

3

Promoting Bone Health and Preventing Bone Disease Across the Life Span

Learning Objectives

- Describe the nutritional, exercise and hormonal issues that relate to bone health at different life stages.
- Identify actions at each life stage to maximize bone health.

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1. Exercise

Bone growth is rapid as children mature, and peak mass is achieved in most parts of the skeleton by the late teens. Maintenance of bone mass or a very gradual loss occurs in women until menopause, at which time bone loss can be as high as 1% to 6% per year. After menopause, age-related bone loss then usually slows to 0.5% to 1% per year.¹

The exercise recommendations that follow are based primarily on the stages of bone growth and loss across the lifespan. An expanded discussion of exercise considerations is located in *Topic 5: Treating and Managing Osteoporosis*. The exercise recommendations below apply to healthy people at different life stages. Modifications are necessary when secondary osteoporosis or co-morbid conditions exist at any age. For example, a woman in her 40s who has glucocorticoid-induced osteoporosis likely would need to follow the exercise recommendations listed here for people with established osteoporosis.

Children

1. Promote physically active lifestyle, including participation in a variety of sports and recreational activities.
2. Encourage development of muscle strength.
3. Encourage good posture and teach about proper body mechanics so positive habits are established early in life.

Adolescents

1. Continue to promote physically active lifestyle.
2. Promote muscle strengthening and weight-bearing exercise.
3. For girls, avoid excessive exercise and/or reduction in body fat, which can result in amenorrhea.
4. Continue to encourage good posture and body mechanics.

Young adults

1. Encourage the establishment of a moderate, regular exercise regimen that includes strength training for 20 to 30 minutes two to three times per week and/or weight-bearing exercise for 30 to 45 minutes three to four times per week. Continue to encourage sports and physically active recreational pursuits.
2. Emphasize the multiple health benefits of exercise (weight control, social aspects, emotional well-being) as additional motivation to schedule exercise into adults' lifestyles.
3. Encourage parents, particularly mothers of small children, to seek child care support by friends and family so appropriate exercise can be scheduled.
4. Continue to monitor for amenorrhea.
5. Teach parents proper posture and body mechanics to use with breastfeeding and caring for children.

Middle-aged adults (men and peri/post-menopausal women)

1. Encourage continuation or initiation of a moderate, regular exercise regimen that includes strength training 20 to 30 minutes two to three times per week and/or weight-bearing exercise 30 to 45 minutes three to four times per week. Continue to encourage sports and active recreational pursuits.
2. In addition to attention to good posture, insure strength and flexibility of muscles that contribute to erect trunk alignment in order to prevent kyphotic deformity.

Elderly without established osteoporosis

1. If already exercising, promote continuation of a moderate exercise regimen of strength training and weight-bearing exercise. If initiating exercise, recommend weight-bearing three to four times per week. Begin strength training programs, if possible, considering bone, orthopedic, and medical status. At the outset, strength training programs should be taught and supervised by health professionals.
2. Continue or begin exercises that prevent/minimize kyphotic deformity. (*See Topic 5: Treating and Managing Osteoporosis.*)

3. Assess falls risk by physical exam (vision, sensory status, muscle strength, joint range of motion) and standardized balance and mobility testing (e.g., functional reach²), Berg Balance Scale,³ Tinetti Gait and Balance Assessment.⁴ Intervene to correct any identified deficits through exercise to improve muscle strength, flexibility, and balance. Provide recommendations on home safety modifications for fall prevention.

Individuals with established osteoporosis

1. If already exercising, promote continuation of a moderate exercise regimen of weight-bearing exercise. If initiating exercise, recommend walking as much as possible for daily activity and an endurance walking program three to four times per week. Strength training will be appropriate for most individuals. This training should be supervised by a professional and approached with caution, because overload to the skeleton via weight training can lead to fracture.
2. Continue or begin exercises that prevent/minimize kyphotic deformity.
3. Reassess for falls risk and intervene as appropriate.
4. Teach good body mechanics for a range of activities. Recommend modifying activities so spinal flexion (forward bending) and rotation are avoided.

