International
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Invest in your bones
Beat the Break
Know and Reduce your Osteoporosis Risk Factors

A thematic report prepared for the IOF World Osteoporosis Outreach Campaign 2007-2008, written on behalf of the IOF Committee of Scientific Advisors by Cyrus Cooper, FMedSci, Professor of Rheumatology and Director, MRC Epidemiology Resource Centre, University of Southampton, Southampton, UK. Professor Cooper is Chairman of the IOF Committee of Scientific Advisors and is Chairman of the Board of Trustees of the National Osteoporosis Society, United Kingdom.

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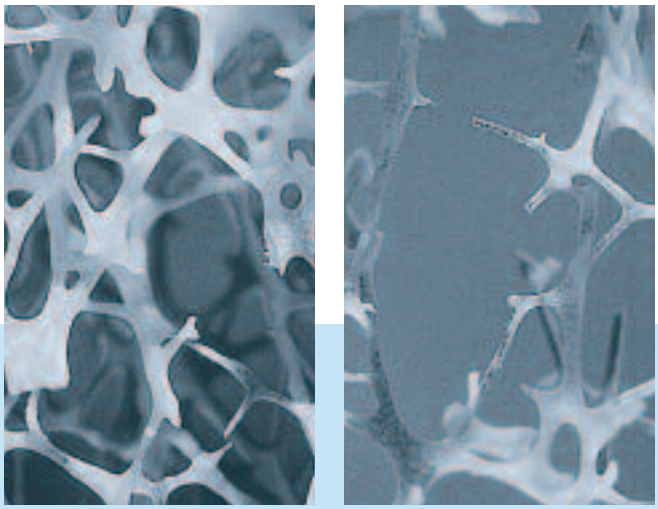


Bone is made of a hard outer shell called cortical bone and a spongy interior matrix called trabecular bone. It is this combination that allows bone to be strong yet relatively light and flexible. In osteoporosis, the normal spongy bone matrix (left) gradually wastes away (right).

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; the disease and its associated fractures are an important cause of morbidity and mortality affecting millions of people worldwide. Osteoporosis not only reduces life expectancy but also negatively affects quality of life. The loss of bone occurs progressively over many years and without apparent symptoms, and often the first sign of osteoporosis is a fracture. For this reason, osteoporosis is often referred to as the "silent epidemic".

- Osteoporosis affects approximately one in three women and one in five men over the age of 50 years, and is increasing in significance as the population of the world grows in size and is living longer.

- The number of hip fractures occurring worldwide each year is expected to rise from the current figure of over 1.5 million to over 6 million by the year 2050, with the steepest increases expected throughout Asia and Latin America (Cooper et al. 1992).

- Having a spine fracture substantially increases the risk for sustaining additional spine fractures within one year (Lindsay et al. 2001).

- Every 30 seconds, someone in the European Union has an osteoporotic fracture (Compston et al. 1999).

- For the elderly who survive a hip fracture, only one in three returns to their previous level of independence.

International Osteoporosis Foundation (IOF)

IOF is an international non-governmental organization which represents a global alliance of patient, medical and research societies, scientists, health care professionals and the health industry. IOF works in partnership with its members and other organizations around the world to increase awareness and improve prevention, early diagnosis and treatment of osteoporosis. Although osteoporosis affects millions of people everywhere, awareness about the disease is still low, doctors often fail to diagnose it, diagnostic equipment is often scarce, or not used to its full potential, and treatment is not always accessible to those who need it to prevent the first fracture. IOF's growing membership has more than doubled since 1999, reflecting the increasing international concern about this serious health problem. There are 176 member societies in more than 87 locations worldwide (June 2007).

For more information about IOF and to contact an IOF member society in your country please visit: www.iofbonehealth.org

IOF
Rue Juste-Olivier 9
CH-1260 Nyon
Switzerland
Tel: +41 22 994 0100
info@iofbonehealth.org
www.iofbonehealth.org

Foreword

The famous Chinese general Sun Tzu claimed that if you "know the enemy and know yourself then you need not fear the result of a hundred battles." That 2,500 year-old adage has since been applied to many walks of life, including sports and business. It equally applies to our health, particularly the health of our bones.

Knowing ourselves – and our risk factors – is the first step in successfully fighting osteoporosis – the gradual wasting away of mineral that weakens bones and makes them susceptible to fracture. Osteoporosis, often called the silent epidemic, is primarily a disease of ageing. It is a major cause of hip and vertebral fractures in the elderly and a harbinger of reduced mobility, lost independence, and deteriorating health. But it does not have to be that way. There are ways of slowing or preventing osteoporosis – if people know that they are at risk.

This year's Thematic Report focuses on risk factors for osteoporosis and fractures. These risk factors come in several shapes and forms. Some, such as lifestyle and dietary habits, can be reduced or eliminated, others we are born with and cannot change. On page 13 of this report we have outlined the new IOF One-Minute Osteoporosis Risk Test, which can help people estimate if they are at risk.

The good news is that measures can be taken to reduce the risk of fractures. Exercise, a diet rich in calcium and vitamin D, healthy lifestyle habits, and regular check ups with one's physician can give people the edge in fighting this debilitating disease. If that is insufficient, modern medicines can help prevent or slow the rate of bone loss. But the first step, as Sun Tzu would agree, is knowing the enemy – osteoporosis risk factors.

Heed the ancient advice. We can encourage everyone to learn their risk factors, and if necessary, take on the battle to protect their bones. Beat the break!

Cyrus Cooper, FMedSci
Professor of Rheumatology and Director, MRC Epidemiology Resource Centre,
University of Southampton, Southampton, UK

Introduction

Hip and vertebral fractures in the elderly were once considered a normal part of ageing. But over the last 50 years or so doctors and scientists have realized that brittle bones in the elderly are far from normal, they are caused by a treatable and often preventable disease, osteoporosis. Osteoporosis occurs when the minerals that give bones their strength leech away to such an extent that the bones become brittle and weak.

Worldwide, the incidence is growing at epidemic proportions as modern medicine and healthier lifestyles reach more people and life expectancy grows as a result. By 2050 it is estimated that incidence of hip fracture, a major consequence of osteoporosis, will increase by 310 and 240 percent in men and women, respectively (Gullberg et al. 1997). Much of this increase will occur in Asia, Latin America and the developing world. Suffering from osteoporosis often implies pain, loss of function and, in the worse cases, death. The impact of the disease on relatives should not be ignored, as they must devote time and energy helping a family member who lacks autonomy.

