PREVENTING OSTEOPOROSIS

Strengthening Bone Density

DID YOU KNOW?

- More than 3 million people in the UK are estimated to have osteoporosis, a condition that causes around 500,000 broken bones every year - that's one every minute.[1A]
- 60,000 people a year are treated for hip fracture in the UK.[1]
- The incidence of osteoporosis trebles in women around the age of menopause, and can double again as women get older.[2]
- The number of both men and women being diagnosed with osteoporosis before the age of 40 is steadily increasing.[3]

It is never too early to start supporting our bone density, both through diet and weight bearing exercise. Our bone density tends to peak in our 20s, and then we all need to be more proactive in strengthening our skeletal structure. So what can we all do to improve the health and density of our bones? And why is it that menopausal and post-menopausal women are at greater risk for osteoporosis?

BONES ARE LIVING TISSUE

That's the beauty of our bones: they are not fixed, solid objects, but living tissue, constantly changing and renewing.

In a live body they are much softer and more pliable than you would imagine. Minerals, fluids and other nutrients are continually and dynamically moving in and out of them – in fact, one of the main functions listed for bones in anatomy books is storage of mineral reserves, which can be released when needed elsewhere. Bone tissue is also continually being laid down or destroyed to reshape your structure as you place varying demands on it. So the good news is that you can feed, nurture and strengthen your bones just as you can the rest of your body.

Bone tissue, made up of osteocytes, is a form of connective tissue, as is much of your flesh and blood. The bone matrix is made up of 65% mineral salts (calcium, phosphorous, magnesium, boron, sulphur and strontium) plus collagen and ground substance. So as with all connective tissue, bone cells need good levels of oils, amino acids, electrolytes, water and other supporting nutrients to stay vital and strong. They need a healthy flow of blood, lymph and interstitial fluids to carry these nutrients and messages, such as hormones, towards them, and to carry waste and toxins away. Bone matrix needs good levels of calcium and other minerals either for bone matrix ingredients or for the process of forming the matrix, such as zinc, copper, silica and manganese. Silica can be found in wholegrains, root vegetables and beets, alfalfa, nettles and horsetail. Collagen also requires Vitamin C, and ground substance likes to be well hydrated.

RISK FACTORS FOR OSTEOPOROSIS

Bone density peaks in our 20s, and as we age bone density declines. Lifestyle and diet factors that can negatively affect bone density include:

- Certain drugs, e.g. the contraceptive pill
- Chronic diarrhoea leading to loss of minerals and poor nutrient absorption
- Over consumption of alcohol, coffee, or salt
- Poor diets and/or frequent dieting
- Low gastric acid levels
- High consumption of processed food
- High protein diets, such as those containing too much meat, eggs and dairy produce
- High sugar diets
- High milk and dairy intake
- Smoking

During the menopause, oestrogen levels reduce, which is an important hormone involved in stimulating bone formation. This means that menopausal, and especially post-menopausal women are at greater risk of developing osteoporosis.

Inactivity is a major factor in low bone density and weak bone structure. Our bones are continually adapting their density and structure to meet our current needs. So regular weight bearing exercise, such as walking, will send messages to the bone cells to increase density in the areas feeling the impact most, i.e. the legs, hips and spine, which together with the wrists are the main target areas for osteoporosis. Spending your days sitting at the computer/on the sofa/in the car, bus, train or taxi, on the other hand, sends signals that you don't need strong bones in those areas.[6] Postmenopausal women who walk for at least 6 hours per week have a 55% reduction in risk of hip fracture (41% in women who walk for 4 hours a week) compared to those who walk for less than 1 hour a week.[7] And one study noted that professional tennis players can have up to 25% greater bone density in their serving arm than in their other arm.[8]

Diet and nutrient status also plays a vital and profound role in bone health, which we will now consider in detail.

NUTRIENTS FOR BONE HEALTH

CALCIUM

Calcium deficiency is often cited as the major cause of low bone density. Frequently advice is given to add more calcium to the diet, or where osteoporosis or osteopaenia (low bone density) is already diagnosed, calcium supplements are usually prescribed. Research suggests that in the average adult UK diet enough calcium is consumed on a daily basis. Current RNI for calcium is 700mg for UK adults but an average 900-1000mg calcium per day is acutally consumed.[5]

We will discuss the impact of calcium and calcium supplements on page 4 of this Education Article.

