Exercise & Fracture Prevention

A Guide for GPs & Health Professionals

osteoporosis australia

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KEY POINTS

- Osteoporotic fracture is a multifactorial problem requiring a holistic approach to prevention for optimal efficacy and safety.
- Targeted exercise addresses many of the risk factors for osteoporotic fracture, including osteopenia, muscle wasting and weakness, falls, poor balance, depression, use of medications for depression and insomnia, sedentariness, fear of falling, mobility impairment and disability.
- Concurrent management of fracture risk with a physical activity prescription, adequate nutrition and pharmacotherapy for osteoporosis when required offers the best approach to optimal bone health.
- The important elements of the exercise prescription for bone health include high intensity progressive resistance exercise (weight lifting), progressive balance training, moderate to high intensity weight-bearing aerobic exercise and, when feasible, high impact exercise.

This guide outlines the role and rationale for exercise and implementing and prescribing evidence-based exercise regimes for people with osteoporosis.

1. THE ROLE OF EXERCISE

A combination of exercise, adequate nutrition and, when required, pharmaco-therapy offers the best approach to optimal bone health and osteoporotic fracture prevention.

The clinical manifestations of osteoporosis (pain, fracture and subsequent mobility impairment) affect about 2 million Australians currently, and some 20,000 people each year suffer a hip fracture. General Practitioners (GPs) and Health Professionals (HPs) have a critical role to play in preventing such fractures. Current evidence suggests exercise is an important strategy to address the major primary risk factors for such fractures. Physical activity is complementary and additive to the nutritional and pharmacological management of osteoporosis but is a vastly underutilised preventive and therapeutic modality.

SCOPE OF THE PROBLEM

The prevalence of osteoporosis-related conditions in Australia is predicted to increase over the next two decades, from 10% of the population currently to 13.2% by 2021. Also predicted to increase is the incidence of osteoporotic fractures, from one every 5.6 minutes in 2006 to one every 3.7 minutes in 2021.

The total direct costs relating to osteoporosis are currently estimated at $1.9 billion annually. These costs, however, greatly underestimate the suffering caused by osteoporosis-related conditions, such as mobility impairment and activity restriction, pain, fear of falling, need for informal care and support, and loss of self-esteem and emotional wellbeing associated with recurrent injurious falls and fractures. There is, therefore, a great need to better understand osteoporosis and to implement ways to prevent and recover from these morbid events.

PHYSICAL ACTIVITY REDUCES FRACTURE RISK

Epidemiological studies suggest that regular exercise is associated with a reduction in osteoporotic fracture risk of up to 50% in men and women over 65 years of age.

Currently, there is evidence only for the efficacy of exercise in preventing vertebral fractures; no randomised controlled trials investigating exercise and fracture prevention have been carried out at other specific sites. However, optimal physical activity participation clearly maximises the attainment of peak

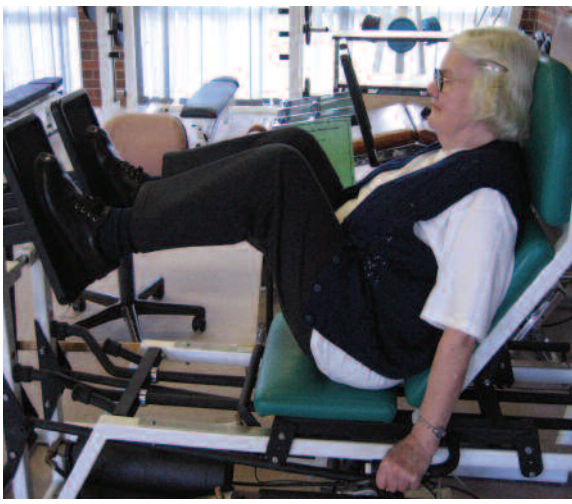


Figure 1. Resistance training, balance training, weight-bearing aerobic exercise and, when feasible, high impact exercise can improve bone and muscle strength and many other modifiable risk factors for osteoporotic fracture.

bone mass and bone strength, and attenuates age- and menopause-related bone loss. It also improves the overall risk factor profile associated with osteoporotic fracture in older adults (such as low muscle mass and strength, poor gait and balance, and depressive symptoms).

Choosing the right kind of exercise for patients with various health profiles requires an understanding of the effects of specific kinds of exercise on bone formation and remodelling at different stages of life.

TYPICAL PATTERNS OF BONE LOSS

In women, bone mass begins to decrease well before the menopause (as early as during their 20s in the femur of sedentary women) and accelerates in the perimenopausal years, with continued decline into late old age. Similar patterns of bone loss are seen in men, although without the acceleration related to loss of ovarian function seen in women.

As with losses of muscle tissue (sarcopenia), many genetic, lifestyle, nutritional and disease and medication-related factors affect the prediction of bone health at a given age. However, a wealth of animal and human data provides evidence for a strong relation between physical activity and bone health/fracture risk at all ages. Mechanical loading of the skeleton generally leads to favourable site-specific changes in bone mineral density (BMD), morphology and strength. In contrast, unloading (in the form of bed rest, immobilisation, casting or spinal cord injury) leads to resorption of bone and increased susceptibility to fracture within a few weeks of unloading. This rapid resorption mimics many years of 'ageing'. Space travel is the most dramatic example of unloading, and much information on the effect of mechanical stresses on bone has been gained from studies of astronauts.

Less extreme variations in mechanical loading patterns seen within normal populations are also associated with differences in bone morphology and strength. Comparative studies of athletic and nonathletic populations usually demonstrate significantly higher BMD in the active cohorts, ranging from 5 to 30% higher, depending on the type, intensity and duration of exercise training undertaken and the characteristics of the athletes studied. Exceptions occur with nonweight-bearing activities, such as swimming, and in amenorrhoeic athletes or elite distance runners with very low body fat, who often appear similar or worse than controls. Measurable differences in BMD are also observed between habitually active (but non-athletic) and sedentary individuals.

