

Episode #41 – Osteoporosis July 23, 2021

Overview

Osteoporosis is a metabolic bone disease characterized by low bone density, deterioration of bone tissue, and an increase risk of fracture. Osteoporosis is known as the "silent disease" because bone deterioration can occur asymptomatically over several years and by the time bones fracture, the disease has significantly progressed and more difficult to treat. [1] [2]

Osteoporosis has been referred to as "a childhood disease with old age consequences," because the bone mass attained in childhood and adolescence is a determinant of lifelong bone health. Up to 90% of peak bone mass is acquired by age 18 in females and age 20 in males, making youth the optimal time for individuals to invest in their bone health through proper nutrition and plenty of physical activity. Around the age of 30 years, for most people, skeletal bone mass has peaked reaching its maximum strength and density. [3] [4]

The most common fracture sites associated with osteoporosis are the hip, vertebrae of the spine (i.e., vertebral compression fractures), wrist, and shoulder. Vertebral compression fractures are the most common osteoporosis-related fracture. Osteoporotic fractures can lead to disfigurement, lowered self-esteem, reduced or loss of mobility, and decreased independence. Osteoporotic fractures are also associated with considerable morbidity, mortality, and costs. For example, 28% of women and 37% of men who fracture a hip will die within the following year. [2] [5]

Hopkins et al. (2016) calculated the annual cost of osteoporosis in Canada at over $4.6 billion in 2014, which included direct costs (e.g., hospitalizations, outpatient care, prescription drugs) and indirect costs (e.g., time lost from work, caregiver wage loss). [6]

Osteoporosis can occur at any age and affects both women and men. However, it is more common among women and older people. Men in their fifties do not experience the rapid loss of bone mass as women do. Women approaching menopause lose bone at an increased rate, approximately 2-3% per year. By age 65 or 70, though, men and women lose bone mass at the same rate and calcium absorption decreases in both sexes. Calcium is an essential nutrient for bone health throughout life. [2] [4] [5] [7] [8]

Prevalence of osteoporosis

Approximately, 2 million Canadians are affected by osteoporosis, with a higher prevalence among individuals 50 years of age or older. At least 1 in 3 women and 1 in 5

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men will experience an osteoporotic fracture in their lifetime. Approximately, 14% of individuals with a wrist fracture will have a repeat fracture within 3 years and over 50% of individuals with a hip fracture will have another fracture within 5 years. There is a 20% risk of having a second vertebral fracture within the first 12 months following an initial vertebral fracture. [5] [7]

Fragility fractures[1] represent 80% of all fractures in menopausal women over the age of 50 years. Osteoporotic fractures are more common than heart attack, stroke, and breast cancer combined. Moreover, the prevalence of osteoporosis in Canada is predicted to increase as the population grows and ages. [5] [7]

According to the 2020 report from the Canadian Chronic Disease Surveillance System:

- In 2015-2016, 2.2 million (11.9%) Canadians 40 years and older had osteoporosis; approximately 80% were women.
- The risk of osteoporosis doubled every 5 years between 40 to 60 years of age.
- There were 147 hip fractures per 100,000 individuals 40 years and older.
- Women were twice more likely to fracture their hip compared to men.
- Approximately 25% who fractured a hip died of any cause within the following year. This risk was 1.3 times higher for men.
- Fewer than 20% of individuals who have a fracture receive an osteoporosis diagnosis, bone mineral density test, or osteoporosis medication within the following year. Men were less apt to receive any intervention. [2]

Treatment of vertebral compression fractures

Treatment for osteoporotic vertebral compression fractures may include:

- Pharmacologic treatment for osteoporosis
- Analgesics
- Physical therapy to learn correct lifting techniques and exercises to strengthen paravertebral muscles.
- Back bracing to provide external support to limit the motion of fractured vertebrae. However, its efficacy is unclear.
- Surgery (e.g., vertebroplasty, kyphoplasty[2]), if conservative treatment options are ineffective and other specific criteria are met. [9] [10] [11]

Types of osteoporosis

There are two main types of osteoporosis: primary and secondary. Primary osteoporosis occurs spontaneously. Secondary osteoporosis is caused by other disorders and/or drugs.