Osteoporosis is largely a result of the dynamic nature of bone turnover. The matrix and mineral that give bone its strength and resilience is not static. Inside the bone there is a constant cycle involving two different types of cells, one laying down new mineral, and another removing old mineral. This cycle of constant change is, in fact, crucial for bone health. If bones were not able to be "remodeled" in this fashion, they could not repair themselves when accidentally broken.

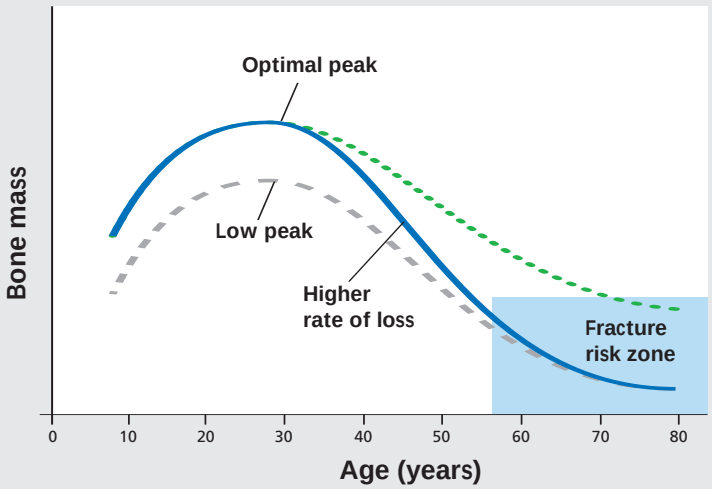
For the first twenty years or so of our lives, the balance is tipped in favor of the bone forming cells, or osteoblasts. New mineral builds as bones lengthen and enlarge during childhood, especially around and just after puberty. But bone mass reaches a peak in early adult life. After that, the balance begins to tip in favor of the bone removing cells, osteoclasts, and there begins a gradual loss of bone mineral that continues for the rest of one's life. How weak one's bones become hinges on two fundamentals – the peak bone mass achieved in early adulthood, and the rate of subsequent bone loss.

There are ways of slowing or preventing osteoporosis – if people know they are at risk.

Because bone remodeling is such a dynamic process, the bone forming/bone removing balance can easily be tilted. In fact, a multitude of factors can accelerate bone loss and lead to osteoporosis. That is the bad news. The good news is that steps can just as easily be taken to redress that balance and slow the loss of bone mineral. But first, people need to know if they are at risk.

Risk factors fall into two main categories, modifiable and fixed. Though there is no way to control the latter, which include age, gender, and family history, there are strategies that can lessen their effect.

Bone mass changes throughout life, showing effect of low peak bone mass, or higher rate of bone loss



This hypothetical graph is a representation of bone mass changes throughout life. The critical years for building bone mass are during childhood and adolescence. 'Peak bone mass' is achieved in the mid-20's, then bone mass remains stable during young adulthood. Bone loss begins after the age of about 40 in both genders.

The graph also shows two hypothetical situations, one in which a low peak bone mass is attained (gray, dashed), and one in which bone loss is faster than it should be (blue, solid). In both situations, this would place a person at risk of fracture at an earlier age in life, i.e. they would enter the shaded 'fracture risk zone' sooner. Healthy lifestyle habits, including good nutrition and exercise, can help to ensure that individuals attain their maximum peak bone mass, and also help to slow bone loss, ensuring they stay on the optimum (green, dotted) line in life.

Risk Factors for Osteoporosis and Fractures

The ability to recognize and control risk factors has become a corner stone of modern medicine. For example, management of high blood pressure and serum cholesterol have helped reverse the growing number of deaths due to cardiovascular disease and stroke in the United States (Centers for Diseases Control, Atlanta, GA) and other parts of the world. This is largely because people adopt exercise, healthier diets, and in some cases, prescription medication to help lower blood cholesterol and blood pressure. Osteoporosis can be fought in a similar manner. Over the last few decades doctors and researchers have compiled vast amounts of information on a variety of osteoporosis risk factors. Like cholesterol, many of these factors can be reduced by individual action, and those that cannot be reduced through lifestyle changes can nevertheless be lessened by taking other measures to increase bone health.

Risk factors fall into two main categories, modifiable and fixed. Though there is no way to control the latter, which include age, gender, and family history, there are strategies that can lessen their effect – once the risk is appreciated. Many people have more than one risk factor, which puts them at even greater risk. Bone mineral density (BMD) should be considered as a conjunction of modifiable and fixed risk factors. Because minerals contribute to bone's inherent strength, low bone mineral density (BMD) is one of the most important indicators that a person is at risk of a bone fracture. In fact, measuring BMD by dual energy X-ray absorptiometry (DXA) is presently the only reliable diagnostic test for osteoporosis. A bone mineral density scan is a simple, painless, non-invasive procedure, and should be considered as useful as blood pressure, blood cholesterol and other routine physical tests that can help prevent disease and mortality. People, especially the elderly, who have many modifiable or fixed risk factors, should consult with their doctor about having a BMD scan. The BMD result is an important basis from which to discuss potential changes to lifestyles and potential treatments.

Modifiable Risk Factors

Modifiable risk factors primarily arise because of unhealthy diet or lifestyle choices. They include poor nutrition, low body mass index, eating disorders, alcohol, smoking, and insufficient exercise. Most of these risk factors directly impact bone biology and result in a decrease in bone mineral density (BMD), but some of them also increase the risk for fracture independently of their effect on bone itself.

Modifiable Risks

- Alcohol
- Smoking
- Low body mass index
- Poor nutrition
- Eating disorders
- Insufficient exercise
- Low dietary calcium intake
- Vitamin D deficiency
- Frequent falls

Alcohol

Studies from Europe, North America and Australia show that more than two units of alcohol per day can increase the risk for osteoporotic and hip fractures in both men and women. (See below) Some of this increased risk is due to decreased bone mineral density, which may be a result of a toxic effect of alcohol on the bone forming cells, or osteoblasts (Laitinen et al. 1991). But some of the risk is also attributable to other poorly understood factors, which may include general deteriorating health and the increased likelihood of falling, especially in the elderly.

Excessive Alcohol Weakens Bones

Excessive alcohol consumption increases the relative risk (RR) of osteoporosis and hip fractures. Over four units of alcohol per day can double the risk for hip fracture in men and women (Kanis et al. 2005).

