



International  
Osteoporosis  
Foundation

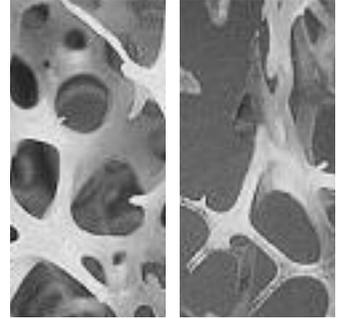
# Good nutrition for healthy bones

Find out how food and nutrition can contribute  
to building and maintaining strong bones



# Osteoporosis – improving the odds with a healthy lifestyle

Osteoporosis is a chronic, debilitating disease whereby the density and quality of bone are reduced. The bones become porous and fragile, the skeleton weakens, and the risk of fractures greatly increases. The loss of bone occurs “silently” and progressively, often without symptoms until the first fracture occurs, most commonly at the wrist, spine and hip. Approximately one out of three women over 50 will have a fracture due to osteoporosis (more than breast cancer) as will one out of five men over 50 (more than prostate cancer).



normal bone

osteoporotic bone

Although genetic factors largely determine the size and density of your bones, lifestyle factors such as good nutrition, regular exercise, and avoiding smoking and excess alcohol also play a key role.

At every stage of life a nutritious, balanced diet promotes strong, healthy bones. A good diet includes sufficient calories and adequate protein, fat and carbohydrates, as well as vitamins and minerals – particularly vitamin D and the mineral calcium. In childhood and adolescence, good nutrition helps to build peak bone mass (maximum bone density, attained in the 20's) thereby reducing vulnerability to osteoporosis later in life. In younger and older adults, a nutritious diet helps preserve bone mass and strength. And in those who have had a fracture, it speeds and aids recovery and reduces the risk of having another fracture.



Varied and enjoyable eating habits, including calcium-rich foods, are a recipe for a lifetime of strong bones and the high quality of life that comes with them.

# Calcium – keeping bones, nerves and muscles in top form

Calcium is a major building-block of our bone tissue, and our skeleton houses 99 per cent of our body's calcium stores. The calcium in our bones also acts as a 'reservoir' for maintaining calcium levels in the blood, which is essential for healthy nerve and muscle functioning.

The amount of calcium we need to consume changes at different stages in our lives. Calcium requirements are high in our teenage years with the rapid growth of the skeleton, and during this time, our body's efficiency in absorbing calcium from food increases. With age, however, this absorption efficiency declines, which is one of the reasons why seniors also need to consume higher amounts of calcium (see table on page 4, for calcium intake recommendations for all age groups).

Milk and other dairy products are the most readily available dietary sources of calcium. 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 good food sources of calcium include some green vegetables, like broccoli, curly kale, and bok choy;

canned fish with soft, edible bones (the calcium's in the bones!) such as sardines, pilchards and salmon; nuts – especially Brazil nuts and almonds; some fruits such as oranges, apricots and dried figs; and calcium-set tofu.

Some calcium-fortified breads, cereals, fruit juices, soy beverages and several brands of commercial mineral water also contain significant amounts of calcium. These foods provide a suitable alternative for people who are lactose-intolerant and for vegan vegetarians.



Some leafy produce, like spinach and rhubarb, contain 'oxalates', which prevent the calcium present in these vegetables from being absorbed. However, they do not interfere with calcium absorption from other calcium-containing foods eaten at the same time. The same is true of 'phytates' in dried beans, cereal husks and seeds.

Caffeine and salt can increase calcium loss from the body and should not be taken in excessive amounts. Alcohol should also be taken in moderation as it detracts from bone health and is associated with falls and fractures. And while no conclusive evidence shows that fizzy soft drinks (e.g. cola drinks) weaken bones, here too, it's best not to overdo it – especially as such drinks tend to 'displace' milk in the diets of children and teenagers.