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[1] A fragility fracture results from minimal trauma (e.g., falling out of bed or from standing height), normal stresses (e.g., lifting, bending, twisting, coughing, sneezing), or no identifiable trauma. A fragility fracture is both a sign and a symptom of osteoporosis. A fragility fracture increases an individual's risk for future fragility fractures. Example of a fragility fracture is an osteoporotic vertebral compression fracture. [19] [20]

[2] Refer to https://emedicine.medscape.com/article/1835633-overview#a1 for more information on vertebroplasty and kyphoplasty.

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Primary osteoporosis

Greater than 95% of osteoporosis in women and approximately 80% in men is primary osteoporosis, with most cases occurring in postmenopausal women and in older men. A main cause of osteoporosis is lack of estrogen, especially due to the rapid decline that takes place at menopause. In fact, most men over 50 years have higher estrogen levels than postmenopausal women. However, these levels in men decrease with age and low estrogen levels are associated with osteoporosis in both women and men. Estrogen deficiency increases bone resorption, resulting in rapid bone loss. In men, low levels of male sex hormones also contribute to osteoporosis.

Bone loss is even more profound if calcium intake or vitamin D levels are low. Low levels of vitamin D led to calcium deficiency, and increased activity of the parathyroid glands (hyperparathyroidism) causes the glands to release excessive parathyroid hormone, which can also stimulate bone breakdown. For unidentified reasons, bone production also decreases. [12]

Secondary osteoporosis

Less than 5% of osteoporosis in women and about 20% in men is secondary osteoporosis. Disorders that may cause secondary osteoporosis include chronic kidney disease and hormonal disorders (e.g., Cushing disease, hyperthyroidism, hyperparathyroidism, hypogonadism,[3] high levels of prolactin,[4] and diabetes mellitus).

Certain types of cancer (e.g., multiple myeloma) and other chronic diseases (e.g., rheumatoid arthritis) can also cause secondary osteoporosis. Drugs that may cause secondary osteoporosis include corticosteroids, progesterone, thyroid hormones, antiseizure drugs, and some chemotherapy drugs. Excessive alcohol or caffeine intake and tobacco smoking can contribute to osteoporosis. [12]

Idiopathic osteoporosis

A third type of osteoporosis is considered idiopathic. Idiopathic osteoporosis is rare and occurs in premenopausal women, men under 50 years, and children and adolescents with normal hormone and vitamin D levels, and with no obvious reason to have bone loss. [12]

Pathophysiology of osteoporosis

Bone is constantly being resorbed and formed (i.e., remodelled) by osteoclasts and osteoblasts, respectively. Osteoclasts and osteoblasts are regulated by parathyroid hormone (PTH), estrogen, calcitonin, vitamin D, various cytokines, and other local factors, such as prostaglandins. Bone resorption and formation are usually closely balanced. However, osteoporosis will occur when bone resorption occurs at a faster rate than bone formation.

[3] Hypogonadism occurs when the body's sex glands produce little or no hormones.

[4] Prolactin is hormone produced by the pituitary gland that stimulates milk production after childbirth. Prolactin levels are normally high for pregnant individuals and new mothers, otherwise levels are low in men and women. High levels may be caused by a prolactinoma (a benign tumour of the pituitary gland), hypothyroidism, disease of the hypothalamus, or liver disease. [40]

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Osteoporosis affects both cortical and trabecular (cancellous) bone where cortical thickness and size and number of trabeculae are reduced, causing increased porosity. Trabeculae can be disrupted or completely absent. Trabecular bone loss occurs more rapidly than cortical bone loss because trabecular bone is more porous and turnover is higher. However, loss of both cortical and trabecular bone contributes to skeletal fragility. [4]

Causes of osteoporosis

The likeliness of developing osteoporosis depends partly on how much bone mass a person attained in their youth. However, no single cause for osteoporosis has been identified. [5] [13]

Osteoporosis risk factors

A number of factors can increase the likelihood of developing osteoporosis, such as lifestyle choices, medical conditions, medications, and non-modifiable risks.

Diet **–** Inadequate dietary intake of calcium, phosphorus, magnesium, and vitamin D increases risk of bone loss. Vitamin D is essential for dietary calcium absorption.[5]

Physical activity – Sedentary lifestyle increases risk of osteoporosis as well as long periods of inactivity, such as long-term bed rest.

