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**Older Adults—Nutrition and Physical
Activity Approaches to Improving Bone Health,
Musculoskeletal Health, and Reducing Falls**

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President's Council on
Fitness, Sports & Nutrition

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In reviewing the Fall 2015 issue of *Elevate Health*, I started to reflect on the importance of being physically active and practicing good nutrition across the lifespan.

In the course of my career, I have been blessed to participate in a variety of physical pursuits to promote healthy lifestyles and good nutrition. I'm blessed to be able to be physically fit and able to move on a daily basis. It's my passion and purpose to spread the gospel of good health; mind, body, and spirit. However, without the opportunities that I have been given, I do not think that I would be able to continue to encourage people to be fit throughout their lifespans.

Physical activity is a huge part of my daily life and I encourage others to get out and move every day. Whether you walk it, roll it, dance it, or hike it, being physically active means that you are building muscles, improving your

balance, and combating the bone loss that is associated with growing older. On top of all that, it makes you feel better, too. Older adults have a wide variety of mechanisms to help them stay active and improve their bone health.

I observed the importance of being physically active on bone and musculoskeletal health while I was caring for my father. As he aged and lost his abilities he became more and more frail, eventually ending up in a wheelchair. I believe that over his lifetime, physical activity kept him mobile and healthy for a great number of years. I was blessed to be a part of caring for my father and I credit physical activity and good nutrition for keeping him healthy as long as it did.

Bess Dawson-Hughes, M.D., and Susan S. Harris, D.Sc., discuss the importance of the various types of dietary and physical activity choices that older adults can make to retain bone and musculoskeletal health as they age. These choices help older adults preserve bone mass and muscle function while ensuring prevention of falls. There is a wide body of evidence-based research that indicates physical activity and good nutrition help preserve both bone mass and muscle function in older adults.

“ Whether you walk it, roll it, dance it, or hike it, being physically active means that you are building muscles, improving your balance, and combating the bone loss that is associated with growing older.

Donna Richardson Joyner



Older Adults—Nutrition and Physical Activity

Approaches to Improving Bone Health, Musculoskeletal Health, and Reducing Falls



Introduction

Both muscle and bone mass decline with age. By age 80 years, the average older adult has lost thirty percent (30%) of his or her muscle mass.¹ Muscle strength declines even more rapidly than bone or muscle mass, or by 55% to 76%, by age 80 years.² Bone mass in older adults is a function of the peak (or maximal) mass achieved by about 25 years of age, and the amount lost, generally beginning at about age 50. In women, bone loss averages 2–3% per year over the first 5–8 years after menopause and then slows to about 1% per year. In men, loss averages 1% per year after age 50. Peak mass by age 25 is largely determined by genetics (about 80%), with lifestyle playing a less important role (20%). With aging, however, genetic influence wanes. By age 40 to 45, the genetic contribution declines to 40% to 70% and by age 65, there is little or no genetic contribution to bone loss.³ Thus, among older adults, lifestyle and other environmental factors become increasingly important for preserving bone health.

Diet and exercise are important determinants of bone and muscle strength, and the choices we make will strongly influence musculoskeletal health as we age. Preventing muscle wasting, which generally occurs at a rate of 1% per year in older adults, is important because it lowers risk of falls and associated injuries. Preventing bone loss is important because for every 10% decline in bone mass, there is an approximate doubling of fracture risk for both men and women.^{4,5} Women are at increased risk for osteoporosis because they achieve a lower peak mass than men and they lose bone rapidly for the first 5 to 8 years after menopause.

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Bone mass is usually assessed by bone mineral density (BMD) scans of the spine and hip. These scans are performed by dual-energy X-ray absorptiometry, or DXA. BMD is expressed as the amount of mineralized tissue in the area scanned. This measurement is noninvasive, has very low radiation exposure, and takes no more than a few minutes. The National Osteoporosis Foundation recommends that women have a screening DXA scan at age 65 years and men at age 70 years to assess their risk for fracture,⁶ and it recommends DXA scans at age 50 years and older for adults with known risk factors for fracture.



