

The Senior Section

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Targeted Exercise for Promoting Bone Health in Women

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Osteoporosis is a devastating chronic disease characterized by low bone mineral density (BMD) and increased bone fragility.^{1,2} Currently, more than 29 million Americans have low BMD (osteopenia and osteoporosis), the majority being middle-aged and older women.² Due to substantial advances in research during the previous three decades, osteoporosis is now considered a preventable disease for most individuals. A combination of healthful nutrition and ample, regular physical activity throughout the life span can help maintain BMD and prevent osteoporosis.

An exercise program composed of the appropriate mode, intensity, and dose may help attenuate and even reverse bone loss.³ Activities ranging from running and vertical jumping to brisk walking and strength training can all have a significant effect on the integrity of bone.⁴⁻⁹ Specifically, high-impact, weight-bearing exercises and progressive resistance training are now considered essential to promoting bone health throughout the life span. Appropriate exercise is particularly important for postmenopausal women because the associated reduction in circulating estrogen at menopause is associated with a loss of lean tissue, including muscle mass and bone, and hence vulnerability to osteoporosis.^{5,8}

Exercise and Bone Health

The prevention of osteoporosis actually begins during childhood and continues into adulthood. Gravitational and mechanical stimuli from targeted exercise trigger anabolic activity in the musculoskeletal system, which helps to increase BMD. Osteoblasts begin bone formation in a particular area of

bone when a significant force is repeatedly applied to that area, which can be accomplished through high-impact, weight-bearing activities and strength training. An exercise program that incorporates these components can have a positive impact on BMD within 6-9 months, although interventions showing the greatest effect are at least 1 year in duration.^{5,8} An established body of research demonstrates the positive effects of targeted exercise in the prevention and treatment of osteoporosis.

Weight-Bearing Exercise

Regular physical activity and specific weight-bearing exercises are essential for bone growth and maintenance.¹⁰ In contrast, there is bone resorption when weight bearing is reduced, such as in cases of bed rest, immobilization, and space travel, demonstrating how extended physical inactivity leads to significant bone loss.

Though it is not a high-impact activity, daily walking throughout the life span is beneficial to bone health. Women who walk regularly throughout their lives have a 30% reduction in hip fractures and have reduced loss of bone over time.^{4,6,10} Walking creates a force on bone that is about equal to one's body weight, while brisk walking and jogging can create a force that is equivalent to two to three times body weight.⁸ This concept is central to the role of exercise in stimulating bone growth.

During the third decade of life, osteoclast activity overwhelms osteoblast activity and the typical age-related bone loss ensues. It is at this point that higher-impact, weight-bearing activity is essential to bone density maintenance, and moderate walking is generally not a sufficient stimulus to attenuate bone



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loss in middle-aged women.¹¹ More appropriate bone-boosting activities (at least for premenopausal women) would be volleyball, jumping rope, and vertical jumping, which can produce up to three times body weight of force.⁷

Exercises such as jogging, jumping, and calisthenics produce stress on the skeleton through ground-reaction forces (GRFs), whereas other activities, like weight lifting, produce stress on the skeleton through joint-reaction forces (JRFs).⁸ Data in women aged 60–74 years from Kohrt and colleagues⁸ demonstrate that after 11 months of either GRF activities, JRF activities, or sedentary behavior, the GRF and JRF groups showed significant and similar improvements in BMD of the whole body, lumbar spine, and proximal femur compared with controls. In contrast with the JRF group and controls, the GRF group exclusively experienced a significant increase in BMD of the femoral neck.⁸

Another GRF research study, conducted by Bassey and Ramsdale,⁷ involved deliberate jumping and skipping. Researchers conducted a randomized controlled trial in which one group of premenopausal women participated in low-impact exercise classes while the other group did the same low-impact exercise classes combined with intermittent high-impact exercise that included weekly jumping and skipping. The latter group stressed their skeletons through GRF of vertical jumping, and they experienced a significant increase in bone density of 3.4% at the trochanter, while the low-impact only group did not experience a significant change. The effect of jumping on the bone density of postmenopausal women is not as encouraging.¹² One long-term study (5 years) did show that postmenopausal women who wore weighted vests during jumping lost less bone density when compared with controls.¹³ In older women, jumping exercises may be done safely if supervised and combined with appropriate strength training.