Body weight – A low body mass index (BMI) increases risk of osteoporosis.

Tobacco – Any type and amount of tobacco smoking contributes to bone loss and increases the risk of osteoporosis. A study by Sophocleous et al. (2016) found heavy cannabis use was also associated with low bone mineral density and an increase risk of fractures. [14]

Alcohol – High alcohol intake, greater than or equal to 3 standard drinks[6] per day on a consistent basis, can adversely affect bone mass.

Eating disorders – Severely restricting food intake and being underweight increases bone fragility in both men and women.

Malabsorption problems – Conditions that impact nutrient absorption, such as celiac disease and Crohn's disease increase risk of osteoporosis.

Gastrointestinal surgery – Surgery to reduce the size of the stomach (e.g., for weight loss) or to remove part of the intestine for medical conditions (e.g., blockage, cancer) interferes with nutrient absorption, including calcium.

[5] Refer to Episode #22 and #24 for more information on vitamin D.

[6] In Canada, a standard drink is 17.05 ml or 13.45 g of pure alcohol, which is equivalent to a 341 ml (12 oz.) bottle of 5% alcohol beer, a 341 (12 oz.) bottle of 5% alcohol cider, a 142 ml (5 oz.) glass of 12% alcohol wine, or a 43 ml (1.5 oz.) shot glass of 40% alcohol spirits. [41]

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Medical conditions – The risk of osteoporosis is increased in individuals who have certain medical conditions, such as rheumatoid arthritis, inflammatory bowel disease, liver or kidney disease, cancer, lupus, hyperparathyroidism, hyperthyroidism, and multiple myeloma.

Medications – Certain medications can cause bone loss. Long-term use of oral or injected corticosteroid medications (e.g., prednisone, cortisone) interfere with the bone formation. Corticosteroids are used to treat rheumatoid arthritis, asthma, inflammatory bowel disease, and other conditions. Bone damage more often occurs from the long-term use of corticosteroid pills (e.g., prednisone), when administered at a daily dose of 7.5 mg or more, for 3 or more months (not necessarily consecutive months) in the previous year. Corticosteroid joint injections, inhalers, eye drops, or skin creams have not been shown to increase osteoporosis risk. [15] [16]

Osteoporosis has also been associated with medications used to treat conditions such as seizures, endometriosis, cancer, transplant rejection, and gastric reflux (e.g., proton pump inhibitors).

Proton pump inhibitors (e.g., Losec, Nexium, Prevacid, Pantoloc, Tecta, Pariet) treat acid-related diseases, such as reflux, heartburn, and ulcers, by reducing the amount of acid produced in the stomach. Long-term use (i.e., several years) of these medications, particularly at high doses, has been associated with an increased hip fracture risk in older adults. This may be caused by less calcium absorption from foods due to decreased stomach acid. [16]

Age – The risk of osteoporosis increases with age in both women and men.

Sex – As noted above, women are at greater risk of developing osteoporosis than men. Estrogen is essential for bone health. After menopause, estrogen levels decline, which can lead to a rapid loss in bone density. Further, women are at greater risk of developing osteoporosis if they have:

- Early menopause before the age of 45.
- A hysterectomy before the age of 45, especially if the ovaries were also removed.
- Amenorrhea for more than 6 months as a result of overexercising or excessive dieting.

Ethnicity – Certain ethnicities, including individuals of white or Asian descent are at greater risk of developing osteoporosis. [4]

Family history – A family history of osteoporosis increases risk, especially if a parent fractured a hip. [4] [13] [17] [18]

Symptoms of osteoporosis

Osteoporosis is typically asymptomatic until a bone breaks or one or more vertebrae collapse (i.e., vertebral compression fracture). Nonvertebral fractures are typically symptomatic. Approximately, two thirds of vertebral compression fractures are asymptomatic. Also, individuals may have chronic back pain from other medical

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conditions (e.g., osteoarthritis) and not realize they sustained a vertebral compression fracture. [4]

Symptoms of vertebral compression fractures include severe back pain, loss of height over time, and dorsal kyphosis (an exaggerated forward rounding of the spine causing hunched or stooped posture), with exaggerated cervical lordosis (dowager's hump). [4]

