**Can exercise prevent postmenopausal osteoporosis?**

E. Ernst  
Postgraduate Medical School, University of Exeter, Exeter, UK

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There has recently been increased interest in the prevention, treatment and rehabilitation of osteoporosis. Being predominantly a problem of the elderly, it is likely to grow out of proportion in the near future – in 1950 our planet housed 200 000 000 individuals aged over 65 years; in the year 2025 it will be inhabited by 1 100 000 000 people of that age range. The goal must therefore be effective prevention of osteoporosis; exercise is a possible option with certain clear advantages, such as low cost and freedom from negative side effects, but it is an option that is sometimes neglected.

**Inactivity, peak bone mass**

Physical inactivity is one of the recognized risk factors for osteoporosis; the doubling of rates of hip fracture in the past 30 years is thought to be partly caused by the drastic decrease of habitual activity. Experimental findings support the hypothesis. Disuse, immobilization, denervation paralysis or prolonged space flight are all associated with marked bone loss. Most notably, bed rest leads to a rapid and severe demineralization with a reduction in bone mass of about 1% per week. Much evidence shows that exercise can prevent osteoporosis and hip fractures. Physically active individuals have higher bone densities than do age-matched controls, as shown in cross-sectional studies. Peak bone mass is usually attained around menopause, and is substantially higher in trained compared with untrained individuals. Similarly, prospective trials demonstrate that pre-menopausal women can train to reach a higher peak bone mass. A recent study on a sizeable ($n=352$) population of perimenopausal activity revealed a clear positive correlation between exercise and bone density. Bone mineral content can be significantly increased by regular exercise in middle-aged and elderly women. Among other possible benefits, exercise reverses postmenopausal bone loss and reduces the risk of injury from falling. A meta-analysis of six trials showed that exercise reduces the incidence of hip fracture by about 50%.

**Intensity of exercise**

Prescribing exercise to individuals at risk is, therefore, appropriate and may allow a reduction in medication and thus avoidance of the side effects of drug treatments.

Mild exercise probably gives no protection. Walking 7 miles (11 km) per week, daily extension exercises, or aerobics do not increase bone mineral content in a clinically relevant way. More intense training, however, does seem to work – running or playing ball games twice a week for 1 h results in an increase of 3.5% in bone mineral content after 8 months. Vigorous exercise such as jogging, rowing and stair climbing is followed by a 5.2% increase in lumbar bone mineral content after 9 months. If continued for 4 years, such an intensive programme will totally reverse the involutionary bone loss after menopause.

**Forms of exercise**

Weight-bearing exercises appear to yield the most bone gain. Load-bearing is one primary function of the skeleton, and bone can adapt to changes in functional load by increasing its density and resistance.

Pure (intensive) aerobic training may well have an effect, but poor compliance is a problem of clinical exercise trials and can reduce the benefit. Weight-bearing and aerobic exercises, with emphasis on the playful element, are most likely to encourage compliance and produce a clinically beneficial effect. More studies are required to define the optimal programme more closely.

**Mechanisms**

The mechanisms by which exercise can induce a response are unclear. The response of the bone is clearly to the strain that is applied, and so local mechanisms may be postulated. Mechanical stress might generate an electric signal creating alkaline conditions locally, which in turn favour new bone generation. An involvement of prostaglandins or effects on vitamin D metabolism might also play an important role.

**Therapy**

Preliminary studies suggest that regular exercise could be used as a treatment in patients whose bone mass is already reduced. One study showed that intense loading exercises for 50 min three times a week for 5 months were followed by a 3.8% increase in bone mineral content, which is clinically relevant compared with the 2% loss in control individuals over the same time. Another trial demonstrated...
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that low-impact aerobic exercise did not prevent the age-related bone loss,35 but the compliance in this programme was very poor.

Discussion

Regular exercise has a place in the prevention and, possibly, in the treatment of postmenopausal osteoporosis. Further studies are needed to identify optimal exercise regimens and define more closely the mechanisms by which exercise operates.

There are many other beneficial effects of exercise,47 and we should advise our patients accordingly.

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