

BONE DENSITOMETRY - a patient's guide
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What is bone density?

Bone mineral density (BMD) is a measure of the amount of calcified tissue in bones and is essentially an estimate of bone strength. 'Thin' bones are bones with less calcified tissue in a given volume of bone. Such bones remain the same size but contain less protein and less calcium, and are weaker and more likely to fracture than normal.

How does bone density relate to osteoporosis?

Bone mineral density is used in the diagnosis of osteoporosis, which is a state where there is a lowered amount of supporting protein (mainly collagen) and calcium in bone which makes it structurally weak and liable to fracture. Reduced bone density is thus usually due to osteoporosis, but occasionally can be due to other causes such as reduced mineralisation (calcification) of bone due to deficiency of vitamin D or calcium (a condition called osteomalacia).

Bone density is relatively low in childhood but increases to a maximum ('peak bone density') in young adulthood.

What are the causes of low bone density?

Bone mineral density falls with age in both men and women. Whereas the decline with age is gradual in men, there is a more pronounced fall in women at and after the menopause due to a decrease in the important ovarian hormone, oestrogen, at that time.

Oestrogen has an important role in women in maintaining bone strength. Thus age and menopause are important causes of reduced bone density and contribute importantly to the risk of osteoporosis.

Other factors that can cause a reduction in bone density include some medications e.g. Prednisone (used for treatment of a variety of conditions including some forms of arthritis and asthma), chemotherapy, and some treatments for epilepsy. High alcohol intake, smoking, low vitamin D and/or calcium intake, and prolonged inactivity can all reduce bone density, as can disorders such as thyroid gland overactivity, excess parathyroid hormone production (primary hyperparathyroidism) etc. Inherited factors, not well understood, also influence BMD, so a family history of osteoporosis or frequent fractures could indicate a familial tendency to reduced bone density.

What problems does a low bone density cause?

Reduced bone density increases the risk of fracture with minor accidents. Obviously, heavy falls or major accidents can lead to fracture in any individual regardless of bone strength, but those with reduced bone density are liable to fracture with minimal trauma.

Osteoporosis is not, of itself, painful and is thus a 'silent' disorder until fracture occurs. Detection of osteoporosis by measurement of BMD is very helpful in order to assess fracture risk and to serve as a baseline to assess the response to treatment.

How is bone density measured?

BMD is best measured by a technique called DEXA scanning (dual energy x-ray absorptiometry). This involves the subject lying on a couch for 5-10 minutes while a x-ray gantry passes over the area to be assessed (usually the lower spine and hip), although the forearm can also be measured.

The technique is painless and very safe since x-ray exposure is only about 1% of that from a chest x-ray. Two different x-ray energies are used which are differentially absorbed by bone compared with soft tissue (muscle and fat) so the density of the bone can then be calculated. The precision of the technique is good, with an error of only 1-2% between repeated measurements, so changes in BMD greater than this over time represent genuine alterations.

Bone density can also be assessed in the spine by computerized tomographic (CT) scanning, but is less precise and uses higher amounts of x-ray than DEXA. Ultrasound of the heel provides a measure of bone 'stiffness' and has been used as a convenient surrogate method to assess risk of fracture at the hip. Good quality ultrasound can be used for screening purposes although there is doubt over the reliability of some machines and the technique is not suitable for following the response to treatment.

How are bone density results reported?

The absolute density value is reported as grams of bone per unit area (e.g. 1.1g/cm²), together with a statement of how this relates as a percentage to the bone density of the 'normal' population of the same sex, age, build and ethnicity.

The normal data have been obtained from large population surveys. Thus, a reading may be reported as '5% above average for age' or '8% below average for age'.

In general, readings 10% or more below average for age suggest an important reduction in bone density requiring tests to exclude possible underlying illnesses affecting BMD (low vitamin D etc). However, the most important calculation made from the BMD result is to estimate how far the reading is above or below the mean value for normal young adults. In the case of low BMD this can be expressed statistically as the number of standard deviations the measurement lies below the young adult mean value. This number is called the 'T score', and standardises the measurement. The World Health Organization has defined a T score between -1 and -2.5 as being osteopenia (mildly to moderately reduced bone density), and a T score of -2.5 or less as osteoporosis.

Importantly, the risk of fracture (relative to the normal young adult population) increases by a factor of 2 for every SD reduction below the young adult average value. Thus, a T score of -3 indicates a 2 x 2 x 2 (8) fold increase in fracture risk. It is important to realise that T-score analysis has been established for DEXA measurements and does not apply to measurements by ultrasound or CT.

Does a low bone density reading mean that I will have a fracture in due course?

Not necessarily. Fractures occur with falls or accidents so someone with a low BMD may never have a fracture if no fall or accident occurs. Falls are more common in the elderly, so special care may be needed to prevent falls in elderly individuals with low bone density e.g. muscle strengthening exercises, walking aids, hip protectors to cushion the effect of falls etc.

Can a low bone density be treated?