2. Nutrition

Various dietary factors have both positive and negative roles to play in bone health throughout life. While adequate calcium intake throughout life is essential, other nutrients are also important in maintaining bone health. Advise all patients to obtain an absolute intake of dietary calcium (at least 1,200 mg daily, including supplements if necessary) and vitamin D (400 to 800 IU per day for individuals at risk of deficiency). Table 3.1 lists recommendations for daily calcium intake for various age groups, and Table 3.2 lists selected calcium-containing foods. Dairy products are the most commonly recognized sources of calcium, but foods such as salmon, broccoli, collard greens, tofu, and almonds also contain significant amounts of this mineral. Calcium-fortified orange juice is another important source of calcium for many. For those individuals who cannot obtain adequate amounts of calcium from their diets, calcium supplements may be used to bring calcium intakes up to recommended levels. Tables 3.3 and 3.4 present information about commonly available calcium supplements and guidelines.

Table 3.1
Recommended Daily Calcium Intakes

Population Group	NIH/NOF* (mg elemental calcium)
Children 1-10 years	800-1,200
Children 11-24 years	1,200-1,500
Men and women 25-64 years	at least 1,200
Pregnant/Lactating	at least 1,200
Postmenopausal women with hormone replacement therapy	at least 1,200
Postmenopausal women without hormone replacement therapy	at least 1,200
Men and women 65+	at least 1,200
<p>*In 1987, 1990, 1994, and 2000, the NIH held consensus conferences on osteoporosis and calcium. This column shows the most recent recommendations regarding calcium intake for preventing and managing osteoporosis.</p>	

Table 3.2**Calcium Content of Selected Foods**

Dairy Foods	Calcium Content (mg)	Non-Dairy Foods	Calcium Content (mg)
Buttermilk, 1 cup	300	Calcium-fortified juice, 1 cup	300
Milk, 1 cup	300	Salmon, canned with bones, 2 oz.	100
Lactaid milk, 1 cup	300-500	Oysters, raw 13-19 medium	226
Soy milk, calcium fortified, 1 cup	200-300	Sardines, canned, with bones, 3 oz.	372
Yogurt (plain, lowfat), 1 cup	250-300	Shrimp, canned, 3 oz.	98
Frozen yogurt (fruit), 1 cup	200-600	Collard greens, cooked, 1 cup	357
Swiss cheese, 1 oz.	250	Turnip greens, cooked, 1 cup	198
Cheddar, mozzarella, or Muenster cheese, 1 oz.	205	Broccoli, cooked, 1 cup	78
Cottage cheese (lowfat), 4 oz.	200	Soybeans, cooked, 1 cup	131
Part-skim ricotta cheese, 4 oz	335	Tofu, 4 oz.*	
Vanilla ice cream, 1 cup	120-300		

*Calcium content of tofu varies depending on processing method; check nutritional label on package for precise calcium content.

Another important nutrient in bone health is vitamin D, necessary for the absorption and utilization of calcium in the body. The recommended daily allowance is 400 IU that can be obtained from drinking a quart of vitamin D-fortified milk or taking a vitamin supplement. Fatty fish, cheese, butter, eggs, and liver also contain vitamin D. It is recommended that *all* people taking calcium supplements also take 400 to 800 IU daily of Vitamin D; however, this is especially critical for those who are homebound or institutionalized and may not receive sufficient exposure to the sun, especially during the winter. However, Vitamin D from sun exposure is so variable that it is difficult to determine how much sun exposure a person needs. Other nutritional factors also are important in developing and maintaining bone health. Citric acid, found in citrus fruits, can help increase calcium absorption. Conversely, diets high in the following can interfere with calcium absorption: protein, certain types of fiber such as wheat bran, caffeine, alcohol, and sodium.

Table 3.3
Commonly Available Forms of Calcium Supplements

Calcium Salt	Elemental Calcium Content	Product Name
Calcium carbonate	40.0%	Various (e.g., Tums)
Calcium citrate	21.1%	Citracal
Calcium glubionate	6.4%	Neo-Calglucon syrup
Calcium gluconate	9.0%	Various
Calcium phosphate tribasic	39.0%	Posture

3. Nutrition and Estrogen Interactions

Estrogen is necessary for the development and maintenance of bone mass. Menopause brings a period of unique risk to the bone mineral status of women's bodies as the body's production of estrogen declines. Increased bone resorption causes an accelerated decline in bone mass at the rate of 1 to 6% per year. Peri-menopausal bone loss is most pronounced in the areas where trabecular bone predominates, such as the vertebral bodies. From age 50 to age 80, a woman's bone density decreases by about 30%. At least half of this loss can be attributed to lowered levels of estrogen. Hormone replacement therapy (HRT) is commonly used as a preventive measure for osteoporosis because it minimizes bone loss.