As a rough guide Units of alcohol per glass*:

Beer or cider (4% alcohol): 250 ml/8.75 oz. = 1 unit	**Wine** (12.5% alcohol): 80 ml/2.80 oz. = 1 unit	**Spirits** (40% alcohol): 25 ml/0.88 oz. = 1 unit (100 ml = 3.5 fluid oz.)

* Standard glasses and alcohol content in beverages vary per country, hence fluid amounts and percentages used rather than standard glasses.

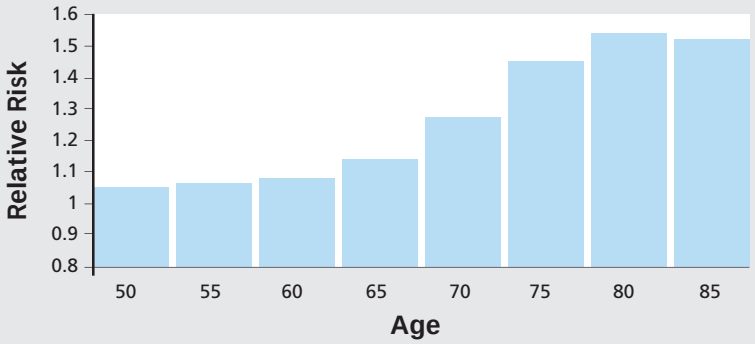
Smoking

Smoking also increases a person's fracture risk. Combined analysis of studies on nearly 60,000 people in Canada, U.S.A., Europe, Australia and Japan shows that smoking increases the risk for hip fracture by up to 1.5 fold (Kanis et al. 2005b). Although the risk from smoking increases with age, the effects of cigarette smoke appear early. Studies carried out in Sweden showed that young male smokers, 18-20 years old, have reduced BMD and a thinning of the hard outer cortical layer of bone (Lorentzon et al. 2007). It is the cortical layer which gives bone much of its strength. This finding is particularly troubling because it suggests that smoking in young people may reduce their peak bone mass – established in the early to mid 20s – and thereby increase the risk of osteoporosis in later life.

As with alcohol, some of the risk associated with smoking is due to decreased BMD. This is particularly true in women after menopause. Studies carried out in the U.K. suggest that post-menopausal women who smoke have a much more rapid decline in BMD than post-menopausal non-smokers (Law et al. 1997). Women who smoke and who are nearing or post-menopause could be particularly at risk. Some of the risk associated with smoking is also due to leanness or low body mass index (BMI), which, like being postmenopausal, is a risk factor for osteoporosis in and of itself.

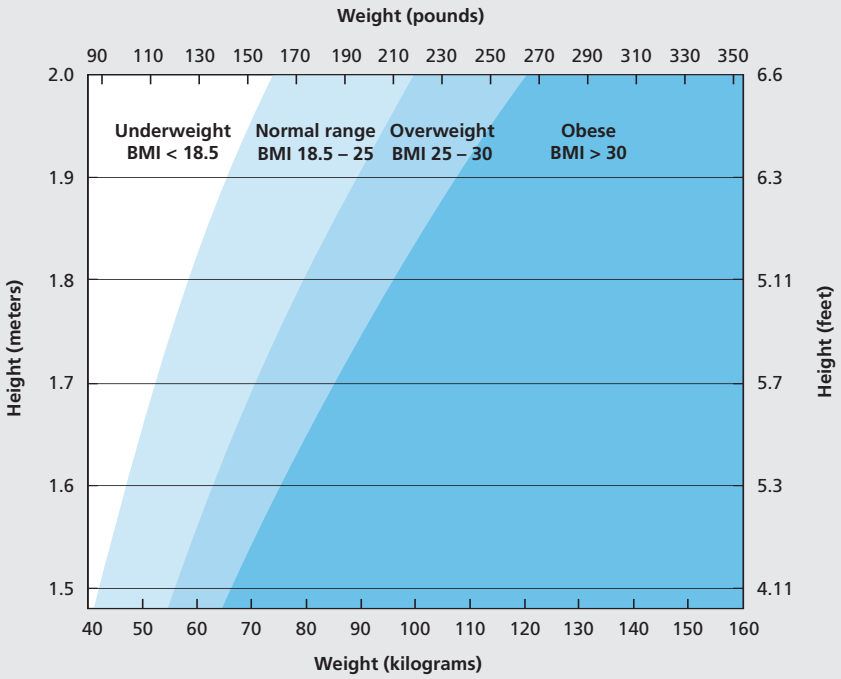
Low BMI

The body mass index, or BMI, is a measure of how lean someone is and can be used as a guide to measure his or her osteoporosis risk. (See below to determine how to measure BMI). Doctors believe that a BMI of 20 to 25 is ideal. Anyone with a BMI of 25 or higher is considered overweight, and anyone with a BMI over 30 is considered obese. BMI below 19 is considered underweight and a



Effect of Smoking on Osteoporotic Fracture Risk

Smokers have increased risk of osteoporotic fracture. This risk increases with age. Eighty year old smokers are 1.5 times more likely to get an osteoporotic fracture than non-smokers.
(Data from Kanis et al. 2005b)



Body Mass Index (metric and imperial)

How to calculate Body Mass Index (BMI)

Body mass index (BMI) is a measure of body fat based on height and weight that applies to both adult men and women.

BMI Categories:

- Underweight = below 18.5
- Normal weight = 18.5-24.9
- Overweight = 25-29.9
- Obesity = 30 or greater

Imperial BMI Formula

The imperial BMI formula accepts weight measurements in pounds & height measurements in either inches or feet.
1 foot = 12 inches. Inches^2 = inches x inches

$$\text{BMI}_{(kg/m^2)} = \frac{\text{weight in pounds} \times 703}{\text{height in inches}^2}$$

Metric BMI Formula

The metric BMI formula accepts weight measurements in kilograms & height measurements in either cm's or meters.
1 meter = 100cms; Meters^2 = meters x meters

$$\text{BMI}_{(kg/m^2)} = \frac{\text{weight in kilograms}}{\text{height in meters}^2}$$

risk factor for osteoporosis. Because bone is a living tissue and responds to the load that is placed upon it, heavier people tend to have higher bone mineral density and hence better bone strength. Combined analysis from several studies undertaken in Europe, North America, Japan, and Australia, confirms this view, showing that the risk for any type of fracture increases with decreasing BMI and that as BMIs fall below 22 there is a substantial increase in fracture risk for both men and women (De Laet et al. 2005). Higher BMIs are, in fact, protective for bone status, but the effect is very small and BMIs over 30 are associated with cardiovascular disease and diabetes.

