

4

Assessing Bone Health and the Risk of Osteoporosis

Learning Objectives

- Obtain a case history that includes nutritional and exercise components for bone health and risk of osteoporosis.
- Identify the components of a physical examination that determine the presence or risk of osteoporosis.
- Identify appropriate and cost-effective laboratory studies for bone health assessment.
- Describe the appropriate use of bone densitometry (BMD) and the choices of BMD techniques.

Topic Contents

1. Assessing Level of Physical Activity
2. Assessing Nutritional Factors in Bone Health
3. Evaluating a Patient for Osteoporosis
 - History
 - Physical Examination
 - Laboratory Studies
4. Assessing Bone Mass

1. Assessing Level of Physical Activity

Just as yearly physical examinations for people of all ages include an assessment of behaviors relevant to prevention of cardiovascular disease, they should also include assessment of behaviors relevant to healthy bone status. Information about a patient's exercise habits may be obtained in two ways: by asking questions as part of the self-reported history and by using standardized questionnaires.

To insure that the self-reported history gives adequate detail for the practitioner to evaluate if the correct exercise is being done in a way that is beneficial to bone health, four parameters of exercise must be determined. These are *type* (what exercise the patients do), *frequency* (how often they do it), *duration* (for how long they do it), and *intensity* (with how much vigor they do it). The primary types of exercise known to be beneficial to bone are weight-bearing exercises (e.g., walking, aerobic dancing, soccer, basketball) and strength training.

Weight-bearing activity performed three to four times per week for 45 minutes per session has been shown to increase bone density.¹⁻⁹ Strength training for the extremities using equipment found in health clubs and performed two to three times per week for 20 to 30 minutes also has been shown to increase bone density.⁹⁻¹⁵ Intensity is the parameter about which the least is known. Current knowledge indicates that weight-bearing routines should involve quick loading of the skeleton, known as impact, as long as bone density is not so low that a fracture could result,¹⁶ and should be of sufficient intensity so that cardiovascular benefit will result.⁴ Several studies have shown improvement in bone density in premenopausal women using types of exercise that provide high-impact loading to the skeleton, such as jumping.¹⁷⁻¹⁹ Strength training should emphasize heavier weights and fewer repetitions.¹⁰

Standardized questionnaires usually give a numerical score, making it easier for both the practitioner and the patient to see if an objective change in exercise behavior has occurred. Several instruments are available for assessing total habitual physical activity.²⁰⁻²¹ A short, three question scale which may be of value is Reuben's Advanced Activities of Daily Living Scale.²²

2. Assessing Nutritional Factors in Bone Health and Risk of Osteoporosis

The best way to deal with osteoporosis is to prevent it. From a nutritional standpoint, assessment of factors likely to reduce the rate of bone accretion and/or accelerate bone loss is a critical part of anticipating and dealing with risk. Numerous diet-related factors, positive and negative, are associated with the likelihood of osteoporosis. These are summarized in Table 4.1.

Table 4.1
Nutritional Factors Commonly Associated with Osteoporotic Syndromes²³

Positive Factors

Adequate calcium and vitamin D status
Adequate vitamin K and mineral intake
Lacto-ovo-vegetarian diet

Detrimental Factors

Negative calcium balance
Milk intolerance/milk allergy syndrome
Lifelong high intake of:

- protein
- sodium
- alcohol
- phosphorus

Anorexia nervosa
Prolonged parenteral nutrition

One of the most important aspects of nutritional assessment is the evaluation of calcium intakes. Because calcium is localized in a fairly small number of commonly eaten foods, it is simple to do a quick assessment of total calcium consumption. Following are a calcium intake quiz and a table of recommended calcium intakes for use in comparing an individual's intake with recommended levels.

Table 4.2

Calcium Intake Quiz²⁴

Dairy products are the primary source of calcium for most people. For a quick estimate of your daily calcium intake, complete the following steps:

1. Use the chart below to determine your daily intake of calcium from dairy foods.

Servings of dairy per day:	1	2	3	4	5	6	7	8
Milligrams (mg) of calcium:	250	500	750	1000	1250	1500	1750	2000

2. Enter your total daily calcium intake from dairy foods:			mg.
3. Add 350 mg., which is the average for all other dietary sources:	+	350	mg.
4. The sum is your total daily calcium intake:			mg.
5. Enter the recommended calcium intake for your age from the chart below:			mg.
6. Enter your daily intake from step 4 above and subtract:	-		mg.
7. The result is how much additional calcium you need:			mg.

