osteoporosis, particular after menopause. The risk of osteoporosis increases with age. As women age, the rate of bone loss quickens, and the body’s capability to form new bone slows down. After menopause, which usually takes place around the age of fifty, estrogen levels decline appreciably. Estrogen plays a critical role in maintaining bone density, so its decline can cause fast bone loss, making postmenopausal women in particular susceptible to osteoporosis [8].

Genetics

Genetic factors additionally play a role in the development of osteoporosis. A family history of osteoporosis is considered a significant risk factor. Certain genetic variations can have negative effect on bone density and quality, influencing a person’s susceptibility to osteoporosis. The vitamin D receptor gene is essential for the body’s capacity to absorb and utilize vitamin D, which plays a critical role in calcium absorption and bone mineralization. Genetic differences in this gene can impact how effectively a person’s body processes vitamin D, which, in turn, can affect bone density. People with specific variants of the vitamin D receptor gene may face an elevated risk of osteoporosis due to diminished vitamin D functionality. Collagen is a key component of bone tissue, providing structural support. Variations in the COL1A1 gene can influence the quality and strength of collagen in bones. Weaker collagen can lead to decreased bone strength and density, increasing susceptibility to fractures and osteoporosis. There are other numerous genes associated with bone metabolism, including those responsible for bone formation and resorption. Genetic variations in these genes can disrupt the delicate equilibrium between bone formation and breakdown, resulting in decreased bone density and an elevated risk of osteoporosis. And beyond specific genes, family history and genetic inheritance play significant roles. If someone has close relatives with osteoporosis, it suggests a genetic predisposition to the condition. Shared genetic factors within families can influence bone density and overall bone health [9].

To this end, genetic testing offers a promising avenue for evaluating an individual’s osteoporosis risk and customizing preventive approaches. First, it can identify particular genetic variations linked to a heightened osteoporosis risk. Individuals with these variants can be informed about their increased risk and may choose to take proactive measures to preserve their bone health. Second, equipped with genetic information, individuals can adopt personalized strategies to reduce their risk. This may involve optimizing vitamin D intake, engaging in weight-bearing exercises, and maintaining a diet conducive to bone health. Third, genetic testing can also assist in selecting the most suitable pharmacological treatments for osteoporosis. Certain medications are more effective for individuals with specific genetic profiles, minimizing side effects and maximizing treatment efficacy. Fourth, identifying genetic risk factors early in life allows for preventive measures during childhood and adolescence when bone development is crucial. This proactive approach can substantially lower the risk of osteoporosis in later years [10–12].

Hormonal changes

Hormonal changes play a substantial role in the development of osteoporosis in women. Estrogen, a hormone that helps keep bone density intact, decreases considerably during menopause. The hormone plays an important role in regulating bone metabolism. It helps maintain a balance between bone formation and bone resorption. During menopause, the ovaries produce less estrogen, resulting to estrogen deficiency. This hormonal change results in an accelerated rate of bone loss, making women more vulnerable to osteoporosis. Furthermore, estrogen deficiency causes an imbalance in the bone remodeling process. Normally, bone tissue is constantly being broken down (resorption) and rebuilt (formation) in a dynamic equilibrium. However, with decreased estrogen levels, the rate of bone resorption surpasses that of bone formation, resulting to a net loss of bone mass and density [13]. Hormonal changes associated with osteoporosis do not only have negative impact on bone quantity, but also affect bone quality. Estrogen deficiency can bring about structural modifications, which includes thinning of trabecular bone (the spongy, inner part of bone), and changes within the collagen matrix, making the bones more prone to fractures [14].

Women who attain menopause early (before the age of forty five) or undergo surgical removal of the ovaries (oophorectomy) have a higher risk of developing osteoporosis. In these cases, the abrupt and critical decline in estrogen levels can bring about accelerated bone loss, further emphasizing the hormonal impact on bone health. Still, some hormonal conditions and medical treatments have been implicated in the development of osteoporosis. For example, extended or excessive use of corticosteroids can disrupt the bone remodeling process, resulting in bone loss. Apart from estrogen and progesterone, the
thyroid hormones (produced by the thyroid gland) also play a pivotal role in bone metabolism. Excessive production of thyroid hormones (hyperthyroidism) can result in bone loss by increasing bone turnover, thereby causing bones to weaken over time. Similarly, inadequate production of thyroid hormones (hypothyroidism) can also affect bone health by reducing bone turnover, potentially leading to brittle and fragile bones. Managing thyroid disorders with appropriate medications can help maintain hormonal equilibrium and, consequently, support bone health. Routine monitoring of thyroid function is crucial for women susceptible to thyroid-related bone complications. The parathyroid hormone on the other hand regulates calcium levels in the blood. High levels of parathyroid hormone can lead to increased calcium release from bones, potentially weakening them over time. Chronic stress and high levels of cortisol can lead to bone loss. Another important hormone is the stress hormone (cortisol) which can interfere with bone formation and reduce bone density. Beyond menopause, both estrogen and testosterone levels decline with age, contributing to bone loss in women and men, respectively [14].