Bones affected by osteoporosis may fracture spontaneously or as the result of minor falls (e.g., falling from standing height) or normal stresses (e.g., lifting, bending), in other words a fragility fracture. A fragility fracture increases an individual's risk for future fragility fractures. [19] [20]

Risk indicators for osteoporosis

Osteoporosis may be suspected in:

- All women 65 years or older.
- Women between menopause and age 65 who have risk factors for osteoporosis.
- All women and men with a previous fragility fracture, even if the fracture occurred at a young age.
- Adults 65 years or older with loss of 2 cm or more in height or unexplained back pain, which is sign and symptom of possible vertebral compression fracture. [21]
- Individuals whose bones appear to have reduced cortical thickness or who have vertebral compression fractures on radiographic images.
- Individuals who are at risk of developing secondary osteoporosis. [4]

Diagnosis of osteoporosis

To diagnose osteoporosis, assess risk of fracture, and determine the need for treatment, a physician will usually order a bone density scan (i.e., dual-energy x-ray absorptiometry).

<u>Dual-energy x-ray absorptiometry (DXA)</u>

Bone density is measured using dual-energy x-ray absorptiometry **(**DXA) to screen individuals at risk of fracture, to provide a quantitative measure of bone loss, and to monitor individuals undergoing osteoporosis treatment. Bone density measurements are usually taken of the spine and of one hip or both. [4]

The results of DXA are reported as T-scores. The T-score is the number of standard deviations a person's bone density lies below the average value of a healthy, young person of the same sex and ethnicity. According to the World Health Organization a T-score < -1.0 and > -2.5 characterizes osteopenia.[7] A T-score ≤ -2.5 characterizes osteoporosis. [4] [22] [23]

[7] Osteopenia means decreased bone mass. Two bone diseases that decrease bone mass are osteoporosis and osteomalacia. Osteomalacia is due to impaired mineralization, usually from severe vitamin D deficiency or abnormal vitamin D metabolism. In osteomalacia, the bone mineral to bone matrix ratio is low. Whereas in osteoporosis, the bone mass decreases; however, the bone mineral to bone matrix ratio is normal. [4] Refer to Episode #22 for more information on osteomalacia.

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Plain x-rays

Plain x-rays are important for determining fractures resulting from bone loss. However, they are not useful for diagnosing osteoporosis because x-rays only reveal decreased radiodensity and loss of trabecular structure after approximately 30% of bone has been lost. Diagnosis of osteoporosis is confirmed by bone density testing. [4]

Other tests

Sometimes serum vitamin D and calcium levels are assessed, as well as testing for causes of secondary osteoporosis. [12]

Treatment of osteoporosis

Objectives of osteoporosis treatment are to preserve bone mass, prevent fractures, reduce pain, and maintain function. Treatment may include risk factor modification, supplements, and pharmacologic therapy. Treatment recommendations are based on various factors, such as bone mineral density and other risk factors (e.g., age, sex, prior fracture, family history, physical inactivity, smoking, etc.) that contribute to osteoporosis. [24]

Risk factor modification

Risk factor modification may include smoking cessation, alcohol reduction, resistance training, and fall prevention. Fall prevention includes exercising regularly (e.g., balance exercises), wearing nonslip shoes, standing slowly after sitting or lying down, having a healthcare provider review all prescription and non-prescription drugs for medications that could increase risk of falls, correcting physical hazards (e.g., removing tripping hazards, increasing lighting, adding grab bars) and consulting with other healthcare professionals, such as a physiotherapist, occupational therapist, or chiropractor. [25]

Medications that can increase risk of falls include:

- Excessive thyroid replacement medications (e.g., Synthroid, Eltroxin) has been associated with muscle weakness and abnormal heart rhythms in older adults, which can increase the risk of falls. Excessive thyroid hormone replacement can also reduce bone mineral density and bone quality, which may lead to fractures.
- Drugs that affect the central nervous system (e.g., some antidepressants, sleep aids [e.g., benzodiazepines], and antipsychotic drugs) can lead to falls by causing drowsiness, confusion, blood pressure drop, abnormal heart rhythms, or altered function of nerves and/or muscles. Falling risk increases with polydrug use, especially during the start or sudden discontinuation of these drugs.
- Some hypertensive drugs can increase risk of falls in older adults during the initial start of treatment.
- Narcotic and opioid medications used for pain (e.g., morphine) have been associated with falling because of effects on the central nervous system, which may lead to disruption of balance and dizziness. [16]

Calcium and vitamin D supplementation

Calcium and vitamin D supplements maybe recommended by a healthcare provider.