Overall, cross-sectional and prospective cohort data support a strong relation for both men and women between lifetime physical activity patterns and preservation of BMD into old age, as well as a protective effect for hip, humerus and vertebral fracture. These reduced risks for fracture remain after adjustment for most major known risk factors for osteoporosis, and are not completely accounted for by differences in BMD, muscle strength or fall rates. It is thought that other changes in bone structure and geometry (such as greater diameter and stronger trabecular architecture) favourably influence skeletal integrity after exposure to exercise. Also, the positive effects of physical activity on gait mechanics, balance, psychological health and nutritional status may help protect against fractures.

EXERCISE AND OPTIMAL BONE HEALTH

The goals of a physical activity prescription for bone health are to enhance bone strength and also address other potentially modifiable risk factors for osteoporotic fracture relevant to exercise, including muscle wasting, poor gait and balance, visual impairment, poor nutritional intake, depression, postural hypotension, polypharmacy, podiatric problems and environmental hazards *(see Table 1 on page 7)*. This holistic approach to the promotion of physical activity is much broader than the simplistic goal of attenuating osteopenia through exercise. Thus exercise is likely to impact favourably not only on bone health but also on the control of many major chronic diseases, mobility impairment and disability, mental health, and quality of life in older patients. Some terms used in association with exercise are defined in the box on page 10.

Principles of exercise prescription

There are many unanswered questions regarding the optimal prescription of exercise for bone health, and in particular its ultimate efficacy for fracture prevention. There is, however, evidence that bone responds positively to novel mechanical forces, and that rapid, short bursts of high intensity loading of bones are more effective than sustained, low intensity loading of bones. Characteristics of exercise that maximise bone adaptation are listed in the box below.

PRINCIPLES OF EXERCISE THAT MAXIMISE BONE ADAPTATION

- Rapid, short bursts of high intensity and/or high impact activities such as jogging, jumping and rope skipping are more stimulating to bone cells than sustained, low impact activity such as walking.
- Effective activity does not have to be weight-bearing. Resistance training is an effective nonweight-bearing activity.
- Aerobic activity that is nonweight-bearing (such as swimming or cycling) does not enhance bone density.
- Lifting heavy weights is more effective than lifting light weights.
- Lifting heavy weights rapidly (power training) seems to be more effective than lifting heavy weights slowly (traditional resistance training).
- Exercising in short bouts with rest periods between has been shown in animal models to be more effective than continuous, long periods of exercise.
- Rapid movements are more stimulating than slow movements.
- Novel forces, such as changing directions and different heights of jumps, are more stimulating than repetitive force patterns.
- As the response of bone to muscle contraction is a local phenomenon, muscles connected to clinically important bones susceptible to osteoporotic fracture (hip, wrist, thoracic spine) need to be targeted specifically to achieve protection at those skeletal sites.

Appropriate types of exercise

Moderate to high intensity weight-bearing aerobic exercise (such as brisk walking, hiking, stair climbing or jogging), high intensity progressive resistance training (weight lifting) and high impact exercise (such as jumping or rope skipping) increase BMD by 1 to 4% per year in pre- and postmenopausal women.

More vigorous exercise interventions seem to produce greater effects. The widest range of benefits relevant to fracture protection seems to be provided by weight lifting and balance training exercises. Whether these benefits translate into fracture risk reduction is not yet known, but it is reasonable to use exercise for risk factor modification pending completion of studies.

The types of exercise appropriate for specific risk factors are listed in Table 1 (opposite), placed in context with other preventive or therapeutic options. It should be noted that prescribing low intensity aerobic exercise alone (such as casual walking) has not been shown to improve gait, balance, muscle mass, muscle strength, bone density, fall risk, clinical depression or fracture rates in older adults.

Although this is the most common exercise advice given by GPs & HPs (such as 'You should take a walk every day' or 'You should be a little more active'), there is no evidence that giving such advice to older patients will prevent osteoporotic fracture. In fact, advising osteoporotic patients with poor balance to walk more without first improving their balance and strength has been shown to increase the risk of fracture.

TABLE 1 OSTEOPOROTIC FRACTURE RISK FACTOR MODIFICATION: ROLE OF EXERCISE

RISK FACTOR FOR OSTEOPOROTIC FRACTURE	PREVENTIVE OR THERAPEUTIC OPTIONS	
	Exercise	Other Options
Osteopenia	Resistance training, power training, weight-bearing aerobic training, high impact training	Bisphosphonates, SERMs (raloxifene [Evista]), hormone therapy, tibolone (Livial), strontium ranelate (Protos), vitamin D, calcium
Sedentary behaviour	Exercise counselling/prescription	Time management & behavioural counselling
Falls	Resistance training, balance training	Hip protectors Evaluate and treat postural hypotension Evaluate and treat visual impairment Environmental modification, home safety evaluation Podiatric problems and footwear evaluation Ambulatory assistive devices Reduce polypharmacy
Muscle weakness/ sarcopenia	Resistance training, power training	Vitamin D or multinutrient supplementation, nutritional counselling Correction of hormonal deficiencies
Impaired balance	Balance training, tai chi, yoga, resistance training, power training	Hip protectors Environmental modification, home safety evaluation Medication management
Depression, antidepressant medications	Substitute moderate to high intensity aerobic or high intensity resistance training for antidepressant medication	Counselling and/or cognitive-behavioural therapy
Protein & calorie under-nutrition, weight loss	Resistance training to increase appetite & protein uptake from diet	Nutritional counselling and support Protein and energy supplementation
Polypharmacy	Substitute aerobic or resistance training for medications for depression, insomnia and anxiety	Drug review and modification as appropriate to reduce drugs, minimise CNS side effects, relieve postural hypotension, minimise myopathy & osteopenia, & reduce anorexia
Visual impairment	Physical activity may reduce adiposity/insulin resistance/ diabetes, all risk factors for cataracts	Ophthalmological evaluation and treatment as appropriate Environmental modification, visual aids and ambulatory and ocular assistive devices; avoid bifocals
Smoking and excessive alcohol intake	Exercise has been shown to support positive behavioural change in other domains (such as dietary change and smoking cessation)	Encourage and support smoking cessation and reduction in excessive drinking

Abbreviation: SERMs = selective oestrogen receptor modulators

Types of exercise to be avoided

Patients at risk for osteoporotic fracture should avoid activities that involve forward flexion of the spine, particularly while carrying an object (for example, lawn bowls, sit ups with straight legs or simply bending over to pick up something from the floor), as this movement in the presence of osteopenia increases the risk of anterior compression fractures of the thoracic vertebrae. Similarly, unsupervised exercise in those with poor balance or a history of osteoporotic fracture is best avoided, as are high risk activities or hazardous environments that may lead to falls.