**Calcium and vitamin D deficiency**

Calcium and vitamin D deficiency can contribute to the development of osteoporosis [15]. Both nutrients play vital roles in maintaining bone fitness, and their deficiencies can have unfavorable effects on bone density and strength. Calcium, for example, is a mineral important for numerous bodily functions, with approximately ninety-nine percent of it being stored within the bones and teeth. Adequate calcium consumption is important throughout life to support bone remodeling process. When calcium levels are inadequate, the body withdraws calcium from the bones, leading to decreased bone density and accelerated threat of fractures.

Vitamin D on the other hand, is important for the absorption and usage of calcium [15]. It regulates blood calcium levels by enhancing its absorption from the intestines and promoting its reabsorption from the kidneys. Additionally, vitamin D stimulates bone cells called osteoblasts, which are responsible for bone formation. Inadequate levels of vitamin D can impair calcium absorption, ensuing in decreased bone mineralization and weakened bones. A deficiency in either calcium or vitamin D, or both, can result in osteoporosis over the years. Risk factors for deficiency consist of inadequate nutritional consumption, limited sun light exposure (which is vital for vitamin D synthesis inside the body), certain clinical conditions affecting nutrient absorption, and some drugs that interfere with nutrient absorption or metabolism [16].

**Lifestyle factors**

Lifestyle factors can also contribute to the development of osteoporosis [17]. Lack of physical exercise or leading a sedentary way of life can contribute to bone loss. Weight-bearing physical activities, such as walking, jogging, or weightlifting, can assist to stimulate bone growth and strength. Consuming alcohol in excess can interfere with the body’s ability to absorb calcium, leading to reduced bone density. It is recommended to restrict alcohol intake to moderate levels or avoid it altogether to maintain most efficient bone health. Smoking has been linked to an increased chance of osteoporosis. It impacts bone fitness by means of reducing the production of estrogen in women, which is critical for preserving bone density. Additionally, smoking may also interfere with the absorption of calcium and impair blood flow to the bones. While moderate caffeine consumption is considered to be normally safe, excessive intake may negatively affect bone health. High levels of caffeine intake have been linked to reduced bone mineral density, especially in postmenopausal women. Having a low body weight or suffering from eating disorders like anorexia nervosa or bulimia can promote the risk of osteoporosis. Inadequate calorie and nutrient consumption can weaken bones and impair their development. Still, prolong use of corticosteroids (such as prednisone) can result in bone loss and promote the risk of osteoporosis. It is vital to discuss the potential side effects of these medications with a healthcare professional before using them. Chronic stress can negatively impact bone health. Stress hormones like cortisol can interfere with bone formation and contribute to bone loss over the years [18].

**Medical conditions and medications**

Certain medical conditions and medications can promote the risk of osteoporosis in women [19]. Conditions affecting the endocrine system, like hyperthyroidism (overactive thyroid), hypogonadism (low sex hormone levels), and Cushing’s syndrome (overproduction of cortisol), can disrupt the balance of hormones responsible for maintaining bone density. Certain gastrointestinal conditions, consisting of celiac disease, inflammatory bowel disease (Crohn’s disease and ulcerative colitis), and gastric bypass surgical treatment, can impair nutrient absorption, leading to deficiencies in calcium, vitamin D, and other vitamins critical for bone health. Chronic inflammatory diseases like rheumatoid arthritis, systemic lupus erythematosus, and ankylosing spondylitis can enhance the risk of osteoporosis due to persistent inflammation and the usage of corticosteroids to alleviate signs and symptoms. Still, blood disorders like multiple myeloma and leukemia can weaken bones by interfering with the everyday production and function of bone cells. Furthermore; numerous medications have been linked to an increased risk of osteoporosis. Prolonged use of corticosteroids (such as prednisone) for conditions like bronchial asthma, rheumatoid arthritis, or organ transplantation can extensively lower bone density. Other medications like some anticonvulsants, proton pump inhibitors, and certain cancer remedies, might also contribute to bone loss [20].

