



Module 4

OSTEOPOROSIS MANAGEMENT

Nonpharmacologic Prevention and Treatment of Osteoporosis

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Nonpharmacologic approaches include smoking cessation, weight-bearing exercise, fall prevention, and adequate daily intake of calcium and vitamin D.

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CME Needs Assessment

Osteoporosis or osteopenia occurs in about 44 million Americans, resulting in 1.5 million fragility fractures per year. The consequences of these fractures include pain, disability, depression, loss of independence, and increased mortality. The burden to the healthcare system, in terms of cost and resources, is tremendous, with an estimated direct annual USA healthcare expenditure of about \$17 billion.¹ With longer life expectancy and the aging of the baby-boomer generation, the number of men and women with osteoporosis or low bone density is expected to rise to over 61 million by 2020. Most patients with osteoporosis are not being diagnosed or treated. All patients should be counseled on the importance of regular weight-bearing exercise and adequate daily intake of calcium and vitamin D. Non-pharmacologic therapy to reduce the nonskeletal risk factors for fracture should be considered. These include fall prevention through balance training and muscle strengthening, removal of fall hazards at home, and wearing hip protectors if the risk of falling remains high.

Intended Audience

This continuing medical education program is intended for primary care physicians and those physicians who treat osteoporosis.

Educational Objectives

After completion of this program, physicians should be able to:

- Understand the role of lifestyle and dietary modifications in the prevention of osteoporosis
- Educate their patients on the recommended daily amounts of calcium and vitamin D
- Educate their patients on appropriate exercise programs and fall prevention measures.



Nonpharmacologic Prevention and Treatment of Osteoporosis

The bone mass attained early in life is perhaps the most important determinant of lifelong skeletal health. Persons with the highest peak bone mass after adolescence have the greatest protective advantage when bone density declines as a result of aging, illness, and diminished hormone production. Bone mass may be related not only to osteoporosis and fragility fractures later in life, but also to fractures in childhood and adolescence. Bone health would be improved if schools appropriately emphasized physical education and activity.^{2,3}

Genetic factors exert a strong and perhaps predominant influence on peak bone mass, but physiological, environmental, and modifiable lifestyle factors can also play a significant role. Among these are adequate nutrition and normal body weight, and regular physical activity. Thus, maximizing bone mass early in life presents a critical opportunity to reduce the impact of bone loss related to aging.³

Preventive strategies include consideration of dietary factors, exercise, smoking cessation (if relevant, especially in children and adolescents) and pharmacologic intervention.

Appropriate goals for an osteoporosis prevention program would include: optimizing skeletal development with maximal peak bone mass at skeletal maturity;

- preventing age-related and secondary causes of bone loss;
- preserving the structural integrity of the skeleton; and
- preventing fractures.

However, these measures alone cannot ensure the prevention of osteoporosis. Depending on individual risk factors and bone mineral density, preventive measures may require the use of pharmacologic therapies as well.

Prevention: Lifestyle and Dietary Modifications

In their physician guidelines for osteoporosis, the National Osteoporosis Foundation identified the following potentially modifiable risk factors for osteoporotic fracture (Table 1).⁵

Patients should be educated to understand that the lifestyle choices they make in their youth will influence future health. While this is readily apparent for cigarette smoking, alcoholism and physical activity, the patient may not be aware of the long-term health consequences of inadequate calcium intake—particularly its impact on reducing peak bone mass, increasing the risk that the inevitable age-related and menopause-related bone loss may result in osteoporosis.

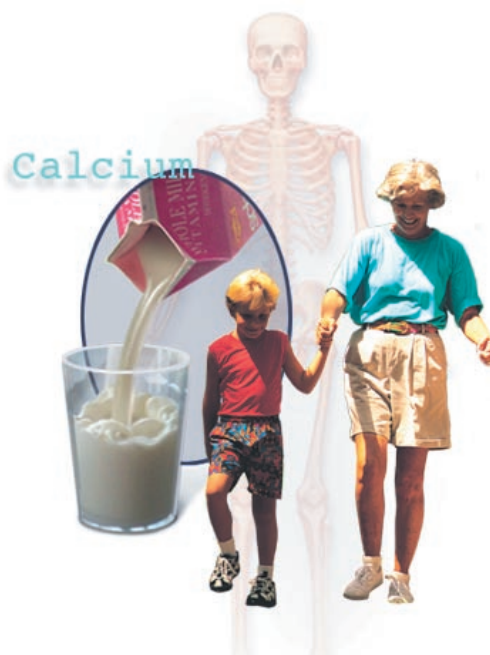


Table 1. Major Risk Factors for Osteoporosis and Related Fractures in Caucasian and Postmenopausal Women