PRESCRIBING EXERCISE

It is part of the GP's and HP's role in fracture prevention to provide a detailed exercise prescription for bone health, including written instructions and other educational support materials *(see the box below)*. For some patients, such as those with cognitive impairment, frailty, balance impairment or severe osteoporosis, the exercise should be performed in a supervised venue at least until the patient is considered safe; the GP or HP should refer the patient to one. When referring patients to a fitness centre or other physical activity program, GPs should specify the nature of the exercises required to ensure that the most appropriate program is provided.

FRACTURE PREVENTION USING EXERCISE: THE ROLE OF THE GP & HP

- Assess the risk factors for osteoporotic fracture that are present in each individual (including osteopenia, muscle wasting, poor gait and balance, visual impairment, depression, poor nutritional intake, postural hypotension, polypharmacy, podiatric problems, environmental hazards, smoking, alcohol intake).
- Record historical and current physical activity patterns, and discuss with the patient how these patterns compare with the optimal physical activity recommendations for bone health.
- Identify any contraindications to exercise participation or need to modify exercise recommendations to enhance feasibility or prevent injury.
- Determine the patient's preferences for specific types of exercise within the range of possible choices relevant to fracture risk.
- Provide a detailed exercise prescription for bone health, in terms of exercise type, volume, frequency and intensity, including written instructions and other educational support materials. (GPs can refer patients to a physiotherapist or exercise physiologist for a detailed exercise plan.)
- When referring patients for physical activity programs, specify the nature of the exercises required (e.g. weight lifting, stair climbing, balance training).
- Recommend a supervised venue for training until independent and safe. Note that for some frail patients, withdrawal of supervision will not be realistic at any time point.
- Establish a strong behavioural change program to accompany the exercise prescription, including recording of adherence, provision of feedback, monitoring and periodic revision of the prescription as the patient's risk profile or health status changes.

2. PRESCRIBING EXERCISE

Rapid, short bursts of progressive high impact or high intensity resistance exercise have been shown to improve the major primary risk factors for osteoporotic fracture in middle-aged and older adults more effectively than other forms of exercise. High impact exercise and balance training can readily be incorporated into daily activities.

DEVELOPING AN EXERCISE PRESCRIPTION

Exercise can be considered like a drug in terms of:

- the type prescribed (modality)
- the dosage (volume, frequency, intensity)
- how to take it (type of equipment, supervision)
- interactions (nutritional or pharmacological treatments for osteoporosis, exercise–drug interactions)
- compliance (behavioural change program accompanying the exercise prescription, practical implementation needs)
- side effects (adverse events, risks of exercise).

Some terms used in association with exercise are defined in the box on the next page.
The flowchart on page 13 provides an approach to choosing the appropriate exercise types for individuals with and without osteoporosis or risk factors for it and/or at risk of falls. Depending on a patient's health status, modifications to standard exercise prescriptions may be required.

KEY POINTS

- The most important elements of the exercise prescription for bone health are high intensity progressive weight lifting exercise and progressively more difficult balance training, with the addition of high impact exercise (such as jumping) when feasible.
- The most economical prescription with the broadest benefits for body composition and bone health as well as neuromuscular function is progressive resistance training as the primary exercise modality.
- Continuous progression in the amount of weight moved, balance exercise difficulty and height of jump is the most critical element of the exercise prescription for bone health; if progression stops, so does adaptation in the bone and muscle.
- Given the short time (several minutes per day) that is necessary for effective high impact exercise or balance training, incorporating such episodes into daily activities may be more successful than planning structured exercise classes away from home.

EXERCISE TERMS DEFINED

- Weight-bearing aerobic exercise
  Use of large muscle groups in a rhythmic pattern in a standing position, at a rate that increases heart rate, blood pressure and breathing to at least a 'moderately hard' level. Examples are brisk walking, hiking, stair climbing, jogging and aerobic dance. (Swimming, cycling, seated steppers and arm exercises are examples of nonweight-bearing aerobic exercises.)
- Resistance training (weight lifting exercise)
  Use of targeted muscle groups to lift and lower moderate to heavy weights slowly.
- Power training
  Weight lifting exercise performed so that the lifting phase is done as fast as possible, and the lowering is done slowly.
- High impact exercise
  Exercises in which the bones of the spine and lower extremities are loaded forcefully and rapidly as the feet hit the ground. Examples include jumping, rope skipping, hopping up or down stairs, jumping off boxes and sports involving jumping, such as basketball.
- Balance exercises
  Exercises that stress the equilibrium by narrowing the base of support, removing vision, decreasing foot contact with the ground and changing the centre of mass. Examples include standing on one leg with eyes closed, sitting on an exercise ball, heel-to-toe walking, leaning as far as possible in all directions while standing without bending at the waist, tai chi and balancing while placing a pillow or rocker board under the feet.

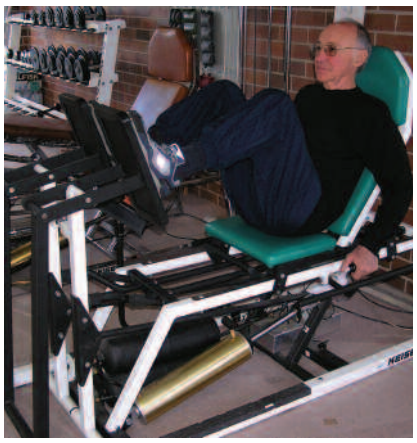
MODALITY

Resistance training

Although weight-bearing aerobic exercise, high impact exercise and resistance training have all been shown to maintain or augment bone density in older adults, resistance training has the added benefits of increasing muscle mass and strength, as well as balance to some extent.