**Consequences of osteoporosis in women**

The consequences of osteoporosis in women are massive and include fractures, reduced workforce productivity, psychological effects, financial burden, decreased quality of life amongst others [4, 21, 22].

**Fractures**

Osteoporosis weakens the bones, making them more susceptible to fractures, even from minor trauma or falls [23]. Common fracture sites in women with osteoporosis include the hips, spine (vertebral fractures), and wrists. These fractures can result in ache, deformity, lack of mobility, reduction in height and changes in posture. Fractures related to osteoporosis can have significant consequences for women’s physical health [2]. Hip fractures, like the intertrochanteric fracture in particular, can bring about long duration of immobility, decreased independence, and a higher risk of dying.

Age related vertebral fractures can cause chronic back ache, height loss, and changes in posture. Wrist fractures can have affects the function of the hand and by extension, daily activity. Fractures associated with osteoporosis frequently necessitate extended period of care and support. Women may additionally require help with every day activities, rehabilitation, physical therapy, and continuous medical management [12, 24].

**Reduced workforce productivity**

Osteoporosis has a considerable impact on workforce productivity in women. As a bone disorder that frequently affects women, osteoporosis can result in increased absenteeism from workplace, reduced work performance, and higher healthcare expenses, all of which result in a decline in productivity. The increased risk of fractures related to osteoporosis frequently results in prolonged sick leave and incapacitate women within the workforce. Fractures, particularly in weight-bearing bones including the hip or spine, can result in extended recovery periods, decreased mobility, and impair performance in job-related tasks. This does not only disrupt a person’s work schedule, but also affect group-work dynamics and productivity [25].

Moreover, the ache, discomfort, and physical limitations resulting from osteoporosis can affect job performance negatively. Women might also experience problems in performing physical demanding duties, experience fatigue more easily, or have trouble maintaining a
constant work schedule because of frequent medical appointments or adverse effects related with their treatment. These factors can contribute to a decline in productivity and efficiency. The monetary burden associated with osteoporosis, along with healthcare costs and treatments, can also have affect the productivity of workers. Women may additionally face elevated medical expenses, insurance claims, and the need for additional support services, which could stress both the person and their employers financially [26].

Psychological effects

Osteoporosis can have a great psychological impact on women. The chronic nature of the disease, along with its physical consequences, can cause women mental stress and emotional misery. One of the primary psychological effects of osteoporosis is the development of anxiety and worry. Women with osteoporosis regularly worry about the risk of sustaining fractures and the associated pain, loss of mobility, and potential impact on their independence. The worry of falling or sustaining additional fractures can lead to heightened anxiety levels and a constant state of fear, affecting each day activities and overall quality of life [27].

Depression is an anguishing consequence of osteoporosis. This emotional weight can be crushing, generating an oppressive sense of futility and disinterest in previously liked activities. What is more, posture changes in response to fractures or height loss can impair a person’s body image, giving rise to profound frustration and dejection. Additionally, social seclusion may happen due to a fear of additional fractures and physical handicaps, leading to a lack of social reinforcement and more mental distress [28].

Economic burden

Furthermore, osteoporosis has a significant financial impact on women [29]. Osteoporosis-related medical expenses may be great. Women with osteoporosis may frequently require more doctor visits, diagnostic tests, and medications to manage the situation. They may also go through procedures like bone density scans and surgeries. The cumulative value of these medical interventions can place an enormous financial burden on individuals and healthcare systems. Fractures can result in great healthcare costs, which include emergency room visits, hospitalization, surgical treatment, and rehabilitation. The recovery manner may be prolonged and require extra support, consisting of domestic adjustments and assistive gadgets, which could further place a strain on their finances. Mobility problems can affect a woman’s ability to work. This can result in decreased working hours, early retirement, or maybe lasting disability. The ensuing loss of income can disrupt financial stability and retirement planning. In advanced levels of osteoporosis, individuals might also require help with daily activities due to physical limitations. Family members or professional caregivers may additionally need to be employed, leading to extra expenses. The financial burden of caregiving can be mainly enormous for women who offer caregiving responsibilities for family individuals, whilst also managing their personal osteoporosis-associated demanding situations. Still, osteoporosis can have oblique financial implications as well. According to Rashki-Kemmink et al. [30], osteoporosis poses a significant economic burden for countries worldwide. The primary cost contributors identified in their research were expenses related to fractures. The direct annual cost of treating osteoporotic fractures, specifically in Canada, Europe, and the USA, is estimated to range between 5,000 and 6,500 billion USD. This estimation does not include indirect costs such as disability and reduced productivity. In Asia, the costs associated with the treatment of osteoporosis-related hip fractures show considerable variability, ranging from as low as US$774 to as high as US$14,198.90, with a median of US$2,943. These costs represent an average of 18.95% of the respective countries’ 2014 gross domestic product per capita, with a range spanning from 3.58% to 57.05%. This underscores the significant burden of managing hip fractures in Asia, as reported by Mohd-Tahir and Li [31].