Current Problem

The individual, societal, and economic burdens of muscle and bone loss are enormous. A major consequence of muscle wasting is an increased risk of falling. Fall rates increase by an average of 10% per decade. By age 65 years, one in three persons falls each year and by age 80 years, one in two persons falls each year.⁷ Of those who fall, 20 to 30% sustain moderate or severe injuries, at least half of which are fractures.⁷ Direct total cost for all fall injuries for people 65 and older in the United States exceeded \$19 billion in 2000.⁸ Based on demographic projections, the annual direct and indirect cost of fall injuries may rise to \$54.9 billion in 2020.⁹

The statistics about falls and risk of fracture are striking. The lifetime risk of a fracture for men and women is about 40%. In addition, one in four women will sustain a low-trauma fracture (i.e., a fracture caused by a fall from standing height or less) after age 50 years.¹⁰ There has been an encouraging downward trend in risk of fracture of the hip over the last 15 to 20 years in the United States,^{11,12}

but not in rates of fracture at other skeletal sites.¹² Despite the decline in rate of hip fracture, the total number of hip fractures expected in the United States is rising because the high risk population, men and women age 65 years and older, is increasing. Specifically, the number of men and women age 65 years and older is expected to increase from 40 million to 89 million between 2010 and 2050.¹³ The associated health care cost of fractures in the United States, estimated at \$17 billion for the year 2005, is projected to exceed \$25 billion in 2025.¹⁴

The high prevalence and personal, societal, and financial burden of musculoskeletal diseases provide a strong rationale for consideration of lifestyle factors that can slow the progression of muscle and bone mass loss. Specifically, this paper focuses on the role that diet and physical activity interventions can play in reducing bone and muscle loss while lowering risk of falling in older adults.

Nutrition

Calcium

Calcium is required for muscle contractions and other cell functions.¹⁵ In a recent study, in 564 Australian women age 80–92 years, women consuming 2.2 or more servings per day of dairy foods (milk, yogurt, or cheese) had 3.3% more muscle mass than women consuming less than 1.5 servings per day.¹⁶ Dairy serving sizes are: 8 ounces (1 cup) for milk and yogurt and 1.5 ounces for natural cheeses. Dairy foods are rich in calcium and they also contain protein, potassium, and other nutrients that may contribute to higher muscle mass.

About 99% of the calcium in the human body is in bone, and calcium is critical for the development and preservation of the skeleton. Calcium is part of hydroxyapatite, the crystalline component of bone that gives it strength. In addition to its structural role, calcium intake affects bone mass in adults by lowering the rate at which bone is dissolved and replaced with new bone. A lower remodeling rate is desirable because it is associated with slower rates of bone loss.



Calcium intake requirements cannot be assessed directly and have traditionally been based primarily on short-term calcium balance studies (studies in which the amount of calcium from the diet that is retained in bone is calculated as the difference between calcium consumed and calcium appearing in the urine and stool). Randomized calcium intervention trials with changes in rates of bone loss and fractures have been used as supporting evidence rather than primary evidence of reduced fracture risk because there are limited quantities of trial data. In 155 young adults with calcium intakes ranging from 415 to 1,740 mg per day,¹⁷ a study found that neutral calcium balance (consistent with preservation of bone mass) was estimated to occur at an intake of 741 mg per day. In a reanalysis of earlier balance data in men,¹⁷ maximal calcium retention was estimated to occur at a calcium intake from food of 1,200 mg per day. Several other

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randomized, controlled trials have assessed whether supplemental calcium increased bone density and lowered fracture risk across the spectrum. A meta-analysis of these trials in postmenopausal women found that calcium supplementation increased bone density at the spine and hip by 1% to 2%.¹⁸ It did not, however, significantly lower risk of vertebral or non-vertebral fractures.¹⁸ The trials included in this analysis tested calcium doses in the range of 500 to 2,000 mg per day over periods ranging from 18 months to 4 years. Additional meta-analyses that included further studies similarly found no significant effect of calcium on fracture risk.^{19,20} Given these studies, it appears that supplemental calcium will improve bone density slightly, but calcium supplementation alone is not effective in preventing fractures.