This combination of effects on body composition and muscle function is a direct antidote to age-associated changes in these domains, and offers potential benefit for many health conditions in addition to osteoporosis. Therefore, the most economical prescription with the broadest benefits for body composition and bone health, as well as neuromuscular function, is resistance training as the primary exercise modality. Adding high velocity forces/movements may further enhance bone strength benefits for the femoral neck or trochanter, improve lower extremity muscle power and augment balance. Thus, traditional weight lifting exercise (slow lifting and lowering) or power training (rapid lifting and slow lowering of the weight), either on machines or using free weights, are the key exercise modalities.

The effects of muscle contraction on bone appear to be primarily regional (stimulation of osteoblast function) rather than systemic. Therefore, muscle groups connected to bones of relevance to osteoporotic fracture should be emphasised in a resistance training program (e.g. spinal extensor muscles, hip abductors and extensors, knee extensors and flexors) as well as those related to gait and balance (such as ankle plantar flexors and dorsiflexors and hip abductors). Typical exercises would include the machine-based leg press, seated rowing, lat (latissimus dorsi) pull down and knee extension and flexion, the free weight versions of these exercises, and standing calf raises *(Figures 2a to 2c)*.



Figures 2a to 2c. *Resistance training exercises using machines or free weights increase both bone density and muscle strength. Figure 2a (left): Leg press. Figure 2b (centre): Knee extension. Figure 2c (right): Hip extension (note the weight bands around the ankles).*

High impact exercise

In middle-aged and older adults, high impact exercise is typically prescribed as some form of jumping, including jumping in one place or up and down boxes and stairs, and rope skipping, also known as jump rope *(Figure 3)*.

Fast heel drops (fast drop with sudden stop, then slow raise) are more suitable, although not as effective, for patients with previous injuries or osteoarthritis of the knees and hips. Jumps and heel drops should be performed with hips and knees fully extended (straight) when landing so that the forces are transmitted to the bones, rather than dissipated by the muscles.

Doing high impact exercise between sets of weight lifting exercise incorporates resistance training and high impact exercise in one session without extending the time required, an economical prescription for busy adults.

Figure 3. High impact activities such as rope skipping, jumping and hopping increase bone density. Jumping up and down stairs can be incorporated into everyday life.

Balance training

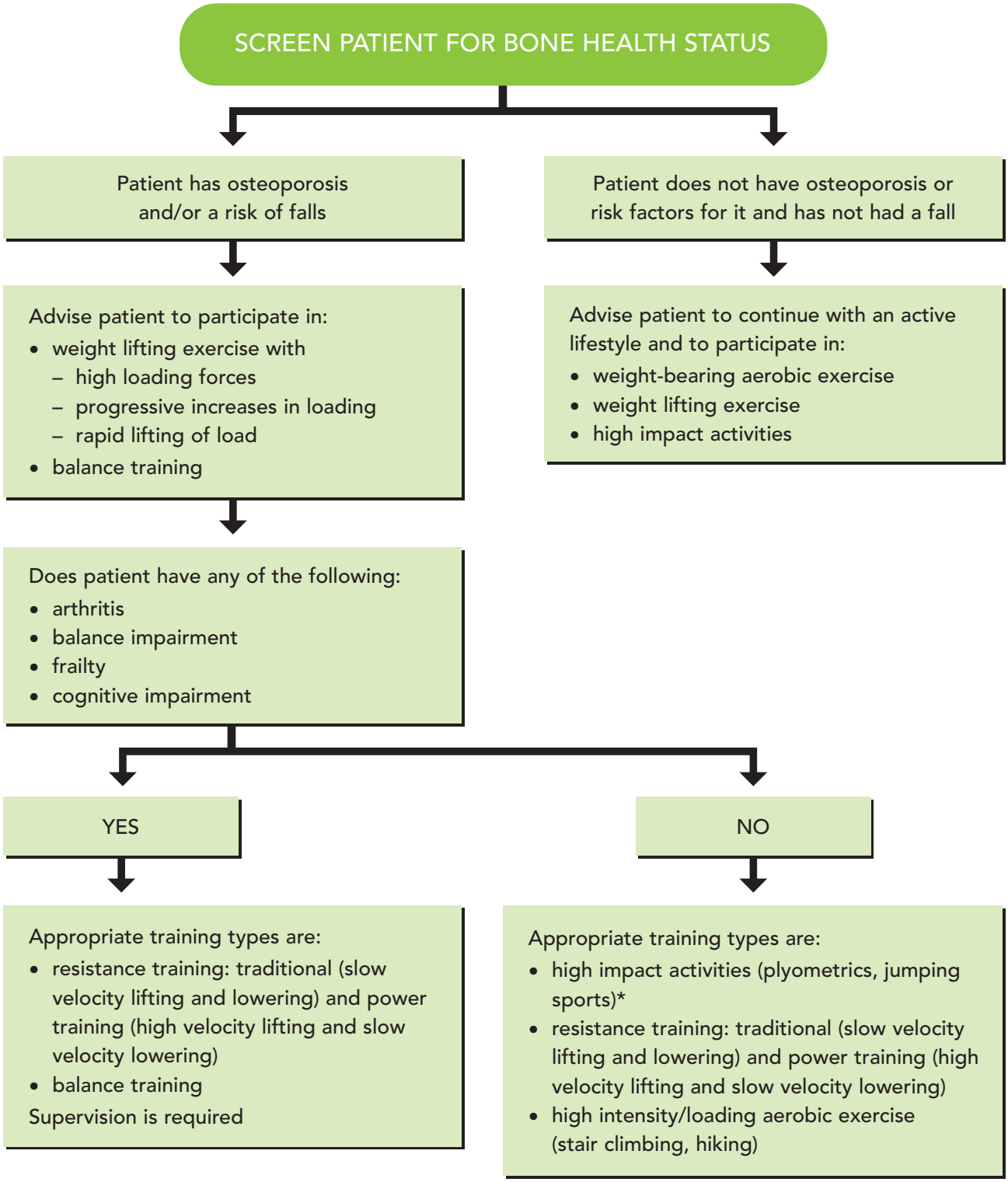
Balance training will not have any impact on muscle strength, sarcopenia or osteopenia, but will improve balance, mobility and fear of falling, and is thus an additional modality of exercise important for prevention of osteoporotic fractures.