Progressive Resistance Training

Progressive resistance training, also commonly termed strength training or weight lifting, is unique in its ability to increase bone density by regularly increasing the load that is being lifted (intensity) and thereby consistently increasing mechanical stimulation of bone. As mentioned previously, the skeleton is stressed through JRFs during these exercises, which can have a positive effect on bone mass accumulation and maintenance. As muscles lift a particular load, they pull against tendons, which thereby exert that force on bone, causing bone growth. When muscles increase in strength and size, they exert more force and provide greater stimulation to bone throughout daily activities.

Several studies demonstrated increased BMD at the hip and spine in postmenopausal women with

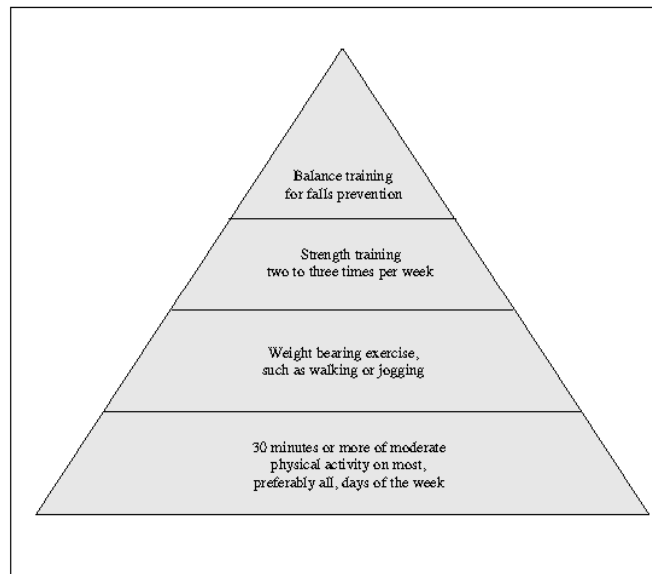


Figure. Physical activity recommendations for strong bones (and general health) for midlife and older women. A variety of activities, such as brisk walking, jogging, and strength training are important components of maintaining bone health and overall fitness. For frailer, older adults, balance training is important to help minimize falls, which often lead to fractures and subsequent disability. Adapted from *Physical Activity and Health: A Report of the Surgeon General*. Washington, DC: US Dept of Health and Human Services; 1996.

strength training, and one small study in older women has shown a reduction in vertebral fractures with targeted back strengthening exercises.^{5,8,9,14–16} A randomized, controlled trial with women aged 50–70 years observed increased BMD as well as improvements in strength, muscle mass, and dynamic balance after 1 year of twice-weekly progressive resistance training in estrogen-depleted women.⁵ Important research by Cussler et al.¹⁴ demonstrated evidence of a dose response between BMD change and total weight lifted over the year, indicating the importance of exercise intensity for optimal improvements in bone composition.

Conclusion

Starting in early childhood and continuing into the third decade of life, peak bone mass and density progressively increase. During these years, high-impact, weight-bearing activities and sports such as basketball, volleyball, running, and jumping are critical components to achieving maximal bone benefits. As age increases, more targeted exercise becomes essential to maintaining the bone's integrity.

Research demonstrates that weight-bearing exercises and progressive resistance training combined with other appropriate lifestyle factors will greatly

reduce risk for osteoporosis in today's rapidly growing aging population. Programs designed to affect fracture-vulnerable bones should focus on large muscle group exercises such as squats and leg presses, which target the hip, as well as upper body exercises such as overhead presses, trunk exercises, and chest presses, which target the spine and wrist.

A progressive, targeted, and multidimensional exercise prescription (Figure) has the potential to attenuate and even reverse bone loss in older adults and, if sustained throughout life, will help younger individuals achieve and maintain high bone mass. ■

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