The 2011 Institute of Medicine (IOM) recommendations for calcium intake are 1,000 mg per day for men age 51–70 years, 1,200 mg per day for men age 71 years and older, and 1,200 mg per day for women age 50 years and older.²¹

Older adults generally have lower vitamin D levels because they are less able to make vitamin D in their skin and because many avoid sun exposure.

Vitamin D

Vitamin D is acquired from the diet and through production of the vitamin in the skin in response to sun exposure. Few foods contain significant amounts of vitamin D (e.g., fortified milk, fortified breakfast cereals, wild salmon, and other fatty fish), so supplementation may be required. In addition, when sun exposure is lacking or ineffective, many people will need vitamin D supplements. The effectiveness of sun exposure in stimulating vitamin D synthesis is related to latitude, altitude, time of day, degree of skin pigmentation, sunscreen use, and other factors. In much of the heavily populated temperate zones (i.e., the latitudes range of 23.5 to 66.5° north and south), sun exposure in the winter does not promote skin synthesis because the needed UVB rays do not reach Earth's surface. Older adults generally have lower vitamin D levels because they are less able to make vitamin D in their skin²² and because many avoid sun exposure. Absorption of ingested vitamin D (e.g., foods and supplements) does not appear to decline with aging.²³ The vitamin D that is absorbed from the diet and that made in the skin are not biologically active. It becomes active only after it undergoes chemical changes in the liver and kidney. Vitamin D status is assessed clinically by measurement of blood levels of 25-hydroxyvitamin D (a compound that helps determine whether an individual has enough vitamin D in his or her blood). This compound is not biologically active, but nonetheless it is the best available indicator of whether an individual has enough vitamin D.

Foods such as fortified milk, fortified breakfast cereals, wild salmon, and other fatty fish contain significant amounts of vitamin D, but supplements may be required when sun exposure is lacking or ineffective.



Severe vitamin D deficiency is characterized clinically by profound muscle weakness, particularly in muscles of the thighs and upper arms, and by muscle pain and impaired gait.^{24,25} Mild vitamin D insufficiency is associated with impaired muscle performance in observational studies in older adults.^{26,27} In randomized, controlled vitamin D intervention trials, vitamin D supplementation improved leg muscle strength only in individuals with low starting vitamin D blood levels.²⁸ Vitamin D may also be important to preserve balance in older adults. In two independent trials, 800 international units (IU) of vitamin D per day resulted in a 28% improvement in balance over periods of two and 12 months.^{29,30}

The impact of vitamin D on risk of falling has been examined in several studies. Meta-analyses indicate that risk of falling in men and women is decreased by 17 to 20% in the trials administering 700 to 1,000 IU per day of vitamin D, whereas doses of 400 IU per day were ineffective.^{31,32} Higher doses have been tested. In acute hip fracture patients, a dose of 2,000 IU of vitamin D per day was no more or less effective than 800 IU per day in affecting fall rates.³³ In older adults, a 500,000 IU dose given orally once per year, when compared with placebo, actually increased their risk of falling.³⁴

Current evidence indicates that a vitamin D intake in the range of 700 to 1,000 IU per day is the amount needed for maximum protection against falling and that large doses should be avoided.