There are many ways to improve balance, from yoga and tai chi postures and exercise ball and rocker board exercises, to navigating obstacle courses and integrating one-legged standing postures into daily activities *(Figure 4)*.

It is possible to do some weight lifting exercises in the standing position on one leg with reduced hand support, thus completing both resistance training and balance training at the same time.

Figure 4. Balance enhancing exercises such as tandem or heel-to-toe walking improve balance, mobility and fear of falling.

FLOWCHART 1 AN APPROACH TO EXERCISE PRESCRIPTION FOR MIDDLE-AGED AND OLDER INDIVIDUALS



** Plyometrics = any exercise where the muscle is stretched (i.e. loaded) before it is contracted, e.g. jumping up a step or off a box.*

Aerobic exercise

Aerobic exercise has many health benefits for older patients, but it should be remembered that nonweight-bearing aerobic exercise (cycling, swimming, seated rowing or stepping machines) has little effect on bone health, balance or muscle strength, and should, therefore, not be the primary prescription for these health-related outcomes. Even though walking is a weight-bearing aerobic exercise, it does not increase muscle mass and strength nor improve balance, and it only augments bone density when moderate to high intensities, such as brisk walking, hiking, stairclimbing and jogging, are used.

Aerobic exercise is, therefore, much less potent and comprehensive in its effects on the multiple risk factors for osteoporotic fracture. The type of weight-bearing aerobic exercise used will vary with the health status of the patient.

For example, obesity and osteoarthritis often contraindicate jogging and stairclimbing as appropriate or feasible exercise.

DOSE

Intensity

The physiological responses in bone and muscle are proportional to the magnitude and rate of strain imposed, and successful exercise programs generally use intensities at the higher ranges. Therefore, moderate to high intensity progressive resistance training and/or high impact exercise is recommended as the primary intensity of planned exercise. High intensity progressive resistance training means that the weight feels hard to lift, or is rated about 15 to 18 on the Borg Scale for ratings of perceived exertion when first picked up or pushed at each training session *(see Figure 5)*. As soon as the weight used no longer feels hard, the next higher weight increment (machine setting or free weight) should be used. Such continuous progression keeps the intensity at the intended level over time. If progression stops, so does adaptation in the bone and muscle. This is the most critical element of the exercise prescription for bone health.

Jumping programs incorporating 10 to 50 jumps of approximately 8 cm height each day have successfully increased trochanteric BMD by 3 to 4% in women This kind of jump is high impact (producing ground-reaction forces that are three to four times bodyweight) but feasible for nonathletic women and infrequently associated with injuries.

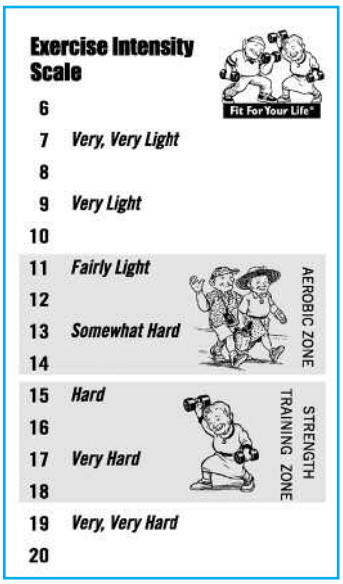


Figure 5. Modified Borg Scale of Perceived Exertion for use with weight lifting and aerobic exercise.

Also, programs incorporating these jumps take only about two minutes per day to perform. Such prescriptions may need to be modified in the presence of osteoarthritis of the knee, hip and ankles or balance impairments *(see Table 2 on pages 16 & 17)*.

However, it is possible to jump while holding on to a railing or another person, enabling safe prescribing of this training modality without sacrificing the intensity of the impact on bone and muscle.

Volume and frequency

The optimal volume of exercise (i.e. the product of the number of sets completed of each exercise, the number of repetitions completed in each set and the number of exercises, or the total minutes of aerobic exercise) for reduced fracture risk has not yet been determined.

However, programs involving resistance training, weight-bearing aerobic exercise and/or high impact exercise on about three days each week have been shown to augment BMD significantly compared with sedentary controls if continued for at least one to two years.

In the case of resistance training, this amount of training is also sufficient for the other body composition changes (increased muscle mass, decreased fat mass) and improvements in muscle strength, power and balance as well as depression. Animal studies do not show benefits of very high numbers of repetitions compared with low numbers for aerobic, weight lifting or jumping exercises.

Each of the following recommendations for exercise volume and frequency is supported by clinical trials evidence as being effective for increasing BMD:

- about 50 jumps three to six days per week
- two or three sets of eight to 10 repetitions of each of six to eight weight lifting exercises three days per week
- 45 to 60 minutes of weight-bearing aerobic exercise three days per week.

Animal models strongly suggest that, for bone strength adaptation, optimal recovery periods are 10 to 14 seconds between loading cycles (repetitions) and at least eight hours between bouts of loading (training sessions). These rest intervals between repetitions are longer than currently prescribed by most practitioners, who wait only one to two seconds.

However, long intervals are not detrimental to muscle function outcomes, and are likely to enhance adherence to technique and therefore minimise injury. It has also been shown in animal models that doses of exercise may be broken down into three or more mini sessions, which can be easier to incorporate into a busy day.

Therefore, recommending exercise no more frequently than every other day (about three days per week) satisfies both muscle and bone health requirements, and is not overly burdensome to most individuals.