- Personal history of fracture as an adult
- History of fragility fracture in a first-degree relative
- Low body weight (< about 127 lbs)
- Current smoking
- Use of oral corticosteroid therapy for more than 3 months

Additional Risk Factors

- Impaired vision
- Estrogen deficiency at an early age (<45 years)
- Dementia
- Poor health/frailty
- Recent falls
- Low calcium intake (lifelong)
- Low physical activity
- Alcohol in amounts >2 drinks/day

Reprinted with permission from the National Osteoporosis Foundation Physician's Guide to Prevention and Treatment, 2003.

Adequate physical activity is highly promoted as a general health measure. There have been a number of controlled trials that have examined the relationship between exercise programs and BMD, and suggest that load-bearing exercises are most effective in preserving skeletal mass.⁶ In terms of fracture risk, exercise may prompt beneficial bone remodeling, and reduce the risk of falls by increasing muscle strength. Certainly, lack of physical exercise (*i.e.*, immobilization or bed rest) produces rapid disuse atrophy of muscles and bone loss. However, excessive exercise, resulting in amenorrhea, may also be associated with bone loss.

Calcium and Vitamin D

As suggested by randomized controlled trials, dietary calcium and vitamin D supplementation increases bone mass in older adults and decreases fracture risk.⁷⁻⁹ Therefore, both calcium and vitamin D supplementation should be considered in all elderly patients.^{5,10-11} Vitamin D supplementation should also be considered in those patients suspected to be vitamin D deficient. Calcium and vitamin D supplementation are also routinely given as an adjunct to specific drug therapy for secondary prevention of osteoporosis. Calcium absorption decreases with advancing age, and renal excretion of calcium increases; consequently, these considerations are particularly important in older adults.

Table 2. Recommendations for Calcium Intake

Age	Recommended Intake
Infants (birth to 6 months)	210 mg/d
(7 to 12 months)	270 mg/d
Young children (1 to 3 years)	500 mg/d
Older children (4 to 8 years)	800 mg/d
Adolescents (9 to 18 years)*	1300 mg/d
Men and women (19 to 50 years)*	1000 mg/d
Men and women (51 and older)	1200 mg/d

*Pregnancy and lactation needs are the same as for non-pregnant women.

Adapted from Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. Food and Nutrition Board. Institute of Medicine. 1997. National Academy Press, Washington, DC.

Calcium

Adequate calcium intake is the cornerstone of any osteoporosis prevention (or treatment) plan. Calcium supplementation should occur whenever the recommended daily intake of calcium is not being met. It has been shown that calcium absorption decreases with advancing age, and that renal excretion of calcium increases. Intra- and extracellular levels of calcium are tightly controlled. Since bone is a major reservoir for calcium, bone mass may be sacrificed to maintain target intra- and extracellular concentrations. The Institute of Medicine (IOM) Food and Nutrition Board's Dietary Reference Intakes (DRIs) for calcium, phosphorous, magnesium, vitamin D, and fluoride, which have replaced the previous Recommended Daily Allowances, specify adequate

Table 3. Estimating Daily Dietary Calcium Intake

Step 1: Estimate calcium intake from calcium rich foods*

Product	No. of Servings/Day	Calcium Content per Serving, mg	Calcium, mg
Milk (8 oz)	_____ X	300	= _____
Yogurt (8 oz)	_____ X	400	= _____
Cheese (1 oz)	_____ X	200	= _____
Fortified foods or juices	_____ X	80 – 1000**	= _____

Step 2: Total from above +250 mg from nondairy sources = total dietary calcium

*About 75% to 80% of the calcium consumed in American diets is from dairy products.

**Calcium content of fortified foods varies

Permission from the National Osteoporosis Foundation. Physician's Guide to Prevention and Treatment of Osteoporosis. 2nd ed. Belle Meade, NJ : Exerpta Medica Inc.;2003. ⁵

Table 4. Some Commonly Used Calcium Supplements

Type	Brand Name	Strength per Tab (mgs)	Elemental Calcium
Calcium Carbonate	Alka Mints	850	340
	Caltrate	1600	600
	OsCal	625 or 1250	250 or 500
	Titralac	420	168
	Titralac Liquid	1000	400
	Tums/Tums E-X	500 or 750	200 or 300
	Tums Ultra/Tums 500	1000 or 1250	400 or 500
Calcium Citrate	Citrical Liquitabs	2376 mg/tab	500
	Citrical	950 mg/tab	200
	Citrical Caplets, +D	1500	315 + 200 IU vitamin D

Understanding Osteoporosis. Chicago, IL: American Medical Association; 2000.