Decreased quality of life

Osteoporosis has a great impact on the quality of life in women [32]. This bone disease can cause numerous physical, psychological, and social challenges that affect a woman’s total health. One major consequences of osteoporosis is the incidence of fractures, especially in weight-bearing bones along with the hip, backbone, or wrist, as mentioned earlier. These fractures frequently bring about chronic pain, decreased mobility, and limitations in daily activities. Simple tasks like taking walks, lifting objects, or performing household chores can become difficult and painful, significantly impacting a woman’s independence and overall quality of life. The fear of falling and sustaining additional fractures can also take a toll on a woman’s emotional well-being. Anxiety and melancholy may additionally arise because of the physical limitation and regular fear of potential future fractures. The fear of getting involved in sport activities that were previously enjoyed may soon result in social isolation and a loss of interest in social hobby and interactions and leisure activities, further diminishing the quality of life [33].

Furthermore, osteoporosis can indirectly affect a woman’s body image and self-esteem. Changes in posture because of vertebral fractures or height loss can have a negative impact on a woman’s self-perception and assurance. Chronic pain and physical limitations may additionally contribute to emotional frustrations, inner helplessness, and a reduced quality of life. The economic burden associated with osteoporosis, consisting of hospitals expenses, medications, and potential loss of income due to decreased work capability, can further impact the quality of life. Managing the costs of healthcare, medications, and compulsory lifestyle adjustment can exert great pressure and strain on a woman’s financial stability [34, 35].

Control strategies for osteoporosis in women

A lot of strategies are currently being deployed for the control of osteoporosis in women including: nutrition, weight-bearing exercises, avoiding harmful habits, hormonal therapy, routine screening, medications, community support and education amongst others [36].

Nutrition

A balanced and nutrient-rich food plan plays a pivotal function in maintaining top-rated bone fitness. Women need to focus on eating adequate amounts of calcium and vitamin D, important for bone formation and strength. Good sources of calcium encompass dairy products, leafy greens, and fortified foods. Exposure to sun light and nutritional supplements can provide the necessary vitamin D levels. Additionally, consuming a lot of fruits, vegetables, whole grains, and lean proteins ensures an overall nutrient-rich diet, promoting bone and overall fitness [37, 38].

Avoiding harmful habits

Certain lifestyle choices will have damaging effects on bone health, making it critical to keep away from or limit their impact. Smoking and excessive alcohol consumption is associated with decreased bone density, increasing the danger of osteoporosis. Smoking cessation programs and moderation in alcohol consumption are empowering steps towards building stronger bones [37, 38].

Exercise

Engaging in normal physical exercise, especially weight-bearing activities, is crucial for building and maintaining bone density [39]. Weight-bearing physical activities placed stress on the bones, prompting them to adapt and become stronger. Activities like walking, jogging, dancing, and weightlifting are excellent options for healthy bone (Table 1). Moreover, incorporating resistance training exercises can similarly enhance bone strength and muscle development. Consulting a healthcare expert or an authorized instructor can help design an exercise program tailored to individual needs and capabilities [38].
Table 1 Relevance, advantages and disadvantages of different bone-enhancing exercises