Vitamin D lowers rates of bone loss in older adults by about 50%,^{35,36} with most of the benefit occurring in winter.³⁶ This effect on bone loss is too small to account for the impact that vitamin D has on lowering fracture risk (to be described below); most of the anti-fracture benefit from vitamin D likely results from its improving strength and balance while lowering risk of falling. Many randomized controlled trials have examined the effect of vitamin D on fracture rates in older men and women. A subject-level meta-analysis of available trials was performed in 31,022 persons age 65 years and older.³⁷ In the group as a whole, vitamin D showed only a trend toward lowering risk of hip fracture (by 10%) when compared with placebo. When the data were examined by the amount of vitamin D taken in the trials (calculated as the product of dose administered and proportion of study pills taken, or adherence), there was a 30% lower risk of hip fracture in the highest quarter of intake (intake range 792 to 2,000 IU per day, median 800 IU per day) than in each of the other quarters. The highest quarter also had significantly lower risk of non-vertebral fracture (a 14% risk reduction). These findings suggest that an intake of at least 800 IU of vitamin D per day is needed to lower fracture risk in men and women age 65 and older. This intake is in accord with the

IOM recommended vitamin D intake of 800 IU per day for men and women age 71 years and older, but higher than the intake of 600 IU recommended for persons age 50 to 70 years.²¹ This meta-analysis provides strong support for the findings as it contains data from a large number of trials, including the Women's Health Initiative; it takes account of compliance with study pills, which was highly variable in the trials; and it accounted for vitamin D intake not only from study pills but also from personal supplement use during the trials. Meta-analyses can be used to estimate the dose needed to minimize fracture risk, but they can never be as precise as a single multiple-dose study with fracture as the primary outcome.

At least 800 IU of vitamin D per day is needed to lower fracture risk in men and women age 65 and older.

Meeting the requirements for *both* calcium and vitamin D is important for preservation of muscle and bone mass and lowering risk of falls and fractures in older adults. This combination is also very important for individuals with osteoporosis who are taking antiresorptive drugs, which slow bone loss, such as alendronate, risedronate, or raloxifene, or hormone therapy to prevent fractures, because it increases the effectiveness of the therapy.^{38,39} The IOM considers a vitamin D blood level (specifically, a 25-hydroxyvitamin D level) of 20 ng/ml to be sufficient for the general older population, whereas several professional societies including the Endocrine Society and the American Society of Clinical Endocrinologists recommend minimal levels of 30 ng/ml for those at risk for, or with, osteoporosis.

Protein intake and the acid-base balance of the diet

Dietary protein favorably influences muscle and bone by several mechanisms. It stimulates the production of a factor that promotes the growth of bone and muscle, IGF-1,⁴⁰ increases calcium absorption;⁴¹ and provides the amino acids needed to build bone and muscle.

In older adults, higher protein intake has been associated with greater lean mass,⁴² with higher BMD of the total hip,⁴³ and with reduced rates of bone loss from the hip and spine.⁴⁴ Calcium intake appears to influence the impact of dietary protein on bone. Favorable effects of protein on rates of bone loss are observed at calcium intakes above 800 mg per day, but not at lower intakes.⁴⁵ The IOM recommends a protein intake of 0.8 g/kg per day for adults. For example, for a 60 kg (or 132 pound) person, 48 grams per day (60 X 0.8) of protein is recommended.



Diets rich in fruits and vegetables are associated with higher bone mineral density and with reduced rates of bone loss.

The acid-base balance of the diet appears to influence bone and muscle loss in older adults. Aging is associated with a low-grade, progressive metabolic acidosis, where your blood becomes more acidic as you age.⁴⁶ This results from the combination of age-related decline in kidney function (limiting the capacity to excrete hydrogen ions)⁴⁷ and consumption of acid-producing diets. An acid-producing diet is one in which intake of fruits and vegetables (which are metabolized to alkaline bicarbonate) is inadequate to neutralize the intake of acid-producing cereal grains and protein (which are metabolized to sulfuric acid).⁴⁸⁻⁵⁰ Of 171 healthy older adults recruited for an alkali intervention trial, 96% had positive urinary net acid excretion (NAE) values, indicating that their usual diets were acid-producing.⁵¹