## Recommended calcium allowances

	Calcium (mg/day)
<b>Infants and children:</b>	
0-6 months	300-400
7-12 months	400
1-3 years	500
4-6 years	600
7-9 years	700
<b>Adolescents:</b>	
10 to 18 years	1300*
<b>Women:</b>	
19 years to menopause	1000
Postmenopause	1300
During pregnancy (last trimester)	1200
Lactation	1000
<b>Men:</b>	
19-65 years	1000
65+ years	1300

The 'recommended allowance' refers to the amount of calcium that each age group is advised to consume (with daily intake corresponding to an average intake over a period of time), to ensure that calcium consumed compensates for calcium excreted from the body each day. The calcium allowance figures for children and adolescents also take account of skeletal growth (net calcium gain), and those for postmenopausal women and the elderly also take account of a lower intestinal calcium absorption efficiency.

\*Particularly during the growth spurt.

Figures based on Western European, American and Canadian data. Source: FAO/WHO: Human Vitamin and Mineral Requirements, 2002.



Varied and enjoyable eating habits, including calcium-rich foods, are a recipe for a lifetime of strong bones and the high quality of life that comes with them.

## Approximate calcium levels in foods

Food	Serving size	Calcium (mg)
Milk, whole	236 ml / 8 fl oz	278
Milk, semi-skimmed	236 ml / 8 fl oz	283
Milk, skimmed	236 ml / 8 fl oz	288
Goats milk, pasteurized	236 ml / 8 fl oz	236
Yoghurt, low fat, plain	150 g / 5 oz	243
Yoghurt, low fat, fruit	150 g / 5 oz	210
Yoghurt, Greek style, plain	150 g / 5 oz	189
Fromage frais, fruit	100 g / 3.5 oz	86
Cream, single	15 g / 1 tablespoon	13
Cheese, cheddar type	40 g / medium chunk	296
Cheese, cottage	112 g / 4 oz	142
Cheese, mozzarella	28 g / 1 oz	101
Cheese, Camembert	40 g / average portion	94
Ice cream, dairy, vanilla	75 g / average serving	75
Tofu, soya bean, steamed	100 g / 3.5 oz	510
Soya drink	236 ml / 8 fl oz	31
Soya drink, calcium-enriched	236 ml / 8 fl oz	210
Broccoli, cooked	112 g / 4 oz	45
Curley kale, cooked	112 g / 4 oz	168
Apricots, raw, stone removed	160 g / 4 fruit	117
Orange, peeled	160 g / 1 fruit	75
Figs, ready to eat	220 g / 4 fruit	506
Almonds	26 g / 12 whole	62
Brazil nuts	20 g / 6 whole	34
Sardines, canned in oil	100 g / 4 sardines	500
Pilchards, canned in tomato sauce	110 g / 2 pilchards	275
Whitebait, fried	80g / average portion	688
Bread, white, sliced	30 g / 1 medium slice	53
Bread, wholemeal, sliced	30 g / 1 medium slice	32
Pasta, plain, cooked	230 g / medium portion	85
Rice, white, basmati, boiled	180 g / medium portion	32

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

# Vitamin D – made by the sun to keep bones strong

Vitamin D plays a key role in assisting calcium absorption from food, ensuring the correct renewal and mineralization of bone tissue, and promoting a healthy immune system and muscles.

In children, severe vitamin D deficiency results in delayed growth and bone deformities known as rickets, and in adults, a similar condition called osteomalacia (a ‘softening’ of the bones, due to the poor mineralization). Milder degrees of vitamin D inadequacy can lead to a higher risk of osteoporosis, and an increased likelihood of falling in older adults whose muscles are weakened by a lack of the vitamin.

Vitamin D is made in our skin during the summer months from exposure to the sun’s ultraviolet B rays. In children and adults, casual exposure of the face, hands and arms for as little as 10-to-15 minutes a day outside peak sunlight hours (before 10am and after 2pm) is usually sufficient for most individuals.

Vitamin D can also be obtained from food, and dietary supplements, and these sources increase in importance during the winter months for populations in northern latitudes (when no skin synthesis of vitamin D takes place), and for the elderly.