Poor nutrition

Poor nutrition is associated with low BMI, but independently it can also affect bone health, particularly when diets are insufficient in calcium. Calcium is an essential part of bone mineral but it is also essential for muscles, nerves and other cells in the body. When insufficient calcium is absorbed from dietary sources, the body produces more parathyroid hormone, which boosts bone remodeling, mobilizing osteoclasts in the bone to break down and sacrifice bone calcium to supply the nerves and muscles with the mineral they need (Reginster 2005, Boonen et al. 2006). This accelerates osteoporosis. A "calcium calculator" is available at www.iofbonehealth.org. It can help determine the amount of calcium contained in a person's diet.

Poor nutrition is associated with low BMI, but independently it can also affect bone health, particularly when diets are insufficient in calcium.

Getting Enough Calcium?

Recommended daily allowance[1]	(mg)
Women, premenopause	1000
Women, postmenopause	1300
Men, 19 to 65	1000
Men, over 65	1300
Adolescents, 10 to 18	1300

Foods rich in calcium[2]	(mg)
Milk (250 ml/8.75fl oz)	297
Low Fat Yoghurt (150 g/5 oz)	243
Cheese (cheddar type-40 g)	296
Steamed Tofu (100 g/3.5 oz)	510
Curly Kale (112 g/4 oz) 168	
Figs (4 fruit/220 g)	506
Sardines (in oil, 100 g/4 fish)	500
Peeled Orange	75
Almonds (26 g/12 whole)	62
Broccoli (112 g/4 oz)	45

[1] Figures based on FAO/WHO: Human Vitamin and Mineral Requirements, 2002.
[2] Food Standards Agency (2002) McCance and Widdowson's The Composition of Foods, Sixth summary edition. Cambridge Royal Society of Chemistry.

Adequate dietary calcium is particularly important for children to ensure that optimal peak bone mass is achieved. Dietary calcium is also important throughout life, especially in later years, because the body's ability to absorb the mineral from the intestines and in the kidney decreases with age. Vitamin D is also essential, since it helps calcium absorption from the intestines into the blood. At least 800 international units of vitamin D and 1,000 to 1,200 mg of calcium daily can protect against osteoporosis (Boonen et al. 2006).

Studies have also shown that protein intake can help maintain healthy bones. Elderly men and women with lower intake of protein have greater hip and vertebral loss than those who eat higher amounts of protein (Dawson-Hughes and Harris 2002) and there are indications that protein may act synergistically with vitamin D and calcium (Delmi et al. 1990). Lean red meat, poultry and fish are good sources of protein as are nuts, grains and soya products. For more information please see IOF thematic report 2006 "Bone Appétit" www.iofbonehealth.org.

Eating disorders

Osteoporosis can also be compounded by eating disorders such as anorexia and bulimia (Legroux-Gerot et al. 2005). These conditions can dramatically reduce calcium intake and accelerate mineral loss from bone. The

extreme loss of weight caused by anorexia and bulimia also affects women's ovaries, which stop producing hormones. Estrogen deficiency in women afflicted by these disorders hastens bone loss in a similar way to that in post-menopausal women, but to make matters worse, these diseases reduce the robust build up of bone mineral density that usually occurs in adolescence and early adulthood. This may be related to both hormone imbalance and nutritional factors. In addition, the earlier in life these disorders strike and the longer they go untreated, the more severe the bone loss that may occur. Osteoporosis develops in about 35 to 50 percent of cases of anorexia.

Women who sit for more than nine hours a day are 50% more likely to have a hip fracture than those who sit for less than six hours a day.

Insufficient exercise

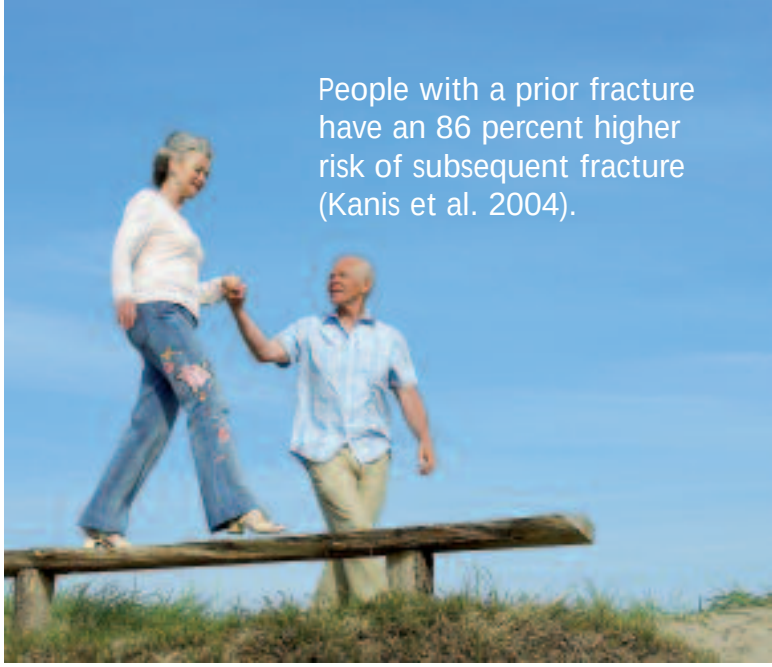
People with a more sedentary lifestyle are more likely to have a hip fracture than those who are more active. For example, women who sit for more than nine hours a day are 50% more likely to have a hip fracture than those who sit for less than six hours a day (Pfeifer et al 2004). Higher levels of leisure time, sports activity, and household chores and fewer hours of sitting daily were associated with a significantly reduced relative risk for hip fracture. Just like muscles, bones respond when they are "stressed," in other words, when they are forced to bear more weight than they are used to. This can be achieved by "weight bearing" or impact exercises such as walking, running, lifting weights, jumping, or dancing. This is true for everyone, not just those over 40. Studies show school children who exercise have higher bone mineral density than those with more sedentary lifestyles. Although weight-bearing exercise appears to enhance bone mineral accrual in children, particularly during early puberty, it remains unclear as to what constitutes the optimal exercise programme (Hind et al.). Besides, some studies have suggested that this beneficial effect tends to be limited as the years go by. A regular, well structured exercise regimen has been demonstrated to help protect against osteoporosis, osteoporosis-related fractures, and can also help in rehabilitation in adulthood. Exercises that improve posture and balance will help protect from falls and reduce the likelihood of having a first, or further bone fractures.