An acidic environment has negative effects on muscle by mechanisms that are not well understood. In a small metabolic study in postmenopausal women on acid-producing high-protein diets, daily treatment with an alkaline salt, potassium bicarbonate, reduced nitrogen excretion.⁵⁰ Under the conditions of the study, reduced nitrogen excretion was an indicator of reduced muscle loss. The authors calculated that the bicarbonate-induced decline in nitrogen wasting, if sustained, would be sufficient to offset the decline in muscle mass that occurs with aging. In a recent three-month trial, administration of 67.5 milliequivalents (meq) of potassium bicarbonate per day, the amount that neutralized the average dietary acid load of

the study participants, significantly lowered nitrogen excretion in healthy older men and women and improved lower extremity muscle power in the women.⁵¹ Long term studies are needed to assess the effect of alkali on muscle mass. Additional studies are also needed to identify the optimal dose of alkali and the optimal ratio of fruit and vegetable intake to grain intake. Meanwhile, adhering to the *Dietary Guidelines for Americans*, which recommend nine servings per day of fruits and vegetables and six servings per day of grains, seems prudent.

In older adults, higher protein intake has been associated with greater lean mass, with higher BMD of the total hip, and with reduced rates of bone loss from the hip and spine. Calcium intake appears to influence the impact of dietary protein on bone.

Consuming acid producing diets has well-established negative effects on bone. It impairs the ability of bone tissue to regenerate itself⁵²⁻⁵⁴ and increases the rate of bone breakdown.^{55,56} Acid also blocks the process by which calcium is deposited in bone.⁵⁷ Diets rich in fruits and vegetables are associated with higher BMD and with reduced rates of bone loss.⁵⁸⁻⁶² In short-term studies, a daily dose of alkali, as potassium bicarbonate, over a period of one to three weeks lowered bone breakdown.^{63,64} In a recent randomized controlled trial, supplementation with 90 meq per day of the alkaline salt potassium citrate (equivalent to the alkali in 9–12 servings of fruits and vegetables per day) significantly improved calcium balance over a six-month period.⁶⁵ Improved calcium balance implies improved bone mass because over 99% of the calcium in the body is located in bone. The effect of supplementation with alkali on rates of bone loss has been assessed in three randomized controlled trials. In the first, supplementation of postmenopausal women with 35 meq per day of an alkaline salt of potassium for one year reduced rates of bone loss.⁶⁶ In the second, a two-year trial in 201 older men and women, a larger dose of 60 meq per day of potassium citrate significantly lowered rates of bone loss.⁶⁷ In contrast, in the third trial, in postmenopausal women, neither 54 meq per day of an alkaline salt of potassium nor the addition of three extra servings per day of fruits and vegetables for 2 years altered the rates of bone loss.⁶⁸ The reasons for the inconsistent findings in these trials are not clear and further work is needed to fully define the effect of supplementation with alkali on rates of bone loss in older men and women.



The Physical Activity Guidelines for Americans recommend a mix of muscle-strengthening and aerobic exercise for adults age 65 years and older as well as balance training for those at risk for falls.

Acid-producing diets can be balanced by increasing intake of alkali-producing fruits and vegetables and/or by reducing intake of acid-producing foods, protein, and cereal grains. Protein intake is important for musculoskeletal health in older adults, and so a decrease in intake of this nutrient is not generally recommended. Alternatives are to increase intake of fruits and vegetables and, if excessive calorie intake is a concern, to reduce intake of cereal grains. In addition to their contribution of net alkali with its favorable effects in reducing bone turnover, fruits and vegetables likely have other beneficial effects on bone related to their phytonutrient and micronutrient contents.