A number of treatments can help restore bone density when this has been found to be low. It is important to maintain a generous intake of calcium (normally as a supplement of 500-1000 mg per day taken as calcium tablets) and, if elderly or out of the sun a good deal, a supplement of vitamin D (normally using 1 or 2 multivitamin tablets each day).

Female hormone (oestrogen) in post menopausal females or male hormone (testosterone) in males is very effective at improving bone strength. This is popularly known as hormone replacement treatment or HRT.

Medications called bisphosphonates are also often very good at increasing bone density and can be given orally (e.g. etidronate, trade name Didronel), or intravenously (pamidronate or clodronate). A new oral bisphosphonate (alendronate, trade name Fosamax) is also available but is not currently funded under the pharmaceutical schedule and costs, on average, about \$800 per year.

An activated form of vitamin D, calcitriol (trade name Rocaltrol), has also been found to be helpful in some patients, particularly those with osteoporosis due to taking Prednisone. General practitioners or specialist physicians are able to advise on suitable options of treatment for individual patients.

Should bone density measurements be repeated?

There are guidelines published by the Australasian Bone and Mineral Society concerning follow-up BMD measurements. In those with low bone density needing treatment it is wise to repeat the measurement after 1-2 years to ensure the treatment is working and BMD is improving.

In those with mild reductions of BMD the measurement can be repeated after 3-5 years to check if there has been any further reduction, in which case treatment may be needed.

Those with bone density at or above average levels should normally have a repeat measurement done at a longer interval (5-10 years) to ensure there is no undue acceleration of bone loss over time.

Where can a bone density measurement be done?

A number of DEXA bone scanners are available through the country in the private sector, and measurements are covered by medical insurance. Costs are usually around \$100-\$150.

Groups such as Auckland Bone Density give detailed reports and specialist advice on management to the patient's family doctor. Some public hospital also operate densitometry services, although waiting times can be prolonged and reporting may be limited. Local general practitioners will usually know where scans can be arranged.

BONE HEALTH - an overview for patients
Dairy Advisory Bureau

Your bone health and the years ahead

The stooped back ... the falls that result in fractures ... little incidents that become more and more serious to your health and independence as the years go by.

Is this what we have to look forward to - a life marred by pain and deformity? Not necessarily - if you take the time now to take a little care of your bones. It's an investment that will pay off in a more active, independent lifestyle for longer - helping to ensure you get the most of the years ahead.

The importance of good bone health

Bones perform vital functions in your body. They provide the framework for your body to move and protect your vital organs. Understanding now what keeps your bone structure healthy will help keep you mobile and agile in later years.

Bone is a living tissue that is continually remodeled and rebuilt throughout your life. New bone is made and old bone is lost. When we are first born, bones are quite soft. They harden (or calcify) when calcium, protein and phosphorus are deposited in them.

Your body cannot make its own calcium, so it is essential to supply your calcium needs from your diet. (99 percent of the calcium in your body is in your bones, and 1 percent is in your blood and body fluids). Eating a balanced diet that includes calcium-rich foods can supply the calcium required to maintain these levels.

Under the microscope you can see bone has a honeycomb structure with lots of tiny holes. In some circumstances your body may start to take the calcium it needs from your bones. This leaves the honeycomb structure inside your bones thinner and weaker.

As we grow we need to provide enough calcium for building new bone as well as rebuilding and remodelling bone structure. By about age 30 bones have reached their strongest and most dense point. At this time bones contain high levels of calcium and have reached a stage called peak bone mass.

How does ageing cause bone loss?

As a natural part of ageing the bones lose calcium, making them less dense and therefore weaker. This decrease in bone mass affects both men and women. In women it becomes more pronounced during the middle years at menopause when the levels of the female hormone oestrogen fall.

Oestrogen helps to keep calcium in bones, so when levels drop women lose calcium from their bones more rapidly.

The rapid loss slows down after a few years, but if bone mass falls below a certain percentage of its maximum, you may cross the 'fracture threshold'. Below this point even minor falls can result in fractures. This is the condition called osteoporosis.

It is estimated that more than one in three women in this country over the age of 60 will suffer a broken bone due to osteoporosis.

What happens when bones become thin?

When bone loss occurs the hard outer shell of the bone thins out and the holes in the honeycomb structure become larger, causing a decrease in bone mass.

While bones remain the same size on the outside, they become thinner and weaker on the inside - particularly at the hip, wrist and spine.

The weakening of the bones makes them more prone to breaking. If this becomes severe it can result in older people getting shorter (due to the bones in the spine squashing), and suffering a variety of bone fractures - especially of the hip and wrist.

In extreme cases, bones have been known to fracture as a result of very minor movements such as sneezing.

As well as the pain and inconvenience of broken bones other health problems can often set in while people are immobilised, such as pneumonia.

Fractures occurring from low bone density have been diagnosed in people both young and old. For the elderly, this can be a real threat to their health, their independence and their enjoyment of life.

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