<table>
<thead>
<tr>
<th>Type of exercise</th>
<th>Relevance</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight-bearing exercises</td>
<td>Stimulate bone growth and density</td>
<td>- Easily accessible</td>
<td>- High-impact activities may be unsuitable for those with joint issues</td>
</tr>
<tr>
<td>Walking</td>
<td>- Each step promote bone development, restructing and resilience</td>
<td>- Has low impact on joints</td>
<td>- May not provide high-intensity impact</td>
</tr>
<tr>
<td>Jogging/running</td>
<td>- Subject the bones to significant mechanical pressure, a vital factor in prompting bone restructuring and enhancing bone density</td>
<td>- Greater impact on bone health</td>
<td>- Higher risk of joint stress and injury</td>
</tr>
<tr>
<td>Dancing</td>
<td>- Combines weight-bearing impact, muscle involvement, equilibrium, coordination and pleasure.</td>
<td>- Improves bone density with dynamic movements</td>
<td>- May require some prior dance experience</td>
</tr>
<tr>
<td>Stair climbing</td>
<td>- Weight-bearing impact</td>
<td>- Targets lower body bones</td>
<td>- Risk of joint stress and impact, not suitable for those with existing joint injuries</td>
</tr>
<tr>
<td>Resistance training</td>
<td>- Builds bone strength</td>
<td>- Focuses on lower body bones</td>
<td>- Requires access to weights or resistance equipment</td>
</tr>
<tr>
<td>Weightlifting</td>
<td>- This pressure triggers the process of bone remodeling and fosters the growth of denser and more resilient bones</td>
<td>- Can be tailored to individual needs</td>
<td>- Proper form is crucial to prevent injury</td>
</tr>
<tr>
<td>Yoga and pilates</td>
<td>Improves balance and flexibility</td>
<td>- Enhances balance and posture</td>
<td>- Not strictly weight-bearing</td>
</tr>
<tr>
<td>Tai Chi</td>
<td>Enhances balance and coordination</td>
<td>- Low-impact, gentle movements</td>
<td>- May not suit those seeking high-intensity workouts</td>
</tr>
<tr>
<td>Bodyweight exercises</td>
<td>Stimulate bone growth</td>
<td>- No need for equipment</td>
<td>- Intensity may plateau without added resistance</td>
</tr>
<tr>
<td>Functional training</td>
<td>Enhances real-world functionality</td>
<td>- Mimes daily activities - Improves bone strength for practical use</td>
<td>- May not target all muscle groups effectively</td>
</tr>
<tr>
<td>Balance and posture</td>
<td>Improves stability</td>
<td>- Reduces risk of falls and fractures</td>
<td>- Requires creative exercise design</td>
</tr>
<tr>
<td></td>
<td>exercises</td>
<td>- Enhances coordination</td>
<td>- Potential for injury if exercises are not performed correctly</td>
</tr>
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</table>

Hormone replacement therapy (HRT)
Empowering women with information about hormonal balance and discussing potential remedies with healthcare specialists can aid in making knowledgeable decisions. HRT can be recommended for postmenopausal women to compensate for declining estrogen levels (and occasionally progesterone) and decrease the threat of osteoporosis [19]. This will help to manage menopausal symptoms and slow down bone loss. HRT can be taken into consideration for women who are suitable candidates and within an appropriate time frame. However, the decision to use HRT has to be made in consultation with healthcare professionals, considering individual benefits and risks (Table 2). Regular bone density screenings and early intervention can help mitigate the effect of hormonal imbalance and reduce the risk of fractures in women with osteoporosis [30].

Routine screening for early detection
Regular screening is crucial, especially for women over 50 or the ones at higher risk. By understanding their bone density status, women can take appropriate measures to prevent further bone loss and improve bone health. Firstly, healthcare specialists need to educate women about the need for osteoporosis screening, its risk factors, and the potential consequences of untreated osteoporosis. Secondly, healthcare givers have to routinely examine a woman’s risk factors for osteoporosis during regular check-ups [2].
Tools like Fracture Risk Assessment Tool can help in evaluating the individual’s risk level. Thirdly, for women recognized as high risk based on their risk assessment or those above certain age (typically postmenopausal women), bone mineral density (BMD) screening have to be recommended. Dual-energy X-ray absorptiometry is the gold standard screening test for measuring BMD at the hip and spine.

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Table 2 Benefits, risks and considerations of hormonal replacement therapy