Table 5. Selected Food Sources of Calcium

Food	Amount (mg)	Percent DV
Yogurt, plain, low fat, 8 oz	415	42%
Yogurt, fruit, low fat, 8 oz.	245-384	25%-38%
Sardines, canned in oil, with bones, 3 oz.	324	32%
Cheddar cheese, 1 ½ oz shredded	306	31%
Milk, non-fat, 8 fl oz.	302	30%
Milk, reduced fat (2% milk fat), no solids, 8 fl oz.	297	30%
Milk, whole (3.25% milk fat), 8 fl oz	291	29%
Milk, buttermilk, 8 fl oz.	285	29%
Milk, lactose reduced, 8 fl oz.**	285-302	29-30%
Mozzarella, part skim 1 ½ oz.	275	28%
Tofu, firm, made w/calcium sulfate, ½ cup***	204	20%
Orange juice, calcium fortified, 6 fl oz.	200-260	20-26%
Salmon, pink, canned, solids with bone, 3 oz.	181	18%
Pudding, chocolate, instant, made w/ 2% milk, ½ cup	153	15%
Cottage cheese, 1% milk fat, 1 cup unpacked	138	14%
Tofu, soft, made w/calcium sulfate, ½ cup***	138	14%
Spinach, cooked, ½ cup	120	12%
Instant breakfast drink, various flavors and brands, powder prepared with water, 8 fl oz.	105-250	10-25%
Frozen yogurt, vanilla, soft serve, ½ cup	103	10%
Ready to eat cereal, calcium fortified, 1 cup	100-1000	10%-100%
Turnip greens, boiled, ½ cup	99	10%
Kale, cooked, 1 cup	94	9%
Kale, raw, 1 cup	90	9%
Ice cream, vanilla, ½ cup	85	8.5%
Soy beverage, calcium fortified, 8 fl oz.	80-500	8-50%
Chinese cabbage, raw, 1 cup	74	7%
Tortilla, corn, ready to bake/fry, 1 medium	42	4%
Tortilla, flour, ready to bake/fry, one 6" diameter	37	4%
Sour cream, reduced fat, cultured, 2 Tbsp	32	3%
Bread, white, 1 oz	31	3%
Broccoli, raw, ½ cup	21	2%
Bread, whole wheat, 1 slice	20	2%
Cheese, cream, regular, 1 Tbsp	12	1%

*DV=Daily Value

**Content varies slightly according to fat content; average =300 mg calcium

*** Calcium values are only for tofu processed with a calcium salt. Tofu processed with a non-calcium salt will not contain significant amounts of calcium.

Daily Values (DV) were developed to help consumers determine if a typical serving of a food contains a lot or a little of a specific nutrient. The DV for calcium is based on 1000 mg.

intakes for these five nutrients, which play a key role in the development and maintenance of bone and other calcified tissue.

The IOM used classic metabolic studies of calcium balance to determine the amount of calcium needed for bone expansion during growth and maintenance, after peak bone mass has been reached. It is important to note that adequate intake of calcium was based on the estimated level required to sustain a given population, with average maximal retention. Maximal calcium retention may not be determined by calcium intake alone, since other factors affect calcium retention, including the rate of growth (high in children), hormonal status, other dietary components, and genetics. Table 2 summarizes the recommendations for calcium.

The recommended daily calcium intake for patients over the age of 50 is 1,200 mg. However, optimal daily calcium intake may be higher (*i.e.*, 1500 mg) in men and women over the age of 65. In postmenopausal women not receiving HRT, the optimal daily calcium intake is 1500 mg.¹² The NOF guidelines also recommend an intake of at least 1200 mg/d in postmenopausal women.⁵ Recommended calcium intake corresponds to the amounts required to sustain the average maximal retention of BMD. Calcium supplementation in the range of 500 mg/d to 1000 mg/d and vitamin D at 400 IU/d to 800 IU/d decrease the rate of bone loss in women who are 5 years postmenopausal.¹⁰ Maximal calcium retention may not be determined by calcium intake alone, as other factors affect calcium retention: the rate of growth (high in children), hormonal status, other dietary components, and genetics. The NOF has developed a useful guide to assist in estimating calcium intake (Table 3).⁵

There are various food sources for calcium, and many types of calcium supplements are available. Refined preparations are preferred, since these contain low levels of lead and other contaminants. Calcium (*e.g.*, calcium carbonate) is best given with food, because the acid load of the meal provides better absorption.