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Pharmacologic therapy

There are several pharmacologic therapies available for osteoporosis, including:

- Antiresorptive agents, such as bisphosphonates, selective estrogen receptor modulators (SERMs), receptor activator for nuclear factor κ B (RANK) ligand inhibitor, and hormone therapy (estrogen/progesterone).
- An anabolic (bone-forming) agent, i.e., parathyroid hormone (PTH).
- An agent with both antiresorptive and anabolic effects, i.e., a sclerostin inhibitor.

These therapies have a range of dosing frequencies and administration routes. [4] [23] [26]

Pharmacologic therapy for osteoporosis

Bisphosphonates [27] [28]				
Drug name	**Alendronate**	**Etidronate**	**Risedronate**	**Zoledronic acid**
Brand name	Fosamax; Fosavance (Fosamax with vitamin D), generics available	Didrocal, generics available	Actonel; Actonel DR, generics available for Actonel	Aclasta, generics available
Mechanism of action	Bisphosphonates bind to the surfaces of bones and slow down bone resorption by osteoclasts allowing osteoblasts to work more effectively.			
Effectiveness	All four bisphosphonates increase bone density and reduce the risk of vertebral fractures. Alendronate, risedronate, and zoledronic acid have also been shown to reduce the risk of hip fractures and fractures of other bones.			
Use	Treatment of osteoporosis in postmenopausal women and in men; and in women and men of any age taking steroid medications.			
Administration	Daily first thing in morning, at least 1/2 hour before eating. Taken with 250 ml plain water. Stay upright (don't bend or lie down) for the first 1/2 hour and until after the first food of the day.	Etidronate tablet is taken daily for two weeks followed by a calcium tablet taken daily for an additional 10 weeks. Etidronate tablet is taken mid morning, mid afternoon, or evening with full glass of water at least 2 hours before and after eating. The calcium tablet is taken with food.	Daily (5 mg), once a week (35 mg), or once a month (150 mg) first thing in morning at least 1/2 hour before eating with a full glass of water. Stay upright (don't bend or lie down) for the first 1/2 hour and until after the first food of the day.	Once a year via 15-minute intravenous infusion by a healthcare provider.
Side effects	Common side effects: nausea, abdominal pain, and loose bowel movements. Infrequent reports of bone, joint, and/or muscle pain. Small risk of esophageal ulcers with alendronate and risedronate, especially if taken incorrectly. The most common side effects of zoledronic acid, usually lasting 1-2 days, are fever, pain in muscles, bones, or joints, and headache. Rare cases of kidney dysfunction following infusions of zoledronic acid have been reported, with the vast majority of cases being reversible. In very rare cases, alendronate, risedronate, and zoledronic acid have been linked to osteonecrosis of the jaw following dental surgery			

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Bisphosphonates [27] [28]	
	(e.g., dental extractions). Rare cases of atypical fractures of the femoral (thigh) bone have been reported with bisphosphonates.

Selective estrogen receptor modulators (SERMs) [29]	
Drug name	**Raloxifene**
Brand name	Evista
Mechanism of action	SERMs are non-hormonal medications that mimic estrogen in some tissues of the body, such as the bones, and block estrogen's effects in other tissues (e.g., uterus, breast). Estrogen helps to build and maintain bone density. During menopause estrogen level decreases as ovaries cease to function leading to decreased bone density.
Effectiveness	Increases bone density and prevents fractures of the spine.
Indication(s) for use	Treatment of osteoporosis in postmenopausal women.
Administration	One 60 mg tablet taken daily, preferably at the same time each day.
Side effects	May increase hot flashes. Increased risk of venous thromboembolism, similar as women using hormone replacement therapy.