With the FDA approval of other medications for the prevention of osteoporosis, women now have choices. (Refer to *Topic 5* for a full discussion of osteoporosis medicines.)

Calcium and estrogen

It has been estimated that menopause and age-related alterations in calcium homeostasis produce a negative shift in calcium balance of 25 mg per day. (See *Topic 5: Treating and Managing Osteoporosis* for full explanations of nutritional therapies that should be recommended to people with osteoporosis.) ***It must be understood, however, that even generous intakes of calcium cannot fully compensate for the effects of lowered estrogen during the perimenopausal period of accelerated bone loss.*** Remember, women who are taking HRT still need to have appropriate nutritional intake.

Table 3.4

Suggested Guidelines for Calcium Supplement Use

- Calcium is absorbed most efficiently if taken in small amounts throughout the day. Always divide the daily dose into smaller amounts if the total daily dose is 500 mg or more per day. The body cannot use more than 500 mg calcium at any one time.
- The use of manufactured supplements is encouraged. Calcium as bone meal or dolomite may contain lead or other heavy metals as contaminants.
- Calcium supplements should not be taken with high fiber meals or with bulk forming laxatives.
- If calcium carbonate is used as the supplement form, it should be taken with meals to assure that stomach acid production is present to facilitate optimal dissolution and absorption of calcium. This is important if atrophic gastritis with hypo- or achlorhydria is present, which it is in 20 to 50% of older individuals.
- It is important to drink plenty of fluids while using the supplement to help reduce problems with side effects like constipation or bloating. If these symptoms become a problem, switching to another form of supplement may be the answer. (See Table 3.3 opposite.)
- Another alternative is calcium-fortified foods, including fruit juices, cereals, and breads. These foods are now marketed with added calcium and may be less likely to cause side effects.
- Those with personal or family histories of kidney stones should be monitored to assure that hypercalciuria does not occur.

Table 3.5
Health Promotion Strategies

Group	Exercise	Calcium (mg/day)	Special Considerations
Children	<ul style="list-style-type: none"> • Physical activity • Muscle strength • Posture 	Birth-6 months: 400 6 months-1 yr: 600 1-10 years: 800	<ul style="list-style-type: none"> • Consider lactose intolerance
Adolescents	<ul style="list-style-type: none"> • Physical activity • Muscle strength/weight-bearing/impact • Posture 	Pregnant/lactating: at least 1,200	<ul style="list-style-type: none"> • Peak bone mass • Avoid prolonged amenorrhea • Support making time for physical activity
Young adult women	<ul style="list-style-type: none"> • Physical activity • Muscle strength weight-bearing/impact • Posture 	Pregnant/lactating: at least 1,200	<ul style="list-style-type: none"> • Peak bone mass • Avoid prolonged amenorrhea • Support making time for physical activity
Peri- and post-menopausal women	<ul style="list-style-type: none"> • Muscle strength and/or weight-bearing • Posture • Flexibility 	at least 1,200	<ul style="list-style-type: none"> • Consider bone mass measurement • Consider hormone replacement therapy or another preventive therapy
Adult men, under age 65	<ul style="list-style-type: none"> • Muscle strength and/or weight-bearing • Posture • Flexibility 	at least 1,200	<ul style="list-style-type: none"> • Assess for hypogonadism
Elderly people without osteoporosis	<ul style="list-style-type: none"> • Muscle strength and/or weight-bearing (initially supervised) • Posture • Fall prevention 	at least 1,200	<ul style="list-style-type: none"> • Medical check-up • Home safety modifications to prevent falls • Consider bone mass measurement
People with osteoporosis	<ul style="list-style-type: none"> • Weight-bearing, especially walking • Muscle strength only with supervision • Posture • Fall prevention 	at least 1,200	<ul style="list-style-type: none"> • Medical check-up • Home safety modifications to prevent falls

4. **Summary: Strategies to Promote Bone Health**

A healthy lifestyle can help prevent bone weakness in later life. Following the regular practice of moderate, weight-bearing exercise and eating a balanced diet high in calcium can provide a basis for bone health throughout the life span (Table 3.5). After menopause, extra attention to obtaining adequate calcium, along with the possible use of hormone replacement or another preventive therapy, can help women avoid the consequences of decreased hormonal levels.

Suggested Learning Activities

For general suggestions on instructional strategies, see *Section IV, Resources for Teaching and Assessment*.