TABLE 2 PRESCRIBING EXERCISES FOR BONE HEALTH & MODIFICATIONS REQUIRED

EXERCISE MODALITY	STANDARD OR OPTIMAL MODE	MODIFICATIONS FOR PATIENTS WITH ARTHRITIS
Progressive resistance training	• Prescribe 6 to 10 exercises for major muscle groups, including muscles attaching to greater trochanter and vertebral bodies, as well as those involved in gait and balance. The most important exercises are the machine-based leg press or hip extension, squats, knee extension, knee flexion, hip abduction, hip flexion, dorsiflexion, lat* pull down, back extension, upright seated rowing, abdominal crunch, the free weight versions of these exercises, and standing calf raises • Include novel planes of movement, free weights and standing postures if possible • High intensity (about 80% of peak capacity, progressed continuously) • Use high velocity for concentric (lifting) portion of movement for optimal power development, and slow velocity for lowering weight (i.e. lift rapidly and lower slowly)	• Ensure technique is good to prevent injuries • May need to limit range to pain-free motion, provide good back support, adjust machines or free weights to accommodate joint deformities or restrictions • Intensity may need to be individualised for some exercises • May need to medicate for pain prior to exercise
Aerobic training	• Moderate to high intensity stair climbing, hiking, brisk walking, walking up hills • Weight-bearing • High ground-reaction forces (jogging, running, step aerobics)	• May need to reduce or eliminate weight-bearing or high impact component: substitute brisk walking or walking up hills for stair climbing, step aerobics, jogging, running
High impact exercise	• Jumping, hopping, rope skipping (jump rope) • Progressively increase height of jumps or step boxes, hop on one leg, jump or hop up and down stairs	• May need to reduce or eliminate high ground reaction forces (heel drops instead of jumps) • Substitute power training (rapid concentric muscle contraction against moderate to high load on weight lifting machine) to produce rapid onset of high muscle contraction forces as in take off of jump, but with no impact
Balance training	• Combine progressively more difficult static and dynamic postures (e.g. one-legged standing, tandem walking,† crossover walking,‡ turning, stepping over objects, leaning to limits of sway) • Improve lateral stability (side stepping over objects & leaning) • Reduce base of support (e.g. tandem or one leg standing)† • Perturb centre of mass (lean to limits of sway in all directions, or balance while seated on exercise ball or standing on rocker board) • Withdraw vision (close eyes during exercises) • Decrease proprioception by increasing compliance of standing surface (stand on pads, mattress or pillows) • Add cognitive distractor (e.g. animal naming, mental calculations out loud) to increase difficulty • Incorporate postures from yoga and tai chi or other exercise forms that emphasise the above principles	• May not be able to place full body weight on osteoarthritic joints: use less painful leg to perform one-legged postures, assist weight bearing with use of walking stick • Keep sessions short to avoid pain from prolonged weight bearing • Reduce angle of flexion at knee during tai chi movements

** lat = latissimus dorsi muscles.* *† Tandem walking and standing = walking and standing with one foot placed directly in front of the other; also*

FOR SPECIFIC PATIENT GROUPS

MODIFICATIONS FOR PATIENTS WITH FRAILTY AND/OR NEUROMUSCULAR IMPAIRMENT	MODIFICATIONS FOR PATIENTS WITH CARDIOVASCULAR AND/OR PULMONARY DISEASE
• Usually little modification needed • May need to alter certain exercises for neurological impairment • May need to perform exercises in seated rather than standing positions due to fatigue or poor balance • Supervision usually needs to be more intensive for safety and when progressing the amount of weight lifted	• Usually no modification needed • If angina or ischaemia is provoked by exercise, keep intensity below the level at which this occurs • Avoid breath holding, Valsalva manoeuvre, sustained isometric contractions or tight handgrip during weight lifting
• May need to substitute seated exercises if weakness or poor balance prevents standing postures; however, this limits bony adaptation • May need to begin with low to moderate intensity level and short sessions until improved	• Keep training intensity below the level that causes ischaemia or severe dyspnoea • Walk or exercise beyond the onset of claudication if possible (1 to 2 minutes), then rest and repeat • Avoid breath holding, Valsalva manoeuvre, sustained isometric contractions or tight handgrip during activity
• Start with heel drops instead of jumps • Perform exercises under supervision and while holding on to a support rail initially • Gradually reduce hand support as tolerated	• Keep training intensity below the level that causes ischaemia or severe dyspnoea
• Perform exercises under supervision and while holding on to a support rail initially • Gradually reduce hand support as tolerated	• Usually none

called heel-to-toe walking and standing

[‡] Crossover walking = walking with one foot placed to the other side of the other foot.

EXERCISE PRESCRIPTIONS FOR SPECIFIC PATIENT GROUPS

Certain patient groups require specific exercise prescriptions. For example, high impact activities are not suitable, and probably not feasible, for very frail older adults with osteoarthritis of the hips and knees as well as risk of osteoporotic fracture and falling because of the likelihood of exacerbation of arthritis as well as fall-related injuries. In such cases, therefore, a low impact but high loading form of exercise (such as seated and standing weight lifting) would be both effective and tolerable.

A guide to exercises for bone health and the modifications necessary for patients with arthritis, neuromuscular disease/frailty, and cardiopulmonary disease are presented in Table 2 *(see pages 16 and 17)*.

RISKS OF EXERCISE

As already mentioned, people at risk for osteoporotic fracture should avoid physical activities involving forward flexion of the spine, particularly while carrying an object, because of the risk of anterior compression fractures of thoracic vertebrae in the presence of osteopenia. Such activities include sit-ups with straight legs, lawn bowls and bending over to pick up something from the floor.

Unsupervised exercise in individuals with poor balance or a history of osteoporotic fracture is also best avoided, as is participation in activities that are at high risk of falls themselves or involve hazardous environments that may lead to falls.

The potential risks of exercise in patients with osteoporosis and suggested means to avoid such complications are summarised in Table 3 opposite.

