

Exercise

Medical guide



Regular physical activity and exercise is recognised as one of the most effective lifestyle strategies to maximise peak bone mass and to reduce the risk of fractures later in life.

Regular weight-bearing exercise and progressive resistance training can increase bone density and prevent bone loss associated with menopause and ageing. High challenging balance and mobility training is also effective for improving balance, gait and co-ordination, which can reduce the risk of falling. Exercise can also help speed rehabilitation following a fracture.

Exercise and bone density

There is significant evidence that children who participate in moderate-high impact weight-bearing interventions that include activities such as hopping, skipping and jumping experience greater gains in bone density compared to less active controls.^{1,2} In middle aged and older adults, there is evidence that exercise programs including a combination of progressive resistance training with a variety of moderate impact weight-bearing activities are most effective for increasing bone density or preventing age-related bone loss.

Maintaining an habitually active lifestyle that incorporates regular weight-bearing exercise can also reduce fracture risk. Hip fracture incidence has been observed to be as much as 38-45% lower in older adults with a history of higher levels of physical activity in daily life, compared to age matched less active people.³

A range of studies has shown that a lack of stress placed upon bone leads to a decline in bone density; for example, prolonged bed rest, impact of weightlessness on astronauts and people who are wheel-chair bound.⁴

Types of exercises

The main types of exercise recommended for bone health include:

- Weight-bearing aerobic exercise (lower limbs bear weight which places stress on bones).
- Progressive resistance training (lifting weights that become more challenging over time).
- High velocity resistance training (lifting weights quickly and then lowering slowly).
- Moderate to high impact exercise (eg: jumping, skipping, dancing, basketball, tennis).
- Balance and mobility exercise (eg: standing on one leg with the eyes closed, heel-to-toe walking).

Bone building 'osteogenic' exercises

Particular types of exercise are osteogenic (bone development specific). It is well known that bones respond to changes in mechanical loading. The different ways that loads are applied to bones can be particularly effective for stimulating an osteogenic response.

Examples of different types of osteogenic exercises are detailed in the table below:

The impact of selected exercises on bone health

Highly osteogenic	Moderately osteogenic	Low osteogenic	Non-osteogenic*
Basketball/Netball	Running/Jogging	Leisure walking	Swimming
Impact aerobics	Brisk/Hill walking	Lawn bowls	Cycling
Dancing/Gymnastics	Resistance training	Yoga/Pilates/Tai Chi	
Tennis	Stair climbing		
Jump rope			

* While certain exercises may have low to no osteogenic benefits this should not be construed to imply that these exercise do not offer a wide range of other health benefits.

Exercise and stage of life

The goal of exercise changes throughout life, beginning with building peak bone mass in childhood and adolescence, followed by optimising muscle and bone strength in young adulthood, to reducing bone loss in old age. For the elderly, the focus is on prevention of sarcopenia (muscle wasting) and addressing risk factors for frailty and falls, particularly impairments in balance, gait and mobility.

Exercise and its effects

Age	Bone status	Exercise effect
Childhood/ Adolescence	In girls and boys the major build up of bone occurs in the pre-teen and adolescent years. Peak bone density is reached during mid to late 20s.	Can increase bone density and structure to maximize peak bone strength, which helps keep bones strong for longer in adulthood. ⁵
Early to mid adulthood	Bone density is maintained or starts to decrease very gradually when a person reaches their 30-40s although increases are still possible during middle adulthood.	Can maintain or increase (1-3%) bone density and improve cardiovascular health and fitness; resistance training can also improve muscle mass and strength. ⁵
Post menopausal women	In women from the age of 45 years, bone loss begins to increase to 1-2% per year. Bone loss accelerates up to 2-4% per year at the onset of menopause.	Can maintain bone strength by helping to slow the rate of bone loss following menopause. ⁶ It is very difficult to increase bone density during or after menopause by exercise alone. Can effectively improve muscle function (balance) and reduce falls risk.
Men	Bone density tends to remain relatively stable until middle age, decreasing by about 0.5-1.0% per year from the age of 45-55 years. Low testosterone or hypogonadism can cause bone loss in men.	Can maintain or increase (1-2%) bone density, improve muscle mass, strength, balance and co-ordination to help prevent falls and maintain general health. ⁵
Older adults without osteoporosis	After 75 years of age, further increases in bone loss occur in both sexes, especially from the neck of the femur (hip). The risk of fracture increases as bone loss increases.	Helps to maintain bone strength and increase muscle strength, balance and co-ordination, which in turn help to prevent falls. ⁵
Older adults with osteoporosis/ fractures	Bones are increasingly thin and fragile.	Exercises recommended by physiotherapists and exercise physiologists can improve general health, muscle strength, balance and posture to prevent falls and reduce the risk of further fractures. ⁷



Principles of exercise for bone health

Exercise must be regular, progressive, varied and can be performed in short intensive bursts.

Key tips:

- Continuous progression of training is critical for bone health. The amount of weight used, degree of exercise difficulty, height of jumps etc. must be progressively increased or varied over time to continually challenge the bones and muscles.
- Heavier weights are better than lighter weights.
- Lifting weights quickly is more effective than lifting them slowly for improving muscle function.
- Regular short bouts of weight-bearing exercise separated by several hours are better than one long session.
- Rapid, short bursts of movements such as jumping or skipping are more effective than slow ones.
- Variety and novel activities that involve changing directions and different jumping heights are better than repetition patterns.

