

## NUTRITION AND OSTEOPOROSIS



### WHAT IS OSTEOPOROSIS?

Osteoporosis is a disease in which the density and quality of bone are reduced, leading to weakness of the skeleton and increased risk of fracture, particularly of the spine, hip and wrist. Osteoporosis is a global public health problem which currently affects approximately one in three women and one in five men, and is increasing in significance as the population of the world both grows in size and is living longer<sup>(1-3)</sup>. Bone loss doesn't have any symptoms, and often the first sign of having osteoporosis is a fracture. For all these reasons, osteoporosis is often referred to as the "silent epidemic".

Although genetic factors largely determine whether an individual is at heightened risk of osteoporosis, lifestyle factors such as good nutrition and exercise play a key role in building bone during youth, and helping to slow down bone loss in adults and the elderly. The importance of these 'lifestyle' factors is that they are amenable to modification – individuals can take positive steps to strengthen their bones and reduce their risk of osteoporosis.

### NUTRITION AND BONE HEALTH

Like any organ in the body, the skeleton needs a balanced diet containing both macronutrients (energy, protein, fat and carbohydrate) and micronutrients (vitamins and minerals) for its normal development and maintenance. However, in generally well nourished individuals, the two key nutrients to consider for bone health are the mineral calcium, and vitamin D. Calcium is a major structural component of bone tissue, and the skeleton also acts as a reservoir of calcium for maintaining calcium levels in the blood. Recommended daily calcium intakes for populations vary between countries. The FAO/WHO (2002) recommendations, based on data from several countries, are as follows: 500-700 mg/day during childhood, 1300 mg/day from age 10-18 years, 1000 mg/day from age 19-65 years (1300 mg/day in women postmenopause), and 1300 mg/day from age 65 years onwards<sup>(4)</sup>.

Milk and other dairy foods are among the richest and most readily available sources of calcium in the diet. Two or three servings of dairy foods a day (e.g. a serving would be a glass of milk, a slice of cheese, or a pot of yoghurt) would ensure that virtually all children and adults would achieve this level of calcium intake. Dairy foods have the additional advantage of being good sources of protein and other micronutrients (besides calcium) that are important for bone and general health. Other food sources of calcium include certain green vegetables (e.g. broccoli, curly kale, bok choy); whole canned fish with bones such as sardines or pilchards; nuts (almonds and Brazil nuts in particular); and tofu set with calcium. Calcium-fortified foods and drinks, including breads, cereals, orange juice and soy beverages are also available in some countries.

Vitamin D is also essential for the development and maintenance of bone, both for its role in assisting calcium absorption from the gut, and for ensuring the correct renewal and mineralization of bone tissue. Vitamin D is synthesized in the skin when it is exposed to sunlight, and although this is usually sufficient for most individuals, dietary or supplemental vitamin D becomes especially important during the winter months for populations in northern latitudes, and for elderly people who do not go outdoors much and in whom the capacity for skin synthesis of vitamin D is reduced. Vitamin D deficiency in older adults can increase the risk for osteoporosis, falls and fractures. Food sources of vitamin D include oily fish such as salmon, sardines and mackerel, and in some countries fortified foods such as margarine, dairy foods and cereals.

Table: Approximate calcium levels in foods

Food	Serving size	Calcium (mg)
Milk, semi-skimmed	236 ml / 8 fl oz	272
Yoghurt (low-fat fruit)	150 gm / 5 oz	210
Cheese, cheddar- type	28 gm / 1 oz	205
Cheese, cottage	112 gm / 4 oz	142
Cheese, mozzarella	28 gm / 1 oz	101
Ice cream, dairy, vanilla	112 gm / 4 oz	112
Tofu, steamed	100 gm / 3.5 oz	150
Broccoli, cooked	112 gm / 4 oz	45
Curly kale, cooked	112 gm / 4 oz	168
Almonds	26 gm / 12 almonds	62
Sardines, canned in oil, drained, whole	100 gm / 4 sardines	500
Bread, white, sliced	30 gm / 1 medium slice	53

Reference: Food Standards Agency (2002) McCance and Widdowson's  
The Composition of Foods, Sixth summary edition. Cambridge: Royal Society of Chemistry

## RESEARCH STUDIES INVESTIGATING THE EFFECTS OF CALCIUM, VITAMIN D AND DAIRY FOODS ON BONE MASS AND FRACTURE RISK



The importance of nutrition to bone health has been demonstrated in a number of research studies, in human subjects across the age range. Studies carried out over one to three years in children and adolescents have shown that supplementation with either calcium, dairy calcium-enriched foods, liquid milk, or a calcium-enriched milk powder enhances the rate of bone mineral acquisition, compared with un-supplemented (or placebo) control groups<sup>(5-8)</sup>. In general, these intervention trials increased the habitual calcium intake of the supplemented children from about 600-800 mg/day, to around 1000-1300 mg/day. Although these studies were short term, if the higher calcium intakes were maintained into the third decade (the time of achievement of peak bone mass), such an increment could possibly account for as much as a 5-10% difference in peak bone mass. At the population level, it is estimated that a 10% increase in peak bone mass could reduce the risk of osteoporotic fractures during adult life by 50%<sup>(9)</sup>.