Frequent falls

While some diseases can affect the dynamics of bone biology and lead to a weakening of the bone matrix, other diseases now can increase the risk for fracture by increasing the likelihood of falls. Some of these factors, such as short-sightedness, may appear innocuous; others can be life-threatening, such as Alzheimer's disease and other neurological diseases. Other factors that can precipitate a fall include environmental hazards, such as slippery or uneven walkways and obstacles underfoot. These can pose a serious risk for fracture, especially for the elderly. Medications with sedative properties or that affect balance should also be considered risk factors for hip, wrist, and other fractures. Many of these risk factors have synergistic effects. Muscle weakness reduces balance, for example, which makes it harder for people to negotiate hazards on sidewalks or in the home.

Some Factors Contributing to Falls

- Dementia
- Neurological disorders impairing gait and balance
- Poor eyesight
- Muscle weakness
- Joint deformities
- Environmental hazards
- Sedatives



People with a prior fracture have an 86 percent higher risk of subsequent fracture (Kanis et al. 2004).

Fixed Risk Factors

Being aware of modifiable risk factors is important, as are proper diet and weight bearing exercise, which help slow the rate of bone attrition. But there are also fixed risk factors that increase a person's risk for osteoporosis and bone fractures. Fixed risk factors are those that one is born with or cannot alter. They include age, gender, family history, the presence of a previous fracture, race or ethnicity, and the onset of menopause or the history of hysterectomy. Even though these factors cannot be changed, they must not be ignored. It is important to be aware of these fixed risks so steps can be taken to reduce losses of bone mineral.

Fixed Risks

- Age
- Female gender
- Family History
- Previous Fracture
- Race/ethnicity
- Menopause/hysterectomy
- Long term glucocorticoid therapy
- Primary/secondary hypogonadism in men

Age

As we have seen, one of the primary fixed risks is age. The vast majority of hip fractures (90%), for example, occur in people aged 50 and older (Sambrook and Cooper 2006). This is partly because of reduced bone mineral density – as people pass through their 20s, 30s and 40s into middle age, the bone remodeling balance tips in favor of bone mineral loss, bringing with it an increased risk of fracture.

But age can also be a risk factor that is independent of bone mineral density. In other words, even older adults with normal BMD are more likely to suffer a fracture than younger people. Poor balance and weaker muscles in the elderly are clearly influential in this regard because they contribute to the risk of falls (see Frequent falls). Elderly people need to be aware not only of the possibility of having weaker bones, but also of the increased likelihood of sustaining a fracture from a fall. The IOF Thematic Report "Move it or Lose it" contains valuable information on how exercise can help prevent osteoporosis, fall-related fractures, and assists in rehabilitation.

Gender

Gender is another major fixed risk. Women, particularly post-menopausal women, are more susceptible to bone loss than men because their bodies produce less estrogen. This hormone supports osteoblast survival and tips the balance of bone remodeling in favor of bone formation (Manolagas et al. 2000). Careful monitoring of bone mineral density in post-menopausal women, combined with exercise, proper diet, and control of other risk factors can help fight osteoporosis. Although women are more likely to sustain an osteoporotic fracture (Johnell et al. 2005), men are not spared from osteoporosis. Some 20-25 percent of all hip fractures occur in men and they have higher rates of fracture-related mortality than women (Center et al. 1999). Hormones can play a role in male osteoporosis, too. Though levels of estrogen are much lower in men than in women, estrogen and testosterone, the male steroid hormone, both support bone formation in men and decreases in levels of these hormones can increase risk for bone mineral loss. Some medical conditions can cause testosterone loss in younger men (see Primary/secondary hypogonadism).

Family history

Genetics also plays a large part in osteoporosis. Scientists are uncovering subtle variations in the human genetic code that make some people more susceptible to bone loss than others (Thijssen 2006). In fact, parental history of fracture is a known risk factor that is independent of bone mineral density, suggesting that there are additional factors beyond bone health that make people susceptible to fracture (Kanis et al. 2004).

Previous fracture

Recently, combined analysis of multiple, worldwide studies revealed that people with a prior fracture are at increased risk of any type of fracture compared to people who have never broken a bone. This is true for both men and women. Both genders are almost twice (1.86 times) as likely to have a second fracture compared to people who are fracture free (Kanis et al 2004). This increased risk cannot be explained by bone mineral density alone, because low BMD accounts for only about 8% of the increased risk. While the reason prior fracture poses increased risk for future fractures is not clear, it may be related to an increased propensity to fall or poor ability to protect oneself from injury. This may also be related to the parental history of fracture discussed above. People who have suffered a previous fracture, or whose parents suffered osteoporotic fractures, should be particularly mindful, even if their BMD values are normal.

Does osteoporosis run in the family? Studies of twins and families have shown that genetic makeup is an important risk factor for osteoporosis. People are at increased risk for hip fracture if their parents had one. (Kanis et al. 2004)

Race/ethnicity

The genetics of osteoporosis are also reflected in the fact that different ethnicities and races have varying susceptibilities to osteoporosis. The disease is more common in Caucasian and Asian populations (Kanis et al. 2005c; Lau et al. 2003), and the incidence of hip and spine fracture is lower in Africans than Caucasians (Bell et al. 1995; DeSimone et al. 1989). Possible bone structure differences such as greater peak bone mass, a slower rate of bone loss after menopause, and better quality of bone microarchitecture may explain this. However, further studies and research are needed.

Menopause or hysterectomy

As we have seen, women are more susceptible to osteoporosis, in part because loss of estrogen leads to an increase in bone remodeling. In elderly people this remodeling predominantly results in bone loss rather than formation. Hysterectomy, if accompanied by removal of the ovaries, may also increase the risk for osteoporosis because of estrogen loss. Post-menopausal women, and those who have had their ovaries removed, must be particularly vigilant about their bone health. While hormone replacement therapy may help prevent loss of bone mineral, these treatments can also increase the risk of heart disease and cancer (Nelson et al. 2002). Post-menopausal women should consult their doctor about lifestyle changes and treatments that can help prevent osteoporosis.