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Risks</th>
<th>Considerations</th>
</tr>
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<tbody>
<tr>
<td>- Increased bone density and reduced risk of osteoporosis</td>
<td>- Risk of blood clots (thrombosis) particularly within the first year of use. This risk escalates among women who smoke, are obese, or have a history of blood clotting.</td>
<td>- Individualized treatment plans based on age, medical history, current health status, symptoms, time elapsed since menopause, and overall health should all be taken into account.</td>
</tr>
<tr>
<td>- Relief from menopausal symptoms (hot flashes, night sweats, mood swings)</td>
<td>- Elevated risk of stroke</td>
<td>- Short-term vs. long-term use should be considered.</td>
</tr>
<tr>
<td>- Improved skin and hair quality</td>
<td>- Possible increased risk of heart disease</td>
<td>- Duration of therapy should be limited based on individual needs and risks.</td>
</tr>
<tr>
<td>- Exert a protective effect on the cardiovascular system in younger women within a decade of menopause by enhancing cholesterol profiles and lowering the likelihood of heart disease</td>
<td>- Side effects like breast tenderness, bloating, and nausea</td>
<td>- HRT is most effective when started early after menopause.</td>
</tr>
<tr>
<td>- Has the potential to enhance vaginal health by boost vaginal lubrication, reduce the risk of vaginal atrophy, tears or irritation and enhances sexual pleasure.</td>
<td>- Increased risk of gallbladder disease</td>
<td>- Lowest effective dose should be used.</td>
</tr>
<tr>
<td>- Relief urinary incontinence</td>
<td>- Unwanted weight gain</td>
<td>- Monitoring and periodic re-evaluation of treatment are essential.</td>
</tr>
<tr>
<td>- Long-term use of estrogen-progestin HRT may slightly increase the risk of breast cancer. The risk varies depending on the duration of use.</td>
<td>- Hormone rebound after discontinuation</td>
<td>- Individual assessment of cardiovascular risk factors (e.g., smoking, hypertension) is crucial.</td>
</tr>
<tr>
<td>- HRT should not be used in women with a history of breast cancer or at high risk.</td>
<td>- Potential mood swings and irritability</td>
<td>- Exploration of non-hormonal alternatives for symptom management. such as lifestyle adjustments (diet, exercise, stress management), non-hormonal medications, or natural remedies</td>
</tr>
<tr>
<td>- In women who have not undergone a hysterectomy, taking estrogen alone (without progesterone) can heighten the risk of endometrial cancer</td>
<td></td>
<td>- Patient should monitor diet, stay hydrated and engage in regular exercise.</td>
</tr>
<tr>
<td>- Risk of blood clots (thrombosis) particularly within the first year of use. This risk escalates among women who smoke, are obese, or have a history of blood clotting.</td>
<td></td>
<td>- Tailor treatment to minimize the potential for weight gain.</td>
</tr>
<tr>
<td>- Elevate risk of stroke</td>
<td></td>
<td>- Gradually decreasing the hormone dosage over several months can assist in mitigating the intensity of rebound symptoms.</td>
</tr>
<tr>
<td>- Possible increased risk of heart disease</td>
<td></td>
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<tr>
<td>- Side effects like breast tenderness, bloating, and nausea</td>
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<td>- Potential mood swings and irritability</td>
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HRT, hormone replacement therapy.

This procedure entails the patient lying on a table whilst a scanner arm passes over the body, emitting X-ray beams of low dosage which are then subsequently used to calculate an individual’s BMD, as expressed by a T-score and a Z-score. The T-score reflects how many standard deviations the person’s BMD is above or below the average, with scores of –1 or above considered normal, –1 to –2.5 indicating osteopenia (low bone mass) and –2.5 or lower representing osteoporosis. The Z-score, on the other hand, compares the patient’s BMD to an age- and sex-matched population, enabling potential insight into factors other than age contributing to reduce bone density [40–42].

Apart from imaging techniques, laboratory testing is an important contributor in making a diagnosis. Assessing levels of parameters such as serum calcium, phosphate and vitamin D could point to abnormal calcium and phosphate metabolism. A complete blood count can help indicate the occurrence of anemia or other blood disorders which may compromise bone health. Testing hormones, such as postmenopausal levels in women, may also be necessary in certain cases. Furthermore, markers of bone resorption and formation, such as serum osteocalcin or C-terminal telopeptide, can provide insight into the degree of bone turnover present. Though useful in understanding the underlying condition, laboratory tests alone are not technically sufficient for making a diagnosis. That being said, combining clinical assessment, medical history, imaging techniques and lab results is the key to correctly diagnosing osteoporosis and ensuring appropriate management. In this regard, consulting a healthcare professional such as a rheumatologist or endocrinologist is paramount [43–45].

Fourthly, electronic health records can be utilized to offer clinical decision support, alerting healthcare providers when osteoporosis screening is due primarily based on age, risk factors, or previous dual-energy X-ray absorptiometry results. These reminders can prompt healthcare providers to order appropriate screening assessments [46].

Fifthly, collaboration between primary care physicians, gynecologists, endocrinologists, and other relevant healthcare experts is vital for effective screening and management of osteoporosis. This collaboration facilitates the coordination of care, interpretation of screening results, and implementation of appropriate interventions. Overall, by integrating osteoporosis screening into routine care of women, healthcare providers can identify individuals at risk, initiate timely interventions, and decrease the burden of fractures and associated complications [46].