In studies among adults, one three-year study in healthy young women aged 30-42 years showed that enriching the diet with dairy foods prevented bone loss in the spine, compared with control subjects who did not increase their dietary calcium intake<sup>(10)</sup>. In postmenopausal women and the elderly, several studies have shown that calcium or milk supplementation slows the rate of bone loss<sup>(11-18)</sup>. In a study carried out in healthy, elderly women living in nursing homes, calcium (1200 mg/day) and vitamin D (800 IU/day) supplementation over 18 months reduced the risk of hip fractures and other non-vertebral fractures<sup>(13)</sup>. A similar intervention over three years (500 mg/day calcium, 700 IU/day vitamin D) was shown to reduce bone loss and the incidence of non-vertebral fractures in elderly men and women living at home<sup>(12)</sup>. In comparative intervention studies, dairy food supplements and calcium supplements were equally effective in preserving hip bone mass in postmenopausal women<sup>(15, 16)</sup>, although these studies were not designed to evaluate reductions in fracture rates.



In summary, adequate calcium intake is an important component of maintaining bone health, and should be encouraged in all age groups. Dairy foods provide the richest dietary sources of calcium, and also improve the nutrient density of the diet in other respects<sup>(19,20)</sup>. However, the typical recommended calcium intake of 1300 mg/day for older adults may be difficult to achieve through the diet, particularly in the frail elderly who may have reduced appetite, or medical conditions. Supplementation might therefore be required where dietary intake is inadequate. In addition, in patients diagnosed with osteoporosis and receiving a drug treatment, calcium and vitamin D supplements are also usually prescribed, to ensure adequate intakes and also maximum effectiveness of the drug therapy.

## SELECTED FACTS ON NUTRITION AND OSTEOPOROSIS FROM THE LITERATURE

- Studies over one to three years in children and adolescents have shown that supplementation with calcium, dairy calcium-enriched foods, milk or a calcium-enriched milk powder, enhances the rate of bone mineral acquisition<sup>(5-8)</sup>.
- Adequate levels of calcium intake can maximize the positive effect of physical activity on bone health during the growth period of children<sup>(21)</sup>.
- Calcium supplementation has been shown to have a positive effect on bone mineral density in postmenopausal women<sup>(11)</sup>.
- Calcium and vitamin D supplementation reduces rates of bone loss and also fracture rates in older male and female adults, and the elderly<sup>(12-14)</sup>. In institutionalized elderly women, this combined supplementation reduced hip fracture rates<sup>(13)</sup>.
- A three-year study in healthy young women aged 30-42 years showed that enriching the diet with dairy foods prevented bone loss in the spine, compared with control subjects who did not increase their dietary calcium intake<sup>(10)</sup>.
- In comparative intervention studies, dairy food supplements and calcium supplements were equally effective in preserving hip bone mass in postmenopausal women<sup>(15,16)</sup>.
- Supplementation with both vitamin D and calcium, compared with calcium alone, reduced body sway in elderly women, suggesting that correction of vitamin D deficiency may improve neuromuscular function and reduce the propensity to fall<sup>(22)</sup>.
- Supplementing the diets of postmenopausal women with milk powder improved the nutrient density of their diets compared with calcium-supplemented women<sup>(19)</sup>, and supplementing the diets of elderly healthy men and women (with habitually low dairy intakes) with liquid milk improved parameters of skeletal metabolism<sup>(23)</sup>.
- In a study in elderly men and women, higher dietary protein intake was associated with a lower rate of age-related bone loss<sup>(24)</sup>.
- Poor nutritional status, especially with respect to protein intake, is an important risk factor for hip fracture, and can also contribute to poor recovery. In the NHANES I Study, hip fracture rates were higher in women with low energy (calorie) intake, low body weight, low serum albumin levels and indices of low muscle strength<sup>(25)</sup>.
- Randomized, clinical trials in patients with hip fracture have demonstrated the beneficial effects of giving protein supplements on the clinical outcome following acute orthopedic management. Protein supplementation resulted in fewer deaths, shorter hospital stays, and a greater likelihood of return to independent living<sup>(26-28)</sup>.
- Dairy foods, calcium-set tofu, some green vegetables, and small canned fish with soft bones (e.g. sardines) provide the most readily-available sources of dietary calcium. Although some plant foods also contain appreciable amounts of calcium, some contain substances that substantially lower the calcium bioavailability, e.g. oxalates in spinach and rhubarb, and phytates in dried beans. Good plant sources of calcium, which are low in such substances, include broccoli, kale and bok choy<sup>(29)</sup>.

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