Receptor activator for nuclear factor κ B (RANK) ligand inhibitors [30] [31]	
Drug name	**Denosumab**
Brand name	Prolia
Mechanism of action	Human monoclonal antibody that prevents RANKL-RANK interaction and thus inhibits osteoclast development and activation.
Effectiveness	Reduces the risk of fractures the spine, hip, and other sites in women with postmenopausal osteoporosis and in men with osteoporosis.
Indication(s) for use	Used to reduce risk of fractures in postmenopausal women with osteoporosis and in men with osteoporosis with high fracture risk. Also indicated as a treatment to increase bone mass in men with nonmetastatic prostate cancer on androgen deprivation therapy with high fracture risk, and as a treatment to increase bone mass in women with nonmetastatic breast cancer on adjuvant aromatase inhibitor therapy with low bone mass and high fracture risk. To increase bone mass for the treatment and prevention of glucocorticoid-induced osteoporosis in women and men with high fracture risk.
Administration	Subcutaneous injection, 60 mg/ml solution twice yearly by a healthcare provider.
Side effects	Side effects may include pain in muscles, arms, legs, or back; red, dry, and/or itchy skin. Slightly increases risk of cellulitis. Rare cases of osteonecrosis of the jaw have been reported.

Hormone therapy (HT) [32]	
Drug name	**Estrogen/progesterone**
Mechanism of action	Following menopause, the body produces much less estrogen and progesterone, resulting in bone density loss. Estrogen/progesterone treatment increases these hormones to the lowest level required to prevent bone loss. Treatment consists of estrogen alone or combination of estrogen and progesterone
Effectiveness	Estrogen/progesterone treatment increases bone density and help prevent spine and hip fractures.

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Hormone therapy (HT) [32]	
Indication(s) for use	Used to treat osteoporosis in postmenopausal women who are also experiencing menopausal symptoms (e.g., hot flashes, night sweats).
Administration	Daily dose of 0.625 mg of oral conjugated equine estrogen or its equivalent. Progesterone is also taken to reduce the risk of developing uterine cancer unless the person has had a hysterectomy. Estrogen/progesterone are available in pill and patch form and in a variety of regimens.
Side effects	Depression, headaches, breast tenderness, premenstrual syndrome, skin irritation, weight gain, menstrual bleeding. Experimenting with doses, types (pills, patches), and regimens may help eliminate or minimize these side effects. Increased risk for breast cancer, stroke, and cardiovascular disease in women who take estrogen/progesterone for more than 5 years.

Parathyroid hormone (PTH) [33] [28]	
Drug name	**Teriparatide**
Brand name	Forteo (generics available)
Mechanism of action	Classified as a bone-forming agent. Activates osteoblast cells to generate new bone faster than old bone is resorbed.
Effectiveness	Increases bone density and reduces risk of vertebral fractures and other fractures related to osteoporosis.
Indication(s) for use	Used to treat severe osteoporosis in postmenopausal women with high fracture risk or who have failed or are intolerant to other osteoporosis therapy. Also used to increase bone mass in men with primary or hypogonadal (low testosterone) severe osteoporosis who have failed or are intolerant to other osteoporosis therapy. Also used to treat osteoporosis associated with sustained systemic glucocorticoid therapy in women and men with increased risks of fracture.
Administration	Sub-cutaneous injection into the thigh or abdominal wall, 20 mcg once a day. This medication should not be taken for longer than 24 months.
Side effects	Possible side effects include dizziness, nausea, and leg cramps.

Sclerostin inhibitor [34]	
Drug name	**Romosozumab**
Brand name	Evenity
Mechanism of action	Monoclonal antibody against sclerostin* with both antiresorptive and bone-building effects. Increases bone mineral density in the lumbar spine and hip, and in both trabecular and cortical bone, resulting in increased bone strength and reduced fracture risk, while also decreasing bone resorption. *Sclerostin a small protein made by osteocytes that inhibits new bone formation by osteoblasts. [4]
Effectiveness	Reduces risk of fractures of spine, hip, and other sites in women with postmenopausal osteoporosis.
Indication(s) for use	Treatment of osteoporosis in postmenopausal women at high risk of fracture, defined as a history of osteoporotic fracture, or multiple risk factors for fracture; or who have failed on or are intolerant of other osteoporosis medications.

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Sclerostin inhibitor [34]	
Administration	Two injections under the skin, 105 mg/1.17 ml solution each, one after the other, by a healthcare provider once a month for a year (12 doses). If required, an anti-resorptive agent may be considered after therapy completion
Side effects	Most common side effects: joint pain, headaches. Other potential side effects include increased risk of cardiovascular events, including heart attack, stroke, and cardiovascular death; low blood calcium levels; osteonecrosis of the jaw; atypical thigh fractures.