Primary/secondary hypogonadism in men

Androgens are needed in the development of peak bone mass and to maintain bone mass. Hypogonadal young men with low testosterone levels have low bone density; studies have shown that testosterone replacement therapy

increases bone density in this group (Amin et al 2000). With age, testosterone levels gradually decline, but low levels in elderly men have not been found to correlate with low bone density (Finkelstein et al. 1989). At any age, acute hypogonadism, such as that resulting from orchiectomy for prostate cancer, accelerates bone loss to a similar rate as seen in menopausal women. The bone loss following orchiectomy is rapid for several years, then reverts to the gradual loss that normally occurs with aging.

Secondary Risk Factors

Secondary risk factors are less prevalent but they can have a significant impact on bone health and fracture incidence. These risk factors include other diseases that directly or indirectly affect bone remodeling and conditions that affect mobility and balance, which can contribute to the increased risk of falling and sustaining a fracture.

Disorders that Affect the Skeleton

- Asthma
- Nutritional/gastrointestinal problems (Crohn's disease etc.)
- Rheumatoid arthritis
- Hematological disorders/malignancy
- Some inherited disorders
- Hypogonadal states (Turner syndrome/
- Kleinfelter syndrome, amenorrhea etc.)
- Endocrine disorders (Cushing's syndrome, hyperparathyroidism, diabetes, etc.)
- Immobility
- Certain drugs (see side bar)

Medical Treatments Affecting Bone Health

Some medications may have side effects that directly weaken bone or increase the risk of fracture due to fall or trauma. Patients taking any of the following medications should consult with their doctor about increased risk to bone health.

- Glucocorticosteroids – oral or inhaled
- Certain immunosuppresants (calmodulin/calcineurine phosphatase inhibitors)
- Thyroid hormone treatment (L-Thyroxine)
- Certain steroid hormones (medroxyprogesterone acetate, leutenising hormone releasing hormone agonists)
- Aromatase inhibitors
- Certain antipsychotics
- Certain Anticonvulsants
- Certain Antiepileptic drugs
- Lithium
- Methotrexate
- Antacids
- Proton pump inhibitors

Disorders affecting the skeleton

Rheumatoid arthritis and diseases of the endocrine system can take a heavy toll on bones. Hyperparathyroidism, for example, results in elevated levels of parathyroid hormone, which signals bone cells to release calcium from bone into the blood. Excess thyroid hormone, either due to overactive thyroid or treatment for poor thyroid function, can also lead to osteoporosis (Vestergaard et al. 2005). Endocrine disorders that compromise the normal balance between female hormones (estrogens) and males hormones (androgens) can cause osteoporosis, too, because these hormones help build bone.

Sometimes the damage comes from prescription medication. Long term use of oral or inhaled corticosteroids, powerful anti-inflammatories prescribed for a variety of conditions, including allergies, Crohn's disease, asthma, and chronic pulmonary problems, have long been known to reduce bone mineral density (Adachi 1997). Combined analysis of data from over 40,000 volunteers worldwide shows that long-term corticosteroid use doubles the risk for hip fracture in women and increases it 2.6 fold in men (Kanis et al. 2004b). These drugs seem to affect bone biology when taken orally or inhaled, as for treatment of asthma and other pulmonary conditions. In some cases the condition being treated can also aggravate the corticosteroid effects. Asthma, for example, is a secondary risk factor for osteoporosis, due to a long-term use of inhaled corticosteroids. Other drugs that impact bone biology include proton-pump inhibitors, which attenuate acid production in the stomach and are commonly used to treat gastrointestinal diseases, such as acid-reflux. These drugs can reduce the absorption of calcium from the stomach and studies show that long-term use (>1 year) of proton-pump inhibitors can increase the risk of hip fracture by up to 60% (Yang et al. 2006).

A New Approach

A new approach to the identification of people at risk of osteoporotic fractures employs an algorithm based on clinical risk factors. It can be used either alone or in conjunction with DXA (Kanis et al. 2005). The clinical risk factors included in this WHO model have been validated in an analysis of 12 international cohorts (approximately 60,000 men and women). They include age, gender, BMD measured at the femoral neck, prior fragility fracture after the age of 50 years, low body mass index, use of glucocorticoids, secondary osteoporosis (e.g., associated with rheumatoid arthritis), parental history of hip fracture, current cigarette smoking and alcohol intake of more than two units per day. The algorithm will yield a score that will be an estimate of 10-year absolute fracture risk for an individual. Thanks to this estimate, people at higher risk of fracture will be able to take action before the first fracture occurs.

Be Proactive – Fight Osteoporosis

Knowing the risks is the first step in the fight against osteoporosis. People who believe they are at increased risk because of one or more modifiable or fixed risk factors, need to work with their doctor to develop a strategy to prevent osteoporosis and keep bones healthy. Remember, secondary risk factors including other diseases and medications, can lead to osteoporosis. People who are concerned about osteoporosis should seek advice from their healthcare provider.

Can the Risk be Reduced?

Yes, if any of the following apply

- Underweight (low BMI)
- Diet low in calcium and vitamin D
- Insufficient exercise
- More than 2 units of alcohol consumed daily
- Smoker
- Eating disorder

Actions to Take to Keep Bones Healthy

Because risk factors vary by age and from person-to-person, there is no one-size-fits-all regimen for preventing osteoporosis. Instead, everyone needs to consider his or her situation and consult with their doctor to adopt a diet, exercise plan and lifestyle that maximizes bone health. Young people should focus on building the peak bone mass that will keep them in good stead for the rest of their lives. A diet rich in calcium and vitamin D (which can also be obtained from sunlight) and weight bearing exercises help promote bone mineral density. Smoking, alcohol, and undernourishment should be avoided. Over exercising in young girls can lead to menstrual irregularities, which are due to an imbalance in hormone production, including reduced secretion of estrogens, by the ovaries (Warren and Goodman, 2003). As we have seen low estrogen is an important risk factor for osteoporosis.

External hip protectors, shells of shock-absorbing propylene or polyethylene, markedly decrease hip fractures. They shunt the energy from impact toward the short tissues around the hip and protect the bone (Kannus et al. 2000).

Pre-menopausal women and middle-aged men should strive to maintain their bone health by adopting good lifestyle choices and monitoring their secondary risk factors. People should be encouraged to take the IOF One-Minute Osteoporosis Risk Test (see page 13).