The elderly are particularly vulnerable to vitamin D deficiency as they are often housebound or living in nursing homes with little exposure to the sun, and because from the 60’s onwards, the skin’s capacity to synthesize vitamin D decreases. Other factors such as the use of sunscreens, a greater degree of skin pigmentation, and an increase in indoor occupations and pastimes also reduce the opportunity for skin synthesis of vitamin D. Recommendations for vitamin D intake by age group are shown in a table on page 7.

Food sources of vitamin D are rather limited, and include oily (or fatty) fish such as salmon, tuna, sardines and mackerel, egg yolk and liver. In some countries, fortified foods specifically labeled as such, including milk and other dairy foods, margarine, and breakfast cereals, are viable options.



## Recommended vitamin D intake

by age group, both as international units (IU) and micrograms (µg) per day

Age group	RNI* (IU/d)	RNI (µg/d)
0-9 years	200	5
10-18 years	200	5
19-50 years	200	5
51-65 years	400	10
65+ years	600	15
Pregnancy	200	5
Lactation	200	5

Figures based on Western European, American and Canadian data. Source: FAO/WHO: Human Vitamin and Mineral Requirements, 2002.

## Approximate vitamin D levels in foods

Food	µg per serving	IU per serving	% RNI* (for ages 51-65 years)
Cod liver oil**, 1 tbsp	23.1	924	231
Salmon, grilled, 100g	7.1	284	71
Mackerel, grilled, 100g	8.8	352	88
Tuna, canned in brine, 100g	3.6	144	36
Sardines, canned in brine, 100g	4.6	184	46
Margarine, fortified, 20g	1.6	62	16
Bran Flakes***, average serving, 30g	1.3	52	13
Egg, hen, average size, 50g	0.9	36	9
Liver, lamb, fried, 100g	0.9	36	9

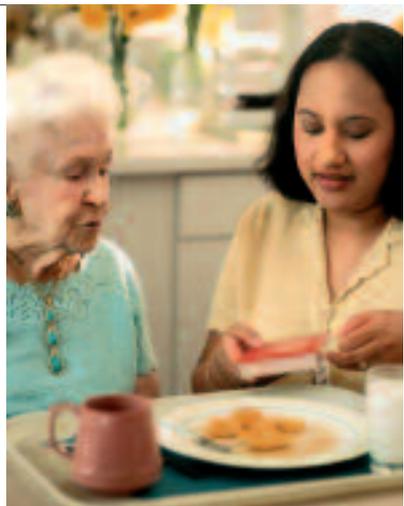
\* The RNI (recommended nutrient intake) is defined by the FAO/WHO as “the daily intake which meets the nutrient requirements of almost all (97.5%) apparently healthy individuals in an age- and sex-specific population group”. Daily intake corresponds to the average over a period of time.

\*\* Fish liver oils, such as cod liver oil and halibut liver oil, also contain appreciable amounts of vitamin A, which can be toxic if consumed in excess.

\*\*\*Bran Flakes are given as an example of a vitamin D-fortified breakfast cereal. Food Standards Agency (2002) McCance and Widdowson's The Composition of Foods, Sixth summary edition. Cambridge: Royal Society of Chemistry.

## Calcium and vitamin D supplements

With age, our ability to absorb calcium from food diminishes. For older adults, particularly the frail elderly with reduced appetite, low activity levels or medical conditions, supplements may be required upon a doctor's recommendation. Persons at risk of vitamin D deficiency should consult their physicians about taking supplements. People at risk may include pregnant and breastfeeding mothers, the elderly as discussed previously, and also people with certain medical conditions, for example liver or kidney problems that affect vitamin D metabolism. In patients diagnosed with osteoporosis and receiving a drug treatment, calcium and vitamin D supplements are also usually prescribed, to ensure maximum effectiveness of the drug therapy. The types of supplements available vary by country, so consult with your physician for the one best suited to your individual needs.



# Other foods and nutrients important for bone health

There are other foods, and nutrients besides calcium and vitamin D, that contribute to bone health, including protein, fruits and vegetables, and other vitamins and minerals.