Osteoporosis prevention

A healthy lifestyle can help prevent, delay, or reduce bone loss, including:

- Regular physical activity involving weight-bearing (e.g., walking, jogging, climbing stairs, skipping rope) and resistance training is beneficial for bone development and maintenance. Balance exercises, such as tai chi, are helpful for people who are at risk of falling.
- Following *Canada's Food Guide*[8] to help ensure a balanced diet which includes a diet rich in calcium for healthy bone development. Good sources of calcium[9] include low fat dairy products, calcium-fortified beverages (e.g., soy beverage), dark green leafy vegetables, canned salmon and sardines with bones, tofu, almonds, and chickpeas. Individuals who are unable to obtain sufficient calcium through their diet, should speak to their healthcare provider for calcium supplement recommendations.
- Ensuring adequate vitamin D. Vitamin D is essential for bone development because it improves the body's ability to absorb calcium. Vitamin D is obtained through sun exposure, certain foods, and supplementation. Natural food sources of vitamin D[10] include fatty fish (e.g., salmon, trout, tuna), fish liver oils, and egg yolks. Other nutritional sources of vitamin D are fortified foods. In Canada, cow's milk and margarine must be fortified with vitamin D. Goat's milk, plant-based beverages (e.g., soy beverages), and some orange juices are vitamin D fortified. Vitamin D is produced in the skin in response to ultraviolet B (UVB) from sunlight. However, many factors affect vitamin D synthesis through sunlight exposure, such as winter season, older age, sunscreen use, and darker skin. Also, too much sunlight can cause skin cancer so vitamin D supplementation is often recommended to maintain bone health.
- Living a healthy lifestyle by not smoking and minimizing alcohol intake.
- Maintaining an appropriate body weight because being underweight increases the risk of osteoporosis.
- Taking osteoporosis agents and other medications as prescribed. [35] [13] [36] [37] [38] [12]

[8] Canada's Food Guide https://food-guide.canada.ca/en/
[9] For calcium content of some common foods refer to https://osteoporosis.ca/bone-health-osteoporosis/nutrition/calcium-requirements/
[10] For food sources of vitamin D refer to https://osteoporosis.ca/bone-health-osteoporosis/calcium-and-vitamin-d/vitamin-d/

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Daily recommended intake (DRIs) for calcium [36]		
Age group	**Recommended Dietary Allowance (RDA) per day**	**Tolerable Upper Intake Level (UL) per day**
Infants 0-6 months	200 mg ▫	1000 mg
Infants 7-12 months	260 mg ▫	1500 mg
Children 1-3 years	700 mg	2500 mg
Children 4-8 years	1000 mg	2500 mg
Children 9-18 years	1300 mg	3000 mg
Adults 19-50 years	1000 mg	2500 mg
Adults 51-70 years Men Women	 1000 mg 1200 mg	 2000 mg 2000 mg
Adults >70 years	1200 mg	2000 mg
Pregnancy & Lactation 14-18 years 19-50 years	 1300 mg 1000 mg	 3000 mg 2500 mg
▫Adequate Intake rather than Recommended Dietary Allowance.		
DRIs for calcium and vitamin D are based on the U.S. Institute of Medicine's (IOM) review of the Dietary Reference Intakes (DRIs) for vitamin D and calcium report released on November 30, 2010. The review was jointly commissioned and funded by the U.S. and Canadian governments. The IOM report states there are no additional health benefits associated with calcium intakes above the level of the new RDA. Total calcium intake should remain below the level of the new UL to avoid possible adverse effects. Long-term intakes above the UL increase the risk of adverse health effects, such as kidney stones.		