Post-menopausal women are at the stage in life when they are at greatest risk. They must be aware of any special risk factors and consult with their doctor about taking routine bone mineral density tests. An appropriate medication should be considered if bone density has become significantly lower than normal. Diet and exercise are as important as ever.

Men share some of the same risk factors as women. In addition, waning testosterone levels can lead to osteoporosis in men in a similar way to menopause in women. Men can get more detailed information from the 2004 IOF thematic report "Osteoporosis in Men" (www.iofbonehealth.org).

People who have had a fracture after 50 years of age should be particularly careful, because having a history of fracture puts one at risk for further bone damage. Elderly people should consider hip protectors and should pay particular attention to conditions that might lead to falls. Simple falls, those sustained from a standing position or even lower become increasingly frequent as people age (Cummings et al. 1994). Exercise becomes critical for the necessary muscle strength and physical balance that can protect against falls.

If needed, there are prescription medicines available (such as bisphosphonates, parathormone, SERMs and strontium ranelate), to be taken in combination with calcium and vitamin D supplements, to help prevent bone loss.

Summary

Osteoporosis affects people of all ages, but is particularly prevalent in the elderly. It can be precipitated by a multitude of risk factors. Some of these can be modified by adopting healthy lifestyles and habits. Other, fixed risk factors can be decreased by taking appropriate measures to build and maintain bone structure. People should consider secondary risk factors, such as other diseases and medication that may predispose to osteoporosis. Recognizing osteoporosis risk factors early in life and taking appropriate action can have enormous positive impact on bone health in later years. Risk factors also change with age. As people get older they should consider age-specific risk factors and continue to take appropriate steps, such as fall prevention, to keep their bones healthy and fracture free.

Case Studies

Danuta Pauk, Poland

I think that taking care of my bones is not a burden at all. It is just a matter of some knowledge and observing some healthy lifestyle rules.

I've never had health worries and I hadn't been concerned about my health until my mother developed rheumatoid arthritis 30 years ago. After seeing her cope with this incurable disease I started to be interested in all possible remedies which might bring her relief from constant pain. I was living in Canada at the time and I found a lot of literature on my mother's illness and also on osteoporosis. Both diseases concern me and I decided to make my bones as strong as possible.

More than 20 years ago I became aware of impact of a balanced diet on my bones and I made the decision to pay more attention to what I ate. I have always liked dairy foods – plenty of cheese, milk and yogurt were my staple and favorite foods – so for me it wasn't too difficult. I realized that I needed more fish, vegetables and fruit, which I introduced onto my plate without the least problem. The only novelty was a calcium and vitamin D supplement, easily available in Canada and which I have been taking for twenty years now. Once I took up these habits they became easy to follow.

After coming back to Poland in 1991 I broke my leg in an accident. At the hospital I met a woman suffering from osteoporosis. Her case was exceptionally severe as practically any uncontrolled movement would result in a fracture. This convinced me that taking care of my bones health was not such a far-fetched idea.

Now I am 53 years old and my latest bone density test has proved that my bones are in a pretty good shape. I still follow the diet including lots of dairy products, fish, fruit and vegetables and I take a calcium and vitamin D supplement.

Although I don't play a sport regularly, I know that any form of weight bearing physical activity is good for me, so I walk whenever I can. I don't have a car and I do not intend to get one. When on holidays, whether I go to the mountains or visit towns, I cover long distances on foot. I work flexible hours so I try to arrange my everyday schedule to have enough time for a walk. I avoid using public transport as much as possible.

I think that taking care of my bones is not a burden at all. It is just a matter of some knowledge and observing some healthy lifestyle rules. I am sure it pays.

Here's what I suggest … Know the osteoporosis risk factors and enjoy a portion of yogurt, salads, fish and fruit every day. Do not forget about a calcium and vitamin D supplement. Walk as much as possible whatever the weather is. It will give you energy and will let you see the changing seasons. You will see that going somewhere on foot does not take much more time than traveling by bus or car.

The benefits are obvious – better health and the prospect of being fit even in older age. And it all depends on you.

Rima Hamdan, Lebanon

I was totally aware of my illness and I had gotten to accept it. It became like a silent enemy… From a young woman in her 20s I had changed to an old woman in her 60s – in only ten years.

I'll go straight to the heart of the subject – it's something which has affected me since my late teens, since I was about eighteen years old. I had to realise that I was suffering from the absence of my menstrual period – which is called amenorrhea. I was diagnosed with a hormonal weakness, one small ovary and an even smaller second one and unfortunately both were not functioning properly. When my doctor performed a laparoscopy it occurred to him that I'd never be able to have kids.

By the time I was 13 years old, I had suffered many fractures including two fractures to my right leg and three to the left one and contemplating my future led me to a nervous breakdown.

About four years afterwards, I started suffering from very strong back pain. Then there was pain in my leg, my ankle and around the hip. The pain was spreading to my neck. I had to cope with the intermittent pain daily. I was even feeling pain in my teeth. It became unbearable. I got to a stage where death would have been a relief from all this pain.

I became depressed and aggres-

sive. I was totally aware of my illness and I had gotten to accept it. It became like a partner or a silent enemy. My nutrition was not appropriate or healthy. I didn't like to drink milk or consume dairy products.

When I was 16 years old there was finally a diagnosis for my illness: osteoporosis. I was relieved. I wanted a cure, to turn back the clock to when I was younger because I was afraid to become a burden on my family.

I had stopped my job as a Head Nurse at the age of 23, I no longer drove, travelled or practiced any kind of physical activity. From a young woman in her 20s I had changed to an old woman in her 60s – in only ten years.

Then I came into contact with the Lebanese Osteoporosis Society (LOPS). I met other people who lived with osteoporosis. I am treated now by a physician who gave me great hope when he explained to me how to deal with my problem. I now see that my amenorrhea was a major osteoporosis risk factor, and I wish that my family and doctors had pointed it out at the time – it could have saved me all this suffering.

I can't perform any activities because sitting or standing is very difficult. But for the time being I am working for a lawyer – I type texts for him while sitting up in my bed.

My advice to all girls is to pay attention to their hormones and treat this matter urgently because negligence can lead to a disaster and can ruin our lives.

I would like to thank all those who encouraged me to start a new life. I thank in particular LOPS who gave me back hope.