## Protein

Adequate dietary protein is essential for optimal bone mass gain during childhood and adolescence, and preserving bone mass with ageing. Insufficient protein intake is common in the elderly and is more severe in hip fracture patients than in the general ageing population. Protein under-nutrition also robs the muscles of mass and strength, heightening the risk of falls and fractures, and it contributes to poor recovery in patients who have had a fracture.

Lean red meat, poultry and fish, as well as eggs and dairy foods are excellent sources of animal protein. Dairy foods offer the extra bonus of being a rich source of calcium, and oily fish, of vitamin D.



Good vegetable sources of protein include legumes (e.g. lentils, kidney beans), soya products (e.g. tofu), grains, nuts and seeds.

## Fruits and vegetables

Fruits and vegetables contain a whole array of vitamins, minerals, antioxidants, and alkaline salts, some or all of which can have a beneficial effect on bone. Studies have shown that higher fruit and vegetable consumption is associated with beneficial effects on bone density in elderly men and women, although the exact components which may give this benefit are still to be clarified.

## Other vitamins and minerals

**Vitamin K:** Vitamin K is required for the correct mineralization of bone. Some evidence suggests low vitamin K levels lead to low bone density and increased risk of fracture in the elderly, but more studies are needed to prove if increasing vitamin K intake would help to prevent or treat osteoporosis. Vitamin K sources include leafy green vegetables such as lettuce, spinach and cabbage, liver and some fermented cheeses and soyabean products.

**Magnesium:** Magnesium plays an important role in forming bone mineral. Magnesium deficiency is rare in generally

well-nourished populations. The elderly could potentially be at risk of mild magnesium deficiency, as magnesium absorption decreases and renal excretion increases with age, and also because certain medications promote magnesium loss in the urine. Particularly good sources of magnesium include green vegetables, legumes, nuts, seeds, unrefined grains, and fish.



**Zinc:** This mineral is required for bone tissue renewal and mineralization. Severe deficiency is usually associated with calorie and protein malnutrition, and contributes to impaired bone growth in children. Milder degrees of zinc deficiency have been reported in the elderly and could potentially contribute to poor bone status. Lean red meat and meat products, poultry, whole grain cereals, pulses and legumes abundantly provide zinc.

**B vitamins and homocysteine:** Some studies suggest that high blood levels of the amino acid homocysteine may be linked to lower bone density and higher risk of hip fracture in older persons. Vitamins B<sub>6</sub> and B<sub>12</sub>, as well as folic acid, play a role in changing homocysteine into other amino acids for use by the body, so it is possible that they might play a protective role in osteoporosis. Further research is needed to test whether supplementation with these B vitamins might reduce fracture risk.

**Vitamin A:** The role of vitamin A in osteoporosis risk is controversial. Vitamin A is present as a compound called retinol in foods of animal origin, such as liver and other offal, fish liver oils, dairy foods and egg yolk. Some plant foods contain a precursor of vitamin A, a group of compounds called carotenoids, for example in green leafy vegetables, and red and yellow colored fruits and vegetables.

Consumption of vitamin A in amounts well above the recommended daily intake levels may have adverse effects on bone, the liver and skin. However, such high levels of vitamin A intake are probably only achieved through over-use of supplements, and intakes from food sources are not likely to pose a problem. Further research is needed into the role of vitamin A in bone health, although many countries at present caution against taking a fish liver oil supplement and a multivitamin supplement concurrently, as this could lead to excessive intake of vitamin A.

# Medical conditions affecting nutrition and bone health

## **Inflammatory bowel disease**

Patients with inflammatory bowel diseases such as Crohn's disease or ulcerative colitis are at increased risk of bone loss due to a variety of factors including poor food intake and nutritional status, poor absorption of nutrients (including calcium, vitamin D and protein), and surgery to remove parts of the intestine. Osteoporosis prevention measures that ensure adequate calcium and vitamin D through food or supplements must be part of the overall care strategy for these patients. Osteoporosis medications may also be advisable, as determined by a doctor.