A dose of calcium before bedtime may help reduce PTH levels at night; however, controlled clinical trials comparing calcium at bedtime to calcium during waking hours have not been done. If more than 500 mg/d

is used, the dosage should be split to increase absorption.

In patients receiving glucocorticoid therapy, a diet that limits sodium consumption is recommended. Sodium restriction has been shown to increase dietary absorption of calcium, and decrease its urinary excretion. Both effects reduce the risk of secondary hyperparathyroidism. Sufficient vitamin D is also required to ensure adequate absorption of dietary calcium. Vitamin D maintains serum calcium and phosphorus concentrations within the normal range by enhancing their absorption by the small intestine. This is particularly important when calcium intake is marginal.

Vitamin D

Adequate levels of vitamin D are also required to ensure adequate absorption of dietary calcium. The two principal forms of vitamin D are D₂ (ergocalciferol) and vitamin D₃ (cholecalciferol). The major function of vitamin D is to maintain serum calcium and phosphorus concentrations within the normal range, by enhancing the efficiency of small bowel absorption of these minerals. Vitamin D-assisted absorption of calcium is particularly important when calcium intake is marginal. When calcium intake is adequate, passive absorption may be enough to achieve target levels.

Vitamin D is generated when patients receive sunlight exposure. Because a variety of factors (e.g., latitude, time of day, season) may limit production, the National Academy of Sciences recommends an intake of 400 to 600 IU/day. Vitamin D supplementation has been shown to decrease vertebral fractures and possibly nonvertebral fractures in postmenopausal women, although some experts believe that this antifracture benefit may only be observed in those who were vitamin D deficient.¹³ The NOF recommends 800 IU/d for older adults, as well as for chronically ill, housebound, or institutionalized individuals.⁵ However, many experts recommend more vitamin D for the frail elderly.¹⁴ Patients who are either vitamin D insufficient or deficient require treatment with higher doses of vitamin D. Severe cases of vitamin D deficiency can lead to osteomalacia or rickets. Patients can be treated with 50,000 IU once a week for up to 3 months with follow-up blood tests of vitamin D, calcium and PTH levels; some patients may require longer courses of treatment.¹⁵

Dietary sources of vitamin D include fortified milk and cereals, egg yolks, salt-water fish, and liver. Over-the-counter preparations of vitamin D are in the form of vitamin D₂ (ergocalciferol) and D₃ (cholecalciferol). The potent active metabolite produced by the kidney, calcitriol (1,25-dihydroxyvitamin D) is available as a prescription

product and has FDA-approved indications for the management of hypocalcemia and metabolic bone disease in patients undergoing chronic renal dialysis or with hyperparathyroidism. Calcitriol has also been used to treat secondary osteoporosis. Because it has been associated with hypercalcemia and hypercalciuria, calcitriol is not routinely used for postmenopausal osteoporosis.

Smoking Cessation

Patients who smoke should be encouraged to quit. Among the other serious health risks of smoking, women smokers are typically more thin, undergo earlier menopause, and experience more fractures. The age-related bone loss that occurs in both men and women in the fifth decade of life and thereafter also appear to be accelerated among smokers.¹⁶⁻¹⁸

Weight-Bearing Exercise

In terms of reducing fracture risk, adequate physical activity may prompt beneficial bone remodeling and reduce the risk of falls in elderly patients by increasing muscle balance and tone. Certainly, lack of physical exercise (i.e., immobilization or bed rest) produces rapid disuse atrophy of muscles and bone loss. However, excessive exercise, resulting in amenorrhea, may be associated with bone loss. The NOF strongly endorses lifelong physical activity.⁵ Weight-bearing exercise, in which the bones and muscles carry the body's weight, is most effective. Examples include walking, jogging,

Table 6. Selected Food Sources of Vitamin D

Food	Amount (IU)	Percent DV
Cod liver oil, 1 Tbsp	1360	340
Salmon, 3 ½ oz cooked	360	90
Mackerel, 3 ½ oz cooked	345	90
Tuna fish, canned in oil, 3 oz	200	50
Sardines, canned in oil, drained, 1¾ oz	250	70
Milk, nonfat, reduced fat, and whole, vitamin D fortified, 1 cup	98	25
Margarine, fortified, 1 Tbsp	60	15
Pudding, prepared from mix and made with vitamin D fortified milk, ½ cup	60	15
Ready-to-eat cereals fortified with 10% of the DV for vitamin D, ¾ cup to 1 cup servings (servings vary according to the brand)	40	10
Egg, 1 whole (vitamin D is found in egg yolk)	20	6
Liver, beef, cooked, 3½ oz	15	4
Cheese, Swiss, 1 oz	15	4