SAFETY OF EXERCISE PROGRAMS

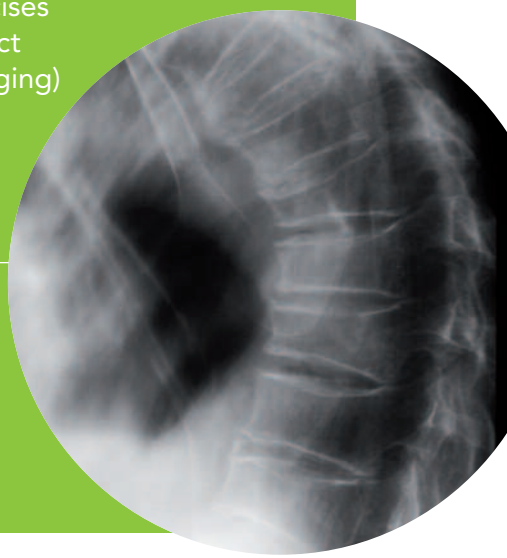
There are many studies suggesting that weight lifting exercise is safe when prescribed as described above in middle-aged and older adults.

Although very little information on high impact exercise is available, studies to date in postmenopausal women exercising unsupervised in their own homes have not reported injuries.

Screening for potential contraindications (hernias, aneurysms, acute joint injuries, unstable cardiovascular disease) and supervision in the initial stages is critical for the safety and efficacy of the exercise prescription.

TABLE 3 RISKS OF EXERCISE IN PATIENTS AT RISK FOR OSTEOPOROTIC FRACTURES

POTENTIAL RISK	PREVENTIVE STRATEGY
Injurious fall	Prescribe balance training prior to aerobic training if gait and balance are impaired Prescribe progressive resistance training for sarcopenia and muscle weakness Optimise lighting, visual aids, safety of exercise environment, climate conditions, footwear Tell patients not to exercise when their judgement is impaired due to use of drugs or alcohol, or when their health status changes Review medications for agents that may increase risk of falls, postural hypotension or altered central nervous system function
Spinal compression fractures	Avoid prescribing exercises involving forward flexion with loading of the spine Avoid prescribing exercises involving twisting movements of the spine Emphasise good sitting and standing postures Tell patients to avoid activities involving spinal flexion (e.g. bowling, cycling, golf, gardening, vacuuming) or provide modifications to these activities Tell patients to bend their knees rather than their back when picking up or reaching low objects
Dislocation of total hip prothesis	Avoid prescribing exercises involving internal rotation and flexion of the hip
Pain from osteoarthritis	Prescribe low impact, high intensity exercises (e.g. weight lifting) rather than high impact exercises (such as jumping, stepping, jogging) Emphasise brief, novel loading of bones with adequate rest periods rather than prolonged, repetitive loading bouts
Pain from hip fracture, spinal osteoporosis or old compression fractures	Rule out new fractures or dislocation of surgical prostheses Brace or support spine during exercise if needed Use analgesia or local pain relieving techniques (e.g. heating, massage)



ENHANCING COMPLIANCE

It is common for novice exercisers to lose motivation within the first six months of developing this new behaviour. Ways to enhance long term adherence to this or any health promoting behaviour include the following:

- provide the patient with simple educational materials
- provide a place to carry out the program under supervision
- ask the patient about the behaviour at each health encounter
- encourage the patient to keep a log of his or her physical activity and regularly review and provide feedback on this
- periodically measure outcomes likely to show change in response to the behaviour (walking speed, balance, muscle strength, depressive symptoms)
- anticipate and provide strategies to overcome common barriers and risks for relapse (such as illness in patient or partner, travel, family commitments, inclement weather, transportation difficulties)
- consider setting up a corner in the waiting room with a demonstration video of bone health-enhancing exercise, brochures to take home and sample exercise equipment or routines that patients can try out in the safety of the office.

Evidence available indicates that although the volume of exercise required for bony adaptation is small (only 12 minutes per week of jumping in one study), the critical factor is the need for progressive high impact or high intensity loading, which is difficult to achieve without good supervision and feedback.

There is a great need to reinforce behavioural strategies that will assist with compliance with any exercise program.

Given the very short time (several minutes per day) that is needed for high impact or balance training exercises, finding ways to incorporate such episodes into daily activities may be more successful than planning structured exercise classes away from home. For example, inserting a few jumps during television commercials, jumping or hopping rather than walking up a flight of stairs, or standing on one leg while washing the dishes, may provide an effective stimulus if such habits can be effectively behaviourally reinforced.

Aerobic exercise can be incorporated into lifestyle by always using stairs instead of elevators/escalators, or walking briskly for 10 minutes or more several times a day.

THE ROLE OF THE GP & HP – SUMMARY

The role of the GP/HP in fracture prevention using exercise is to fully integrate an exercise prescription into the rest of the health care of patients at risk. Patients who sense that exercise is considered just as essential to their health care as the rest of the prescriptions offered to them will be far more likely to adopt and adhere to recommendations for exercise.

To enhance compliance the GP/HP should always:

- assess the risk factors
- compare current physical activity with optimal recommendations
- identify contraindications to exercise participation or exercise modifications needed
- prescribe exercise
- establish an accompanying behavioural program.

Rural GPs/HPs, however, are likely to need to develop home exercise programs because of the lack of suitable training facilities and specialised equipment.

Suggestions for incorporating balance training, high impact and strengthening activities into patients' daily routines rather than using exercise equipment are given in the box below.

INCORPORATING FRACTURE PREVENTION EXERCISES INTO DAILY ROUTINES

Exercise prescriptions can be developed for patients who do not have access to weight lifting and other equipment. The following exercises can be carried out without any specialised equipment:

- Stand on one leg whenever standing at a sink or counter or in a queue (where feasible).
- Walk heel-to-toe between rooms (heel of one foot directly in front of the toes of the other foot, so that they touch or almost touch).
- Stand up and sit down slowly without using arms.
- Squat to pick up items or reach into low shelf or drawer, rather than bending over.
- Jump up and down steps using both feet to land, advance to one leg. Arthritis or balance impairment may preclude this exercise in some patients. Patients may start by holding on to a railing and advance to no hand support.
- Lift items with one hand instead of both.