## **Celiac disease**

Celiac disease is a genetically mediated autoimmune disease characterized by intolerance to gluten found in wheat, rye and barley. People affected suffer damage to the intestinal surface, which results in inadequate nutrient absorption, and symptoms such as diarrhea and weight loss. Poor absorption of nutrients including calcium and vitamin D places sufferers at increased risk of osteoporosis. The disorder must be controlled by strictly following a gluten-free diet, which allows the intestinal surface to heal and for nutrients to be properly absorbed again.

## **Anorexia nervosa**

Anorexia nervosa is a psychophysiological disorder, usually occurring in young women,

that is characterized in part by a persistent unwillingness to eat and severe weight loss. The disorder usually begins during adolescence – the time of life when good nutrition is important in order to gain the highest possible peak bone mass. Besides depriving the body of essential bone-building nutrients, an anorexic patient's extreme thinness also results in estrogen deficiency and amenorrhea (cessation of menstruation). People with anorexia are therefore at high risk of developing osteoporosis, and must be counseled accordingly.

## **Glucocorticoids**

Glucocorticoids are steroid hormone medications including cortisone, prednisone and dexamethasone, and they are used to treat chronic inflammatory diseases such as rheumatoid arthritis, asthma, Crohn's disease, and some skin and liver diseases. They are known to cause substantial bone loss early in the course of treatment and can also interfere with calcium metabolism, and are therefore an important risk factor for osteoporosis. Patients taking glucocorticoids long-term (more than three months) should be assessed for osteoporosis risk and counseled on preventive lifestyle factors including ensuring sufficient calcium and vitamin D intake (probably with supplements) and weight-bearing exercise.

# Key tips for building and maintaining healthy bones

- Ensure an adequate calcium intake which meets the relevant dietary recommendations in the country or region concerned, at all stages of your life.

- Maintain a sufficient supply of vitamin D through adequate, safe exposure to the sun, through diet, or through supplements.



- Enjoy a balanced, nutritious diet including adequate protein, and plenty of fresh fruits and vegetables for both bone and general health benefits.

- Safeguard a healthy body weight, as being underweight is a strong risk factor for osteoporosis (body mass index less than 18.5 kg/m<sup>2</sup>).

- Move it or lose it: Weight bearing exercise (e.g. walking, running, gym, strength training, dancing) helps build bone mass and strength in the young, maintains bone density in adults, and slows down bone loss in the elderly.

- Avoid smoking as it hampers the work of bone-building cells and increases the risk of fracture.

- Avoid excessive alcohol consumption, as high intakes (more than 2 standard units per day) have been linked to increased risk of hip and other osteoporotic fractures.

- Use salt and caffeine in moderation, as these can promote calcium loss from the body, especially if calcium intake is inadequate.

- Assess your risk: If you are concerned you may be at risk of osteoporosis, fill out the "IOF One-Minute Osteoporosis Risk Test" found on the IOF website at [www.osteofound.org](http://www.osteofound.org), and if you answer 'yes' to any of the questions, talk to your doctor about whether you need to undergo further testing.

# Find out more

For further information on osteoporosis in general, and the role of nutrition and other lifestyle factors in bone health, please visit the IOF website.

On the website, you will also discover a variety of publications to download, including "Osteoporosis and you", which discusses the implications of osteoporosis, the importance of early diagnosis, lifestyle aspects and the various treatment options available. A more detailed booklet on nutrition entitled "Bone Appétit" is also available.

Nutrition and bone health is the 2006 theme of World Osteoporosis Day, marked on October 20 each year.



The International Osteoporosis Foundation (IOF) is an independent non-profit, non-governmental organization dedicated to the worldwide fight against osteoporosis.

For further information, and for contact details for national osteoporosis societies worldwide, visit IOF's website at [www.iofbonehealth.org](http://www.iofbonehealth.org)

**IOF**

**9, rue Juste-Olivier**

**CH-1260 Nyon, Switzerland**

**Tel. +41 22 994 0100**

**Fax +41 22 994 0101**

**[info@osteofound.org](mailto:info@osteofound.org)**

Supported by an unrestricted educational grant from four Global Gold World Osteoporosis Day 2006 sponsors:



**International  
Osteoporosis  
Foundation**

[www.iofbonehealth.org](http://www.iofbonehealth.org)