DRIs* for Vitamin D [36]		
Age Group	**Recommended dietary allowance (RDA) per day**	**Tolerable upper intake level (UL) per day**
Infants 0-6 months	400 IU (10 mcg) ▫	1000 IU (25 mcg)
Infants 7-12 months	400 IU (10 mcg) ▫	1500 IU (38 mcg)
Children 1-3 years	600 IU (15 mcg)	2500 IU (63 mcg)
Children 4-8 years	600 IU (15 mcg)	3000 IU (75 mcg)
Children and Adults 9-70 years	600 IU (15 mcg)	4000 IU (100 mcg)
Adults >70 years	800 IU (20 mcg)	4000 IU (100 mcg)
Pregnancy & Lactation	800 IU (20 mcg)	4000 IU (100 mcg)
* DRIs for vitamin D are based on maintaining skeletal health and have been set using the assumption that sun exposure is minimal. ▫ Adequate Intake rather than Recommended Dietary Allowance.		
The IOM report states there is no additional health benefit associated with vitamin D intakes above the level of the new RDA. Total vitamin D intake should remain below the level of the new UL to avoid possible adverse effects. Long-term intakes above the UL increase the risk of adverse health effects.		

Health Canada recommends people over the age of 50 years take a daily vitamin D supplement of 400 IU (10 mcg). [36]

Osteoporosis Canada recommends healthy adults between 19-50 years, including pregnant or breastfeeding individuals, require 400 – 1,000 IU daily. Adults over 50 years

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or younger adults at high risk (e.g., with osteoporosis, multiple fractures, or conditions affecting vitamin D absorption) should receive 800 – 2,000 IU daily. [39]

Take home messages

- Advise smoking cessation.
- Provide clients with dietary counselling (e.g., to ensure adequate vitamin D and calcium intake).
- Advise clients of the importance of adhering to prescribed osteoporosis regimes to reduce risk of fracture.
- Refer clients to a medical provider if osteoporosis is suspected.
- Refer clients at risk of falls to heathcare professions, such as occupational therapists, physiotherapists, chiropractors, for fall prevention strategies.
- Promote and encourage an active physical lifestyle for bone health.

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Client Resources

Osteoporosis Canada information line: 1-800-463-6842
Osteoporosis Canada operates a toll-free information line with access to trained volunteer counsellors who can discuss concerns, send relevant information, and refer individuals to local resources or local support groups where available.
Telephone: (416) 696-2663
Toll-free (English): 1-800-463-6842 (in Canada only)
Toll-free (French): 1-800-977-1778 (in Canada only)

Know your risk quiz. A quiz developed by Osteoporosis Canada to help individuals determine their osteoporosis risk to encourage conversation with their medical provider about their bone health and risk of breaking a bone.
https://osteoporosis.ca/risk#page-1

Exercises For Healthy Bones, Osteoporosis Canada
https://osteoporosis.ca/bone-health-osteoporosis/exercises-for-healthy-bones/

Calcium Calculator for individuals to calculate their calcium intake, developed by Osteoporosis Canada
https://osteoporosis.ca/bone-health-osteoporosis/calcium-calculator/#page-1

Calcium content of some common foods, Osteoporosis Canada
https://osteoporosis.ca/bone-health-osteoporosis/nutrition/calcium-requirements/

Vitamin D food sources, Osteoporosis Canada
https://osteoporosis.ca/bone-health-osteoporosis/calcium-and-vitamin-d/vitamin-d/

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Osteoporosis Canada has several downloadable booklets, facts sheets, and brochures on topics such as:

- Drug treatments
- Men and osteoporosis
- Nutrition
- Secondary osteoporosis
- Too fit to fall or fracture (multiple languages available)
- Your guide to strong bone (multiple languages available)

https://osteoporosis.ca/brochures-and-fact-sheets/

Public Health Agency of Canada has produced downloadable resources to assist with fall prevention:

- How to lower your fall risk https://www.canada.ca/en/public-health/services/publications/healthy-living/how-lower-your-fall-risk.html
- If you fall or witness a fall, do you know what to do? https://www.canada.ca/en/public-health/services/health-promotion/aging-seniors/publications/publications-general-public/you-fall-witness-a-fall-you-know-what.html
- Stay safe! (poster) https://www.canada.ca/en/public-health/services/health-promotion/aging-seniors/publications/publications-general-public/stay-safe-poster.html
- What to do after a fall... (poster) https://www.canada.ca/en/public-health/services/health-promotion/aging-seniors/publications/publications-general-public/what-after-a-fall-poster.html
- 12 steps to stair safety at home https://www.canada.ca/en/public-health/services/health-promotion/aging-seniors/publications/publications-general-public/stair-safety.html
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