Robert Rees, Wales, UK

For me, being able to help other people in a similar position is much better than wallowing in self pity.

Five years ago, when I was 43, I was enjoying a family holiday in the Dominican Republic when, during a dancing competition I went to lift my wife Jean in a 50s-style swing, I felt as though a gun had gone off in my head. I collapsed in agony.

On returning home to the UK, I baffled my doctors. My vertebrae were spongy and they looked as though I had fallen from a three storey building into a swimming pool. Also I had a damaged spinal cord which meant that I couldn't feel or control my legs.

It took nine months to be diagnosed with osteoporosis – doctors were at first looking for something more sinister like a bone tumor and were not as accustomed to osteoporosis affecting men. When, after many tests, I was diagnosed with severe spinal osteoporosis, I was also found to have twelve rib fractures. My T-score was -4.9 and my doctor told me I had the bones of an eighty year old.

I thought that osteoporosis was something that only affected old ladies. My job as a sales director meant that I had a sedentary lifestyle so perhaps I had a risk factor that I wasn't aware of. I had been spending a lot of time seated while driving and many hours each week sitting at my desk, although I had been a rugby player in my younger days and had been fairly active. I have never been a heavy drinker or smoked very much. There hasn't been a family history of osteoporosis and of my six brothers and sisters, only two of my sisters have been recently diagnosed with osteopenia.

My treatment included a prescribed medication, calcium and vitamin D, and now I am taking another medication and vitamin D. My T score has now improved to -2.9. I am four inches shorter than I was before.

For me, being able to help other people in a similar position is much better than wallowing in self pity.

Since April 2006 I have become very active in increasing both awareness about osteoporosis in men and funds for the National Osteoporosis Society (NOS) in the UK, as NOS Ambassador.

Once or twice a week I speak at meetings such as Lions or Rotary clubs, schools and other community groups. People respond positively when I tell my story and I think that this does make them stop and think about their bone health. Especially those who think it can't happen to them.

Although I attend a chronic pain management clinic, I find helping the NOS a form of therapy, it helps take my mind off the pain I suffer everyday.

This year I have set a goal of raising £10,000 (14,700 euros) for the NOS and I hope to raise two or three times that amount. The Cardiff and Welsh Rugby teams have donated signed rugby jerseys and we are going to auction these. Also as part of the NOS osteoporosis helpline, I counsel people who are recently diagnosed with osteoporosis.

My advice to men and women who have busy jobs and a stressful lifestyle is to understand and reduce your risk factors, if possible. Try to do half an hour to an hour of weight bearing exercise every day – even if it just means walking around outside the office in the sunshine. Avoid sitting for long periods, don't smoke or drink too much. Make sure that you have a calcium-rich diet with plenty of vitamin D. Speak to your doctor if you have concerns.

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Take this new IOF One-Minute Osteoporosis Risk Test and find out if you are at risk.

Are you at risk of osteoporosis?

19 easy questions to help you understand the status of your bone health

What you cannot change – your family history

1. Have either of your parents been diagnosed with osteoporosis or broken a bone after a minor fall (a fall from standing height or less)? ☐ yes ☐ no
2. Did either of your parents have a "dowager's hump"? ☐ yes ☐ no

Your personal clinical factors *These are fixed risk factors that one is born with or cannot alter. But that is not to say that they should be ignored. It is important to be aware of fixed risks so that steps can be taken to reduce loss of bone mineral.*

3. Are you 40 years old or older? ☐ yes ☐ no
4. Have you ever broken a bone after a minor fall, as an adult? ☐ yes ☐ no
5. Do you fall frequently (more than once in the last year) or do you have a fear of falling because you are frail? ☐ yes ☐ no
6. After the age of 40, have you lost more than 3 cm in height (just over 1 inch)? ☐ yes ☐ no
7. Are you underweight (is your Body Mass Index less than 19 kg/m2)? (See: "How to calculate you BMI") ☐ yes ☐ no
8. Have you ever taken corticosteroid tablets (cortisone, prednisone, etc.) for more than 3 consecutive months (corticosteroids are often prescribed for conditions like asthma, rheumatoid arthritis, and some inflammatory diseases)? ☐ yes ☐ no
9. Have you ever been diagnosed with rheumatoid arthritis? ☐ yes ☐ no
10. Have you been diagnosed with an over-reactive thyroid or over-reactive parathyroid glands? ☐ yes ☐ no
11. **For women:** For women over 45: Did your menopause occur before the age of 45? ☐ yes ☐ no
12. Have your periods ever stopped for 12 consecutive months or more (other than because of pregnancy, menopause or hysterectomy)? ☐ yes ☐ no
13. Were your ovaries removed before age 50, without you taking Hormone Replacement Therapy? ☐ yes ☐ no
14. **For men:** Have you ever suffered from impotence, lack of libido or other symptoms related to low testosterone levels? ☐ yes ☐ no

What you can change – your lifestyle factors *Modifiable risk factors which primarily arise because of diet or lifestyle choices.*

15. Do you regularly drink alcohol in excess of safe drinking limits (more than 2 units a day)? (See: "How to estimate your alcohol consumption") ☐ yes ☐ no
16. Do you currently, or have you ever, smoked cigarettes? ☐ yes ☐ no
17. Is your daily level of physical activity less than 30 minutes per day (housework, gardening, walking, running etc.)? ☐ yes ☐ no
18. Do you avoid, or are you allergic to milk or dairy products, without taking any calcium supplements? ☐ yes ☐ no
19. Do you spend less than 10 minutes per day outdoors (with part of your body exposed to sunlight), without taking vitamin D supplements? ☐ yes ☐ no

If you answered "yes" to any of these questions, it does not mean that you have osteoporosis. Diagnosis of osteoporosis can only be made by a physician through a bone density test. We recommend that you show this test to your doctor, who will advise whether further tests are necessary. The good new is that osteoporosis can be diagnosed easily and treated. Talk to your local osteoporosis society about what changes you might make in your lifestyle to reduce your osteoporosis risk. You can contact your national osteoporosis society via **www.iofbonehealth.org**

"By increasing understanding of osteoporosis, spearheading medical research, and lobbying for changes in legislation, IOF works towards improved bone health across all segments of society and in every country."

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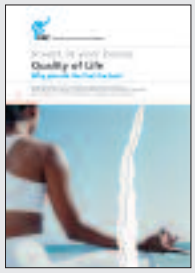

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