Recommended Daily Calcium Intake

Population Group	Calcium (mg)
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

3. Evaluating a Patient for Osteoporosis

History

On evaluating any patient for or with osteoporosis, the history is probably the most critical part of the evaluation. When taking a patient's history, it is important to establish rapport, which will serve as the foundation of the therapeutic alliance throughout treatment. The history should include what the patient desires to receive from the interaction. (For more detail on patient-centered care, see Topic 6.) The clinician should ask about any family history of osteoporosis, other sorts of bone disease, loss of height, presence of chronic or acute back pain, what fractures the patient has had, and whether there has been a personal or family history of nephrolithiasis. A thorough menstrual history should be taken, including when the patient experienced menarche and menopause, type of menopause (surgical or natural), and periods of amenorrhea not associated with pregnancy. In the case of the male, questions about libido and potency are also important. A review of the endocrine system is necessary, focusing on the thyroid gland or in rare cases, the history of Cushing's disease. A medication history should include a review of the use of anticonvulsants, anticoagulants, and glucocorticoids. In patients with established osteoporosis or with suspected fractures of the spine, a thorough history should be obtained detailing pain, its character, where it radiates, and what exacerbates or improves it. For patients with known fractures, the clinician should find out how fractures were incurred. Finally, functional limitations and psychosocial consequences should be determined, including assessments of work roles, social roles, self-esteem, and interpersonal relationships.

Physical Examination

The physical examination is performed to identify and evaluate clinical signs and symptoms. Height should be measured accurately every year. Weight and blood pressure should also be obtained. Particular attention should be paid to dentition and the presence of oral bone loss, which may indicate osteoporosis. The neck is examined to look for an enlarged thyroid gland; the pulse should also be taken to assess signs of hyperthyroidism. The spine should be examined, noting configuration, tenderness to light or firm palpation over the spinous processes, and paraspinal muscles. Range of motion—including extension, side bending and flexion—should be determined. An abdominal exam will reveal whether the abdomen is protuberant. The distance between the rib cage and the anterior iliac crest should be measured. Men should have an examination of the genitalia noting the size and consistency of the testicles (related to hypogonadism). Women should have a breast and pelvic examination to detect evidence of lowered estrogen levels. Examination of the extremities should focus on range of motion in the shoulders, elbows, wrists, hips, knees, and ankles. Gait should be assessed, and the patient should be observed ascending and descending stairs. During the examination of the gait, posture can be noted. To assess gait and balance objectively, the Tinetti Gait and Balance Assessment²⁵ or the Berg Balance Scale²⁶ can be used. Mobility should be observed to assess if the patient is using good body mechanics during sit to stand, transfers, bed mobility, and lifting objects from low surfaces.

Osteoporosis is a diagnosis of exclusion, thus there are no abnormal laboratory values caused by osteoporosis. The baseline laboratory evaluation should include a complete blood count. Blood chemistries include calcium, phosphorus, alkaline phosphatase, creatinine, and electrolytes. In addition, a urinalysis and a thyroid stimulating hormone assessment should be performed. When there is reason to suspect vitamin D deficiency, hyperparathyroidism, cortisol excess, or multiple myeloma, appropriate tests include a parathyroid hormone level, vitamin D level, serum cortisol level or serum protein electrophoresis.

Table 4.3 on the following page provides three checklists that summarize the osteoporosis-related elements of the history and physical, and commonly used laboratory studies.