Physical Activity

A healthy diet provides the nutrients needed to build and repair muscle and bone tissue. Movement and weight-bearing activity provide the stimulus needed for these metabolic processes to occur. The resulting interdependence of diet and physical activity is illustrated by the fact that resistance training produces the greatest increases in muscle mass and strength among older adults when accompanied by sufficient protein consumption.⁶⁹

The *Physical Activity Guidelines for Americans* (see Table 1) recommend a mix of muscle-strengthening and aerobic exercise for adults age 65 years and older as well as balance training for those at risk for falls.⁷⁰ These guidelines are minimums for overall health in older people who are able to be active. Aerobic exercise (also called endurance training) refers to activities such as walking or cycling that improve aerobic capacity, the amount of oxygen consumed during maximal exercise. Muscle-strengthening exercise (also called resistance training) is intended to improve strength, or force-generating capacity, of muscle.⁷¹ Balance training targets specific neuromuscular components involved in postural balance.⁷²

Aerobic exercise (endurance training) benefits skeletal muscle strength and function by increasing muscle fiber size and the number of capillaries supplying blood to muscle tissue.⁷¹ For example, the size of fibers in the calf muscle increased by 12% in older adults who walked or jogged for 45 minutes three times a week for 10 months at 80% of age-adjusted maximum heart rate (MHR).⁷³ Older adults who rode a stationary cycle for 45 minutes three times per week at 70% of MHR had a 128% increase in oxidative capacity of their muscle tissue.⁷⁴

Muscle strength declines in aging. This is primarily due to muscle atrophy and a reduction in the percentage of contractile tissue within muscle.⁷¹ Many studies have shown increases in muscle strength with systematic training using weight machines or free weights.^{71,75-77} Most programs involve two to three training sessions per week at which 2-3 sets of 8-15 repetitions of various exercises are performed.^{71,75-77} Both low- and high-resistance exercises can increase muscle volume and strength if maximal effort is achieved (i.e., muscles are worked close to failure).⁷⁸ High-tech equipment is not needed; strength training with elastic bands can also improve muscle strength in healthy elders.⁷⁹ Specific effects of training that contribute to increased strength include increases in muscle fiber size, capillary density, and contractile portion of muscle



Table 1. Physical Activity Guidelines for Americans: Active Older Adults

Activity Type	Duration or Frequency
Aerobic	At least 150 minutes per week at moderate intensity or 75 minutes per week at vigorous intensity
Muscle-Strengthening	At least two days per week
Balance Training	For those at risk for falls: three or more days per week

fibers, as well as improvements in the recruitment and firing rates of neuromuscular motor units.⁷¹

A wide variety of exercise forms appear to benefit balance, probably because postural control involves many underlying physiological systems.^{80,81} In aging, rapid force production decreases more than maximal force and this can reduce the neuromuscular response to sudden balance perturbations, increasing the risk for falls.⁸² Declines in visual, sensory, and vestibular systems also contribute to impaired balance and the risk for falling.⁸⁰ Formal balance training comprises drills that specifically challenge balance (e.g., maintaining balance on an unstable surface) and that mimic the movements of everyday life (e.g., walking around obstacles). Training difficulty and intensity can be progressively increased to require increased speed of movement and a smaller or less stable base of support.⁷²

A wide variety of exercise forms appear to benefit balance, probably because postural control involves many underlying physiological systems.



Although balance training is likely to benefit a broad range of older adults, those with pronounced impairments should receive training targeted to the specific deficits involved.^{80,83} Strength training, either alone or in combination with balance training, can also improve balance.^{76,84–86} A 12-month program that taught principles of balance and strength training in individuals who had fallen previously resulted in a 31% decrease in falls compared with controls.⁸⁵ A 42-week strength training program involving all major muscle groups led to dynamic balance improvements in older women even without a specific balance component.⁷⁶ Explosive strength training improves dynamic balance control in older adults by improving rapid force production.⁸⁶ Exercise methods that involve core strengthening (e.g., certain calisthenics, Pilates, etc.) contribute to balance, perhaps by fostering more efficient use of the extremities.⁸⁷ Tai chi and yoga have been shown to benefit balance to a degree similar to specific balance training,⁷² probably through a combination of strength building, neuromuscular training, and improved body awareness.