MAGNESIUM

Magnesium is a vital mineral for bone density, as well as production of energy (ATP) for cells throughout the body, including bone cells and conversion of Vitamin D to active forms.

Magnesium deficiency is becoming widespread in the UK population, in part through reduced intake of dietary sources and presence of anti-nutrient factors in the diet such as alcohol and fizzy drinks which deplete magnesium, as well as reduced levels of minerals in general in over-farmed crop soils[33].

For this reason, increasing magnesium rich foods like green leafy vegetables and fresh vegetable juices, as well as organic magnesium citrate supplements (avoiding inorganic magnesium oxide supplement forms) can help to support bone density.

VITAMIN D

We have long known of Vitamin D's importance for avoiding rickets, softening of the bone in children and teenagers, as Vitamin D helps the body to absorb calcium and phosphorous in the gut, both of which are needed for a strong bone matrix. Vitamin D is known as the sunshine vitamin, as we use sunlight to help manufacture it in the skin; we can also get vitamin D from oily fish. Vitamin D3 in supplements is the form associated with supporting bone health.

VITAMIN K

Research has shown that Vitamin K deficiency could lead to impaired mineralisation of bone due to decreased osteocalcin levels. Osteocalcin is one of the proteins in the organic bone matrix that binds calcium. Osteocalcin contains an amino acid called gamma carboxyglutamic acid, which enables osteocalcin to tightly bind calcium. Vitamin K is needed for the conversion of glutamic acid to its gamma carboxy derivative. Vitamin K is found in abundance in green leafy vegetables. Osteoporotic women have been found to have only 35% of the blood Vitamin K levels that are normal in age-matched controls.[25] Vitamin K occurs in two forms; Vitamin K1 (phylloquinone) is mostly used by the liver to activate calcium-binding proteins involved in blood clotting, while K2 (menaquinone) is used to activate proteins that regulate where calcium ends up in the body. Vitamin K2 is the form that has been demonstrated in studies to reduce the risk of heart disease[26] and lower the risk of osteoporosis.[27]

FOLIC ACID

The importance of folic acid (one of the B vitamins) for bone health seems to be connected with its role in the metabolism of the amino acid homocysteine. Methionine, one of the essential amino acids present in food proteins, is converted in the body partly to homocysteine, which, although a normal product of metabolism, becomes toxic if it accumulates. The importance of this has been shown up as a result of finding some individuals with a genetic fault of the enzymes for the removal of homocysteine. In these people, homocysteine accumulates to high levels and they become subject to osteoporosis from an early age. High homocysteine levels have also been linked to cardiovascular disease. Supplementing with folic acid (in MTHRF form) along with other B vitamins can help support a health methylation cycle and balance homocysteine levels.[28]

BORON

The non-metallic trace mineral boron has been recently shown to have a positive effect on calcium and active oestrogen levels in postmenopausal women. Supplementing the diet with 3mg of boron daily reduced urinary calcium excretion by 44% and dramatically increased the levels of the most biologically active oestrogen, oestradiol.[29]

The way it functions is not quite clear, but it has been suggested that it is required for the interconversion of different types of steroid hormone. Whatever the mechanism, intake of extra boron has been found to result in the formation of low concentrations of a form of oestrogen having high activity. It is thought that this obviates the dangers which accompany the administration of much higher doses of oral oestrogen that have to be used in HRT.

The same type of biochemical change, which is required for the interconversion of the above steroids, is also required for the formation of the active form of Vitamin D, the vitamin needed for the absorption of calcium. Some studies show that boron deficiency may lead to poor Vitamin D status. Hence, boron deficiency may be having a marked effect upon calcium absorption.

Boron is most readily available from vegetables, fruits and nuts. Therefore, boron intake may well be yet another case of a micronutrient whose daily human intake is being compromised today by industrialised food patterns and unwise food choices.