Medications

Bisphosphonates, selective estrogen receptor modulators, and denosumab are all forms of treatment that can assist in diminishing the rate of bone dissolution and fracture risk. Bisphosphonates commonly used in the treatment of osteoporosis include: alendronate (fosamax), risedronate (acteonel), ibandronate (boniva) and zoledronic acid (reclast or zometa). They function by suppressing the process of bone breakdown, which subsequently aids in raising bone density and diminishing the likelihood of fractures among individuals suffering
from osteoporosis. Examples of selective estrogen receptor modulators (SERMs) are raloxifene (evista) and bazedoxifene/conjugated estrogens (duavee). Selective estrogen receptor modulators function by specifically attaching to estrogen receptors within various tissues, leading to estrogen-like responses in certain organs such as bones, while simultaneously exerting anti-estrogenic effects in other tissues, like breast tissue. Denosumab is a monoclonal antibody employed in the management of osteoporosis and other conditions related to bone health. It is marketed under the brand names Prolia and Xgeva, each with distinct dosing schedules tailored to the specific medical condition. Denosumab works by inhibiting the function of a protein known as receptor activator of nuclear factor kappa-B ligand (RANKL). RANKL plays a pivotal role in the natural process of bone resorption, wherein old bone is broken down and replaced by new bone tissue [46, 47].

Through its ability to block RANKL, denosumab effectively reduces bone resorption, resulting in heightened bone density and a lowered risk of fractures in women suffering from osteoporosis. It is of paramount significance for individuals to access professional medical advice before selecting an appropriate remedy, to ensure that the needs of each person are taken into consideration. Women must be educated on the associated potential side-effects and contraindications of each of their available options in order to guarantee their safety (Table 3) [20, 24, 41, 48].

Alternative therapies
Numerous orthodox medications designed to prevent and treat osteoporosis exist, yet their effectiveness is hindered by their significant side effects. This highlights the pressing demand for novel treatment alternatives. An encouraging avenue involves exploring alternative methods for preserving bone health and addressing osteoporosis prevention and treatment [49]. Alternative therapies for osteoporosis in women can complement traditional medical treatments. Herbal supplements containing calcium and vitamin D support bone health and calcium absorption. Red clover, rich in isoflavones, may reduce bone loss, but more research is needed. Horsetail, with silica, enhances collagen formation for bone health. Complementary therapies include acupuncture, which can alleviate osteoporosis-related pain and improve well-being. Yoga offers gentle weight-bearing exercises to enhance balance and muscle strength, reducing the risk of falls and fractures. Tai Chi, with slow, flowing movements, improves postural stability. Dietary modifications, such as the alkaline diet, which emphasizes fruits and vegetables, aim to reduce body acidity and potentially prevent bone loss, though scientific evidence is limited. Mind-body practices like mindfulness meditation and progressive muscle relaxation help women manage the emotional and psychological aspects of osteoporosis. These alternative approaches can enhance osteoporosis management alongside conventional treatments [50, 51].

Community support and education
To ensure the capabilities of women in the face of osteoporosis, it is vital to create a supportive environment and implement educational programs that will enable women to stay informed. Support groups, online resources and discussions among women enable them to take the necessary measures for their health, while diminishing any myths that could currently exist [35, 37, 52]. Seeking assistance via home healthcare, medication, and support networks can mitigate the adverse effects of osteoporosis. Numerous online resources offer readily accessible information on locating support groups, financial aid, and caregiver assistance. Support groups for osteoporosis include: the American Bone Health (https://americanbonehealth.org/), Healthline (https://www.healthline.com/health/osteoporosis/osteoporosis-emotional-support), The International Osteoporosis Foundation (https://www.osteoporosis.foundation/), The Bone Health & Osteoporosis Foundation (https://www.bonehealthandosteoporosis.org/osteoporosis-online-support-community/), and the NIH Osteoporosis and Related Bone Diseases National Resource Center (https://www.niams.nih.gov/health-topics/bone-health-and-osteoporosis). Some of the services render include: research, policy formulation, advocacy, training, education, awareness, prevention, diagnosis and treatment of osteoporosis and other musculo-skeletal related diseases. The Osteoporosis Online Support Community (https://www.bonehealthandosteoporosis.org/patients/patient-support/osteoporosis-support-community/) for instance, connects individuals living with or impacted by osteoporosis in a digital space, enabling them to exchange personal experiences and offer mutual support. Participation is opened to all individuals who have an interest in their bone health, those diagnosed with osteoporosis, caregivers, family members, and healthcare practitioners.