*DV = Daily Value. DVs are reference numbers developed by the Food and Drug Administration (FDA) to help consumers determine if a food contains a lot or a little of a specific nutrient. The DV for vitamin D is 400 IU (10 µg) for adults. Most food labels do not list vitamin D content unless a food has been fortified with this nutrient. The percent DV (%DV) listed on the table above tells you the percent of the DV provided in one serving. A food providing 5% of the DV or less is a low source while a food that provides 10-19% of the DV is a good source and a food that provides 20% or more of the DV is high in that nutrient. It is important to remember that foods that provide lower percentages of the DV also contribute to a healthful diet.

Source: NIH Office of Dietary Supplements. Facts About Dietary Supplements - Vitamin D. *NIH Clinical Center* [Web site]. August 7, 2001. Available at: <http://www.cc.nih.gov/ccc/supplements/vitd.html#food>. Accessed December 6, 2002.

tai-chi, stair climbing, dancing, and tennis. Exercise is especially important in patients undergoing glucocorticoid therapy because of the effects of these agents on muscle mass and bone density.

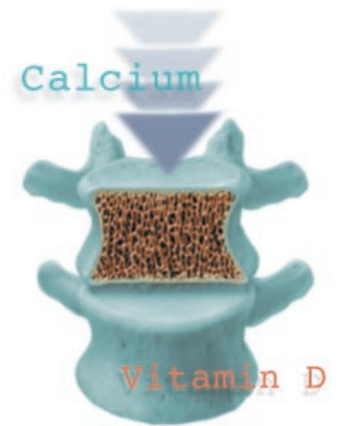
Fall Prevention

The value of assessing the risk of falling, and intervening in those at high risk (e.g., those with pre-existing fragility fractures), is supported by randomized clinical trials in elderly patients.¹⁹ In those with a pre-existing fragility fracture, fall prevention measures are useful. Over 90% of hip and wrist fractures are thought to be the result of a fall.²⁰ Elderly patients may be at risk for falling for a variety of reasons, including frailty and associated deconditioning, poor visual acuity, impaired hearing, and use of medications with neurologic effects that compromise protective neuromuscular reflexes (e.g., long-acting benzodiazepines).⁹

Eliminating environmental hazards is one relatively easy way to reduce the risk of falls and is applicable to any patient with osteoporosis and to all geriatric patients in general.

The AACE recommends the following steps for fall prevention:¹⁰

- Minimize risk of falls with gait and balance training
- Adjust dosage of drugs with sedative effects, which could slow reflexes, decrease coordination, and impair the patient's ability to break the impact of a fall
- Anchor rugs
- Minimize clutter
- Remove loose wires
- Use nonskid mats
- Install handrails in bathrooms, halls, and along stairways
- Light hallways, stairwells, and entrances
- Encourage patient to wear sturdy, low-heeled shoes
- Hip protectors (in patients predisposed to falling)



Summary

Adequate physical activity is highly promoted as a general health measure and controlled clinical trials suggest that load-bearing exercises are most effective in preserving skeletal mass. Adequate calcium intake is the cornerstone of any osteoporosis prevention (or treatment) plan. The effectiveness of dietary calcium and vitamin D supplementation for increasing bone mass in older adults and decreasing fracture risk has been demonstrated in controlled clinical trials. The recommended daily calcium intake for patients over the age of 50 is 1200 mg. However, optimal daily calcium intake may be higher (i.e., 1500 mg) in men and women over the age of 65. In postmenopausal women not receiving hormone therapy, the optimal daily calcium intake is 1500 mg. The NOF recommends 800 IU/d of vitamin D for older adults, as well as for chronically ill, housebound, or institutionalized individuals.

Patients who smoke should be encouraged to quit because age-related bone loss is accelerated after the fifth decade of life in smokers. In terms of reducing fracture risk, adequate physical activity reduces the risk of falls in elderly patients by increasing muscle balance and tone. Weight-bearing exercise, in which the bones and muscles carry the body's weight, is most effective. Examples include walking, jogging, tai-chi, stair climbing, dancing, and tennis. The value of assessing the risk of falling, and intervening in those at high risk (e.g., those with preexisting fragility fractures), is supported by randomized clinical trials in elderly patients.

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