4. Assessing Bone Mass

Bone mass measurements are useful for both clinical practice and research studies. Screening asymptomatic patients with such measurements is not warranted; however, the Scientific Advisory Board of the National Osteoporosis Foundation has suggested five indications for bone mass measurements:

- (1) in women with low estrogen concentrations, to diagnose significantly low bone mass in order to make decisions about osteoporosis therapy;
- (2) in patients with vertebral abnormalities or roentgenographic osteopenia, to diagnose spinal osteoporosis in order to make decisions about further diagnostic evaluation and therapy;
- (3) in patients receiving long-term glucocorticoid therapy, to diagnose low bone mass in order to adjust therapy;
- (4) in patients with asymptomatic primary hyperparathyroidism, to diagnose low bone mass in order to identify those at risk of severe skeletal disease who may be candidates for surgical intervention; and
- (5) in patients who are given therapy for their osteoporosis to determine the efficacy of the therapy.

See Table 4.4 for additional indications. Clinical guidelines developed through the National Osteoporosis Foundation²⁷ include further recommendations for bone density testing.

Bone biopsy and histomorphometric studies are not routinely indicated, but they are useful techniques for determining the effects of experimental interventions on bone resorption and formation indices.

Table 4.3

Assessment Checklists for History, Physical, and Laboratory Tests

Checklist for history	
Patient goals, expectations, and health beliefs	Back pain
Family history of osteoporosis	Gastrointestinal problems that affect intake or absorption of minerals and vitamins
Physical activity	Smoking
Diet: poor calcium or vitamin D status; malnutrition	Alcohol
Estrogen (surgical or natural menopause, prolonged amenorrhea)	Psychosocial concerns
Drug use: excess thyroid, anticonvulsant, steroids, glucocorticoid medications	Prolonged bed rest
Low-impact fracture after age 40 (especially hip, vertebral, Colles)	Anorexia
	Functional status
	Social and work roles
	Height
Checklist for physical examination	
Height/weight	Balance
Thin wrists	Thyroid gland examination
Back: scoliosis, kyphosis	Cortisol (iatrogenic, Cushing's)
Pelvic and breast examination	Testicle examination
Mobility and gait	
Checklist for laboratory studies	
General chemistries	Consider 24-hour urinary calcium and creatinine to test for hypercalciuria if history of kidney stones
CBC	
TSH	Others based on history and physical exam
Urine for markers of bone loss	

Table 4.4

Indications for Bone Densitometry (Diagnosis and Interval Monitoring)²⁷

The decision to test for BMD should be based on an individual's risk profile, and testing is never indicated unless the results could influence a treatment decision.

BMD testing should be performed on:

1. All postmenopausal women under age 65 who have one or more additional risk factors for osteoporotic fracture (besides menopause)
2. All women aged 65 and older regardless of additional risk factors
3. Postmenopausal women who present with fractures (to confirm diagnosis and determine disease severity)
4. Women who are considering therapy for osteoporosis, if BMD testing would facilitate the decision
5. Women who have been on hormone replacement therapy for prolonged periods

Note: There are no defined guidelines for use of bone densitometry for men.

Both x-ray and ultrasound technology can be used to assess bone density. The several methods that use x-ray technology for estimating bone mass vary in the sites to be measured, type of bone measured (cortical or trabecular), precision (the degree of variation among multiple measurements), accuracy (how well measured values compare to actual mineral content of bone), duration of test, and radiation exposure. Table 4.5 below summarizes these differences.

Table 4.5
Comparison of Bone Densitometry Techniques

Technique	Site	Precision (%)	Accuracy (%)	Duration of Test (min)	Effective Radiation Dose (μ Sv)
Dual energy x-ray absorptiometry (DXA)	Spine, hip	1-2	4-8	5	1
Single energy x-ray absorptiometry (SXA)	Wrist, heel	1-2	2-5	4	<1
Radiographic absorptiometry (RA)	Hand	2	6	1-3	1
Quantitative computerized tomography (QCT)	Spine	2-6	3-15	10-20	60-100
Ultrasound	Heel	2	—	10 seconds	0

In early 1998, the Food and Drug Administration approved a new ultrasound device to estimate bone density. Called the Sahara Clinical Bone Sonometer, the device is intended to be used for women at risk of fracture rather than as a general screening tool. It transmits high frequency sound waves through the heel for ten seconds and automatically analyzes the

results. Because it is portable and rapid, the sonometer has potential for allowing bone density testing to be readily available in physicians' offices.