1. **Interactive lecture.** Explore the basic concepts presented within a lecture or assigned reading by carrying out short (two – five minute) activities with a partner. Concepts or questions that might be explored:
 - Explain exercise recommendations for young adults, peri-menopausal women, and elderly women.
 - How would you explain the increased risks of osteoporosis to a peri-menopausal woman?
 - What questions do you still have about a particular topic?
2. **Develop an education program** to teach a certain population group about exercise and nutritional strategies to maximize bone health. Discuss your program.
3. **Interview other students for risk factors** for bone health, using a student-developed assessment tool or a prepared questionnaire. Alternatively, interview middle-aged or older people for risk factors for bone health. Do your subjects meet the recommended guidelines for nutrition and exercise for their age group? Write up or discuss your findings, highlighting risk factors.
4. **Take a self-quiz on your exercise and nutrition habits.** Do you meet the recommended guidelines for your age group? Discuss your findings.
5. **Keep an exercise log** for one week. Analyze whether you are meeting the recommended standards for your age group. Discuss personal barriers to achieving the recommended activity level.

6. **Keep a personal food diary** for three days. Determine your calcium intake for that period, and see if meets the NIH/NOF recommendations (see Table 3.1). Analyze for any additional aspects of your diet that may affect calcium consumption (caffeine, alcohol consumption, etc.). Discuss personal barriers to achieving the recommended intakes. What steps could you take to improve your calcium intake?

Trade food diaries with a partner. Analyze the partner's record as above. Make suggestions tailored to the partner's eating habits.

7. **Plan a three-day diet** that meets NIH/NOF calcium recommendations. Plan a diet for yourself, and/or for a post-menopausal woman without hormone replacement therapy.
8. Do a **survey of calcium supplements**. Go to a pharmacy and record the supplements available. Analyze each for the type and amount of calcium provided. Record the advantages and drawbacks of different supplements. Compute the relative cost for providing the recommended intake.
9. **Case studies**. Read and discuss Case Studies 1, 2, 3, or 4 in the Patient Case Bank in *Section IV*.

Questions:

- What are the patient's risk factors, including inadequate nutrition and exercise, for development of osteoporosis?
 - What other information do you need?
 - What questions would you ask to better determine the patient's possible risk?
 - What recommendations would you make to help this patient prevent or manage osteoporosis?
 - What are this patient's potential barriers to practicing healthy habits?
10. **Case studies**. Evaluate Cases 6 – 12 from *Section IV*, considering proper nutrition and exercise to promote bone health.

Address the following issues for each case:

- Estimate the patient's risks for development of osteoporosis.
- Make recommendations to improve diet and exercise.
- What are possible barriers for this patient?

11. **Chart review.** Analyze a patient’s history for osteoporosis risk factors, including nutrition and exercise. Note what information is missing from the chart and what information is needed. Note any barriers.

Read and **compare several charts** of patients of similar ages, looking for risk factors and positive factors. What do the patients have in common? What is different?

12. **Simulated Patient.** Interview a “patient” for history of risk for osteoporosis, including nutritional and exercise assessment. Assess barriers to prevention of osteoporosis. Advise the patient on recommended actions appropriate for his/her life stage.
13. **Shadow a professional dietitian or physical therapist** as she or he works with patients at risk for osteoporosis. What are the most common problems she or he encounters? What are the barriers experienced by the patients?

Suggested Assessment Strategies

Many of the learning activities above may also be used as assessment activities. For general suggestions on assessment strategies, see *Section IV, Resources for Teaching and Assessment*.

1. **Game creation.** Direct students to create a board game or trivia game, with categories of questions corresponding to actions at each life stage that maximize bone health and to the nutritional, exercise, and hormonal issues relating to bone health at different life stages. Use a checklist of issues to evaluate the completeness and accuracy of the game. Game formats could be based on Jeopardy, Trivial Pursuit, Scattergories, Boggle, Candyland, or Clue.
2. **Short essay question.** Sample assignment. Think of bone health in terms of a Monopoly-like game called “Bonopoly.” The goal is to maximize long-term investments (e.g., nutrition, exercise) and to minimize risks and penalties (“Go to Jail” = risk of osteoporosis). Pick two age groups you have studied. List five specific investments members of those age groups should make to avoid going to jail. Which of these investments are common to the two age groups? Which are unique to each age group?
3. **Paired exam.** Prepare a multiple choice test or short essay exam that students complete in pairs.

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