Rapid bone loss occurs under conditions of “unloading” such as bed rest or space flight.⁸⁸ In contrast, loading, whether from weight bearing activities such as walking or from the pull of muscle contractions in resistance training, provides a stimulus for the uptake of calcium into bone. A Cochran review of 43 randomized clinical trials concluded that exercise can “slightly” improve BMD and reduce fracture risk in women.⁸⁹ It suggested that the most effective type of exercise for preserving femoral neck BMD is progressive resistance strength training for the lower limbs,⁸⁹ and for preserving spine BMD, combination exercise programs (i.e., involving more than one type of activity).⁸⁹ Resistance training and impact-loading activities also appear to preserve BMD in middle-aged and older men.⁹⁰ As a result, the Endocrine Society recommends that men at risk for osteoporosis participate in weight-bearing activities for 30–40 minutes three or four times per week.⁹¹ Studies of strength training with weight machines have demonstrated small to moderate reductions in bone loss from the spine^{75,92} and hip^{75,92} in older adults. A review of walking intervention studies showed a positive effect of walking

on femoral neck BMD but no significant effect on lumbar spine BMD.⁹³ Much research has focused on the effects of physical activity interventions, but self-selected activity levels have also been linked to BMD. A large prospective cohort study showed that self-selected physical activity (mostly moderate) at ages 75 and older can reduce bone loss from the hip.⁹⁴ Physical activity has also been linked to reduced fracture rates in older adults.⁹⁵ Walking was associated with a reduced risk of hip fracture⁹⁶ and a sedentary lifestyle with an increased risk of non-vertebral fractures.⁹⁷

Exercise interventions can benefit BMD and bone quality in individuals with osteoporosis⁹⁸ but should be carefully designed to reduce the risk of exercise-related falls and fractures.⁹⁹ In addition, to reduce the risk of vertebral fracture, individuals with established osteoporosis should avoid activities that involve spinal flexion, especially in combination with twisting.¹⁰⁰

Conclusion

Meeting the requirements for *both* calcium (1,000 to 1,200 mg per day) and vitamin D (600 to 800 IU per day) is important for the preservation of bone mass and for lowering risk of fractures. Vitamin D is also instrumental in preserving muscle function and lowering risk of falls in older adults. Acid-producing diets contribute to bone loss and muscle wasting in older adults. To prevent this, adults can increase consumption of fruits and vegetables and/or reduce intake of cereal grains and protein (while ensuring that they meet the protein requirement). The *Dietary Guidelines for Americans* recommend nine servings of fruits and vegetables and six servings of grains per day. Physical activity, including endurance exercise, strength training, and balance work, benefits the musculoskeletal system and reduces the risk of falls and fractures in older adults. For active older adults, the *Physical Activity Guidelines for Americans* recommend 75–150 minutes per week of aerobic exercise and at least two days per week of muscle-strengthening exercise. In addition to providing other health benefits, this degree of physical activity can be expected to make a substantial contribution to preserving musculoskeletal health in older adults.



Scientific Summary

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Falls, and the potential injuries and disablement accompanying them, represent major threats to health and well-being as people age. Fortunately, as discussed in the article written by Dawson-Hughes and Harris, an extensive body of evidence has shed light on the types of dietary and physical activity choices that older adults can make to help preserve both bone mass and muscle function, as well as lower their risk of falls and fall-related fractures. On the dietary front, recommendations include getting sufficient daily amounts of calcium, vitamin D, and protein, as well as reducing the amount of acid produced in the diet by eating plentiful amounts (i.e., 9 servings) of fruits and vegetables daily.

Just as important, daily physical activity has demonstrable positive effects on bone and muscle health, as well as reducing falls and fracture risk. Notably, research suggests that it is never too late to experience many of the health-enhancing benefits of regular physical activity.

Recommended types of physical activity for older adults include moderate-intensity endurance activities (e.g., walking) on most days of the week as well as simple strengthening exercises at least two days per week. Simple balance exercises can be added for those at risk for falls.

Making such healthful choices can preserve one's musculoskeletal health and help support a vital old age.

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