Avoid having poor posture, particularly forward flexion of the spine (use a Swiss ball or a backless chair when sitting).

EXERCISE AND OTHER TREATMENTS

Exercise does not take the place of nutritional and pharmacological management of osteoporosis, and these treatments should, therefore, be continued when exercise is initiated.

In most trials studying the benefits of exercise, women have received calcium, and in some cases vitamin D, supplementation, and there is evidence that nutritional adequacy in terms of energy, protein, calcium, vitamin D and other micronutrients is necessary for optimal skeletal adaptations. In addition, oestrogen has been shown to be additive to the benefits of exercise on bone in some studies.

More information is needed on the potentially additive effects of exercise and bisphosphonates on bone density and fracture risk. In the meantime, as the effects of bisphosphonates on bone are greater than other currently available treatments, the most rational approach would seem to be to continue these agents and add exercise. Exercise has the added benefits of improving fitness, mental health, neuromuscular function, muscle and fat mass, and general health status in ways that osteoporotic pharmacotherapy alone cannot.

CONCLUSIONS AND SUMMARY

Many epidemiological studies suggest that physical activity substantially lowers the risk of osteoporotic fracture in older men and women. In addition, there is a wealth of experimental evidence that exercise can improve the major risk factors for osteoporotic fracture in older adults (that is, bone density, muscle strength, balance and falls). Thus, the incorporation of evidence-based physical activity counselling and implementation strategies into the care of such patients is critical if the personal and societal burden of fragility fractures in Australia are to be reduced.

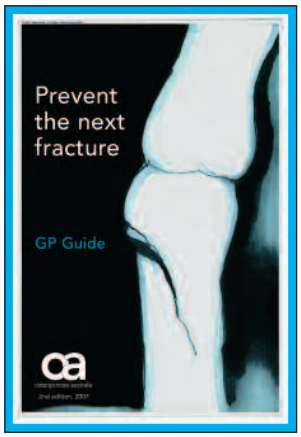
There is evidence that a stabilisation or increase (by 1 to 2% per year) in bone mass is achievable by resistive, weight-bearing aerobic exercise or high impact exercise. Such effects on bone density may be important for both prevention and treatment of osteoporosis and related fractures and disability. Even if exercise alone is an insufficient stimulus to maintain bone density at youthful levels, the effects of exercise on bone strength, muscle mass, muscle strength, balance, mobility, disability and mental health should, in combination, lower the risk of injurious falls substantially in physically active individuals.

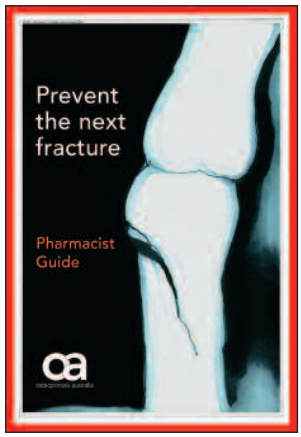
However, large, long term, randomised controlled trials of any exercise modality with osteoporotic fracture as a primary outcome have yet to be conducted, and are a priority for advances in this field.

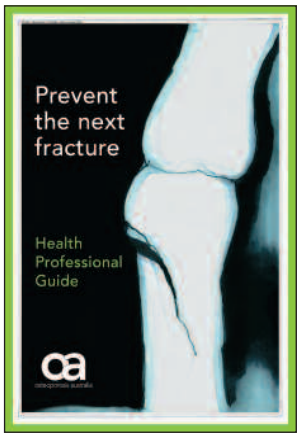
Further information on exercise and osteoporotic fracture prevention is available from Osteoporosis Australia (www.osteoporosis.org.au) and the Fit For Your Life Foundation (www.fitforyourlife.org).

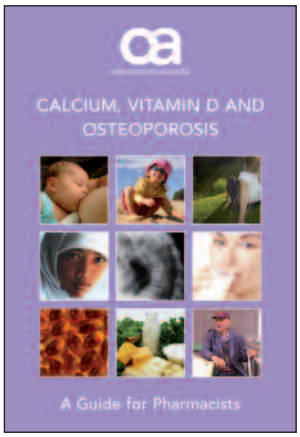
EXERCISE & OSTEOPOROTIC FRACTURE PREVENTION

HEALTH PROFESSIONAL GUIDES

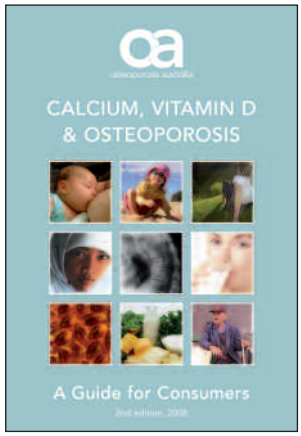


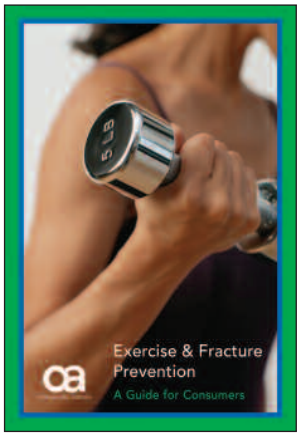




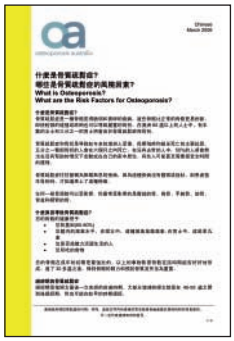


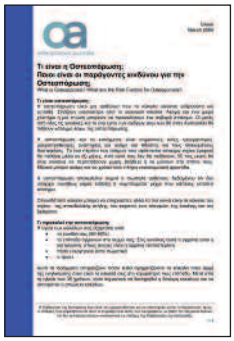
CONSUMER GUIDES





5 FACT SHEETS IN 5 LANGUAGES (PLUS ENGLISH): CHINESE, VIETNAMESE, ARABIC, GREEK AND ITALIAN





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