If exercise needs to be reduced, it is better to reduce the length of each session rather than the number of sessions per week.

Summary of exercises recommended for bone health

Group	Recommended type of exercise
Healthy adults	Encourage regular participation in a variety of weight-bearing activities and progressive resistance training for at least 30 minutes, 3-5 times per week. AVOID prolonged periods of sedentary behaviour.
Post menopausal women and middle aged men	Encourage participation in a multi-modal exercise regimen inclusive of moderate-high impact weight-bearing exercise (eg: 50-100 jumps) and high intensity progressive resistance training ^{8,9} at least 3 times per week. Specific spinal extension resistance training during middle-age has been shown to reduce vertebral fracture rates over 10 years. ¹⁰ Note: leisure walking on its own is not recommended as an adequate strategy for bone health although it has benefit for general health and fitness.
Older adults and people at risk of osteoporosis	Encourage participation in multi-modal ⁸ and supervised exercise programs that include weight-bearing activities, progressive resistance training and challenging balance and functional activities, at least 3 times per week.
Frail and elderly	Include a combination of progressive resistance training and balance exercises to reduce falls and risk factors for frailty including sarcopenia, poor balance, gait instability, fear of falling, depression, and cognitive impairment. ¹¹
Osteoporosis*	Include a combination of weight-bearing exercise with supervised progressive resistance training and challenging balance and mobility exercises, performed at least 3 times per week. ⁸ AVOID forward flexion (bending over holding object, sit ups with straight legs) and twisting of the spine as this can increase risk of anterior vertebral compression fractures.
Osteoporosis – post fracture	Exercise is an important part of rehabilitation. ¹² An exercise program will be determined by the type of fracture and patient's age and level of physical function. Progressive resistance training during recovery from hip fracture in elderly patients is effective. Resistance training has also been shown to be good for depression, which can increase risk of falls and fractures. ¹³

* Moderate to high impact activities are only recommended for people with osteoporosis who do not have a previous fracture(s) or lower limb arthritis.

In the table above weight-bearing activities can include either moderate impact physical activity (eg: jogging, hill walking), moderate-high impact jumping activities (eg: 50-100 jumps or box step ups) and/or various impact loading sports (eg: basketball, tennis).

For resistance training, it is important to focus on training muscle groups connected to bones of relevance to osteoporotic fracture, such as the spinal extensor muscles, hip abductors, hip extensors, knee extensors, knee flexors, as well as those related to gait and balance (ankle plantar flexors and dorsiflexors, inverters and everters, hip abductors).



- 1 Bass SL, Naughton G, Saxon L, et al. Exercise and calcium combined results in a greater osteogenic effect than either factor alone: a blinded randomized placebo-controlled trial in boys. *J Bone Miner Res* 2007;22:458-64.
- 2 Iuliano-Burns S, Saxon L, Naughton G, et al. Regional specificity of exercise and calcium during skeletal growth in girls: a randomized controlled trial. *J Bone Miner Res* 2003;18:156-162.
- 3 Moayyeri A. The association between physical activity and osteoporotic fractures: a review of the evidence and implications for future research. *Ann Epidemiol* 2008;18:827-35.
- 4 Le Blanc AD, Spector ER, Evans HJ, et al. Skeletal responses to space flight and the bed rest analog: A review. *J Musculoskelet Neuronal Interact* 2007;7:33-47.
- 5 Ebeling PR, Daly RM, Kerr DA, et al. Building healthy bones throughout life: an evidence-informed strategy to prevent osteoporosis in Australia. *Med J Aust Open* 2013;2:Suppl 1.
- 6 Wallace BA, Cumming RG. Systematic review of randomized trials of the effect of exercise on bone mass in pre- and postmenopausal women. *Calcified Tissue Int* 2000;67:10-18.
- 7 Giangregorio LM, Papaioannou A, Macintyre NJ, et al. Too Fit To Fracture: exercise recommendations for individuals with osteoporosis or osteoporotic vertebral fracture. *Osteoporos Int*. 2014;25:821-835.
- 8 Howe TE, Shea B, Dawson LJ, et al. Exercise for preventing and treating osteoporosis in postmenopausal women. *Cochrane DB Syst Rev* 2011, Issue 7. Art. No.: CD000333. DOI: 10.1002/14651858.CD000333.pub2.
- 9 Maddalozzo GF, Snow CM. High intensity resistance training: effects on bone in older men and women. *Calcified Tissue Int* 2000;66:399-404.
- 10 Sinaki M, Itoi E, Wahner HW, et al. Stronger back muscles reduce the incidence of vertebral fractures: a prospective 10 year follow-up of postmenopausal women. *Bone* 2002;30:836-41.
- 11 Singh N, Fiatarone-Singh M. Effects of high intensity progressive resistance training and targeted multidisciplinary treatment of frailty on mortality and nursing home admissions after hip fracture: a randomized controlled trial. *J Am Med Dir Assoc* 2012;13:24-30.
- 12 Marks R. Physical activity and hip fracture disability: a review. *J Aging Res* 2011;74:1918.
- 13 Singh NA, Clements KM, Singh MA. The efficacy of exercise as a long-term antidepressant in elderly subjects: a randomized, controlled trial. *J Gerontol A Biol Sci Med Sci* 2001;56:M497-504.

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