Other control strategies
Employers ought to promote bone health by providing workplace wellness packages. Such programs should include teaching on how to prevent osteoporosis, and tips on how to maintain a healthy lifestyle. Employers are also expected to provide flexibility in employees’ schedules and allowance for individuals with physical restrictions.

The adoption of such supportive measures can benefit employers by raising the productivity and morale of their female workers, while also lessening the financial burden generated by osteoporosis treatments. Additionally, mental care needs to be taken into account to address the mental impacts of osteoporosis. Giving support and counseling might be necessary to help manage emotional stress and depression. Encouraging resilience, a positive self-image and recognizing support groups can likewise instruct and help the recovery of those affected. By addressing the psychological impact of osteoporosis, women can enhance their overall well-being and quality of life. It is essential to identify and understand the emotional challenges associated with osteoporosis and provide the essential support to help women address the psychological aspects of living with osteoporosis [33].

<table>
<thead>
<tr>
<th>Medication</th>
<th>Method of use</th>
<th>Regimen</th>
<th>Common side effects</th>
<th>Contraindications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bisphosphonates</td>
<td>Oral (some intravenous)</td>
<td>Weekly or monthly (oral) To be taken on empty stomach</td>
<td>- Stomach upset</td>
<td>- Severe kidney disease</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- Heartburn/iritation of the esophagus</td>
<td>- History of allergic reactions</td>
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<td>- Jawbone problems</td>
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<td></td>
<td></td>
<td></td>
<td>- Atypical femur fractures</td>
<td></td>
</tr>
<tr>
<td>Selective estrogen receptor modulators</td>
<td>Oral</td>
<td>To be taken daily with or without food</td>
<td>- Hot flashes</td>
<td>- Pregnancy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Leg cramps</td>
<td>- History of blood clots</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Blood clots (rare)</td>
<td>- History of breast cancer (consider benefit-risk)</td>
</tr>
<tr>
<td>Denosumab</td>
<td>Subcutaneous injection (under the skin)</td>
<td>Every six months</td>
<td>- Back pain</td>
<td>- History of hypocalcemia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Musculoskeletal pain</td>
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<td></td>
<td></td>
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<td>- Low calcium level in the blood</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- Skin infections (rare)</td>
<td></td>
</tr>
</tbody>
</table>

Table 3 Method of use, regimen, side effects, and contraindications of osteoporosis medications

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Conclusion

Osteoporosis poses a global health challenge for women, and its prevalence varies among different racial and ethnic groups. Asian women have a higher susceptibility, whereas African-American women face a lower risk compared to Caucasian women. To address this diversity, it is crucial to implement customized approaches that take into account genetic and cultural disparities. While osteoporosis is commonly linked to aging, maintaining bone health is an ongoing endeavor. The recommendations in this article primarily target older women but can be adapted to younger demographics, including adolescents and women in their reproductive years, with adjustments tailored to their specific requirements. Individual health factors such as medical conditions, family history, and genetic predispositions may necessitate personalized strategies and medical interventions. Cultural practices and socioeconomic status play a significant role in influencing nutrition, physical activity, and access to healthcare, impacting the feasibility and effectiveness of recommendations in various communities. Therefore, it is imperative to conduct community-specific outreach and interventions that acknowledge the distinctive characteristics and needs of women from diverse backgrounds. To ensure broad-reaching impact and efficacy, future initiatives should: conduct comprehensive studies and interventions encompassing various demographic groups, age ranges, and health situations. Initiate healthcare campaigns that are culturally sensitive, particularly targeting underserved communities. Collaborate with local institutions and schools to facilitate outreach efforts. Provide cost-free or affordable osteoporosis screenings, especially for elderly individuals, utilizing mobile clinics and health fairs. Advocate for accessible telehealth services in remote regions, ensuring financial feasibility. Train healthcare professionals in cultural competence and ensure the availability of interpreters. Involve community health workers from within these communities to provide education and conduct screenings. Establish mobile clinics through collaborations with local organizations. Work in partnership with advocacy organizations to address healthcare access policy issues. Collect data on healthcare disparities among underserved populations. Foster partnerships with local community-based groups and leaders. Implement public awareness campaigns aimed at destigmatizing healthcare-seeking behavior. Empowering all women, regardless of their backgrounds, to prioritize bone health necessitates comprehensive approaches that encompass nutrition, physical activity, lifestyle adjustments, hormonal well-being, and community support. These strategies empower women to mitigate the risk of osteoporosis, maintain their independence, and lead active and productive lives. Timely detection, proper management, and adherence to a bone-healthy lifestyle are pivotal in preserving robust and resilient bones.

References


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