The cost of tests to measure bone density varies enormously nationwide, as do insurance company reimbursement policies. Medicare regulations, effective July 1, 1998, authorize bone density testing for people who are known to have osteoporosis as well as those at high risk (women without ovaries, postmenopausal women not taking estrogen, people taking long-term glucocorticoid therapy, and individuals with primary hyperparathyroidism). Since Medicare coverage often sets the standard for other insurers, reimbursement for such testing may become routine.²⁸

The World Health Organization defines osteoporosis as a value for bone mineral density (BMD) or bone mineral content (BMC) that is 2.5 standard deviations or more below the young adult mean. Although bone mineral density is not the sole determinant of fracture risk, its value in predicting a patient's future risk of fracture has been found to be better than that of cholesterol measurements in predicting the risk of heart disease or blood pressure measurements in predicting the risk of stroke.²⁹ At any skeletal site, a decrease in bone mass of one standard deviation approximately doubles the relative risk of subsequent fracture. (See Table 4.6.)

Table 4.6
NOF/WHO Criteria for Interpreting Results of Bone Density Assessment²⁷

Results	Diagnosis
Within 1 standard deviation (SD) of young adult mean.	Normal
Between 1 and 2.5 SD below mean, repeat in 2 years	Low bone mass (osteopenia)
Greater than 2.5 SD below mean	Osteoporosis
Greater than 2.5 SD below mean <i>and</i> one or more fragility fractures exist	Severe osteoporosis

**Results can be affected by positioning of the body in the DEXA scan, presence of current or old fractures, arthritis, extraneous calcifications.*

Suggested Learning Activities

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

1. **Interactive lecture.** Explore the basic scientific concepts presented within a lecture or assigned reading by carrying out short (two to five minute) activities with a partner.

Questions to consider:

- What elements should be included in a history for bone health?
 - What elements should be included in a physical exam?
 - What types of lab tests might be ordered for a particular type of patient?
 - For which kinds of patients would you order bone densitometry tests?
2. Use **standardized patients** to practice taking a history or to practice performing a physical exam. Recommend appropriate laboratory studies and bone densitometry, as needed.
 3. Watch a **videotape** of a practitioner taking a history or performing a physical exam. Note what elements/questions were included in the procedure. Note what elements were not included but might have given valuable information about the patient's bone health status. Analyze the patient's risk factors for the development of osteoporosis. Request appropriate lab studies for that particular patient.
 4. **Shadowing.** Go to a clinic to observe a practitioner taking a history or giving a physical exam. Note what elements/questions were included in the procedure. Note what elements were not included but might have given valuable information about the patient's bone health status. Analyze the patient's risk factors for the development of osteoporosis.
 5. **Case Study.** Read and discuss Case 2, 3, or 4 from the Patient Case Bank in *Section IV*.

Questions:

- List the risk factors for the patient.
- What other information do you want to know about this patient?
- What lab studies might be ordered, and why?
- Is bone densitometry appropriate for this patient? What else might you need to know to determine the appropriateness of this procedure?
- What would be the costs for this patient's work-up?

Write a letter of referral for this patient to refer her to a specialist.

6. **Chart Review.** Analyze a patient's history for risk factors including nutrition and exercise. Note if any diagnostic information is missing from the chart. Note any barriers to treatment activities.
 - Would bone densitometry be indicated for this patient?

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

7. **Review lab slips.** Write up or discuss the orders and their appropriateness for a particular patient. Analyze the results. Research and determine the costs of the tests ordered.
8. **Role Plays.** Practice taking a history and advise the patient on recommended actions appropriate for his/her life stage. Possible patient roles: female or male college students with steroid use, lactating mother, older female, female with early onset menopause, or patient with complicating drug use.

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. **Performance assessment.** Using role plays or interviews with standardized patients, evaluate students taking diet histories and describing anticipated physical exams with patients. Videotape or audiotape the encounters. Have students complete self-assessment using a form parallel to your evaluation form. View/review the tape with the student, discussing your assessment and the student's self-assessment.
2. **Observe and assess interviews** of actual patients. Use same procedure described above.
3. **Chart review.** Ask students to review charts of selected patients and rate the patients' nutritional and exercise risk factors for osteoporosis as low, moderate, or high. The ratings should include a justification for each designation.

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