ZINC & MANGANESE

Zinc and manganese are necessary for bone formation and mineralisation.[30] Like magnesium, zinc is a cofactor for some 200 enzymes within the living cells, and so is fundamental to healthy and balanced metabolism. It also increases Vitamin D activity and promotes immune functions. When supplementing with zinc and manganese at higher doses and for long periods of time, it is necessary to also ingest copper, since high dose zinc reduces copper absorption and may produce copper deficiency.

COPPER

Copper is thought to be involved in bone, both through its effects upon the production of bone matrix and on bone mineralisation. The effect on matrix formation occurs because copper is needed for the action of an enzyme called lysyloxidase. This enzyme is needed to give the correct properties to the main structural protein of the bone matrix, collagen. In particular it forms cross-linkages between the fibres of protein – such an important aspect of bone strength. The adverse effects of copper deficiency on mineralisation are thought to be through the impact of cellular deficiency in the cells, which form new bone, called the osteoblasts.

SILICON

The non-metallic bulk mineral silicon is often available in the form of plant extracts, such as from horsetail found in food supplements. Silicon aids calcium absorption into bone. Like copper it probably influences both matrix formation and mineralisation.

CHROMIUM

One report indicates that by ensuring adequate status of chromium in the body after the menopause, a woman can increase her internal production of the oestrogen dehydroepiandrosterone (DHEA) by around 20%.[31]

Osteoporosis results from the resorption of bone due in part to the absence or inaction of insulin and oestrogens. Insulin resistance impairs bone calcium deposition and leads to hyperinsulinaemia, which in turn reduces the synthesis of DHEA. Insulin resistance is a growing health problem in the UK population, both young and older generations, and may account for the rise in cases of osteoporosis.[32]

In postmenopausal women, DHEA is the only source of oestrogens, and also an inhibitor of osteoclast activity (i.e. the cells that breakdown bone matrix). Therefore DHEA has a bone protective effect. Chromium is important in enhancing insulin action, reducing insulin resistance, as well as supporting bone health through increasing DHEA levels.

THE PROBLEM WITH CALCIUM

Depletion of any of these bone-supporting nutrients can contribute to bone degeneration. So why do we focus so much on calcium? Well, calcium phosphate does make up 70% of the weight of our bones[9], so for strong healthy bones, we need to make sure this substance is available to them. This can be a problem, however, even when there is plenty of calcium in the diet. When we eat calcium-rich foods – for example, sesame seeds, almonds, green leafy vegetables and broccoli – the body first of all needs to absorb it in the small intestine, for which it needs good levels of Vitamin D.

The parathyroid gland, which is located in your neck just above your thyroid gland, then regulates how much calcium is kept in the blood – this is important as calcium enables muscles to contract, so it's needed in the blood to keep the heart beating, for example. Blood calcium levels have also been linked with nervous system function and with blood sugar regulation[10].

Another important function for calcium in the body is to buffer excess acidity in the tissues. Most bodily tissues and fluids prefer to be just slightly on the alkaline side of neutral, however. Blood, for example, has a slightly alkaline pH of between 7.34 - 7.43; the body will prioritise keeping the blood to this pH as it is involved in so much vital activity. Healthy lymph fluid, which is part of the interstitial fluids that bath the cells and makes up on average around 12-15% of our body mass[16], is also slightly alkaline with a pH of around 7.4.

The body has very intelligent ways of maintaining healthy pH levels. Firstly, we have bicarbonate, phosphate, and protein buffer systems that neutralise acids, for example by combining acids with alkaline minerals like magnesium, potassium, calcium and sodium. This prevents strong acids from building up and causing damage in the blood, lymph and tissue cells. The kidneys, in particular, take centre stage in neutralising acids by combining them with bicarbonate and other alkalis before eliminating them via the urine. Breathing also helps us to alkalise, as we inhale oxygen and exhale acidic carbon dioxide. Finally, our skin eliminates acids through the action of sweating. All of these systems, especially the kidneys, keep a tight rein on controlling body pH, especially the blood.[17] The body must, at all costs, operate at a stable pH, so any increase in internal acid load, for whatever reason, has to be neutralised by one of a number of homeostatic base-producing mechanisms.

One school of thought suggests that as a result of modern dietary and lifestyle choices (e.g. smoking, alcohol, city pollution), low-grade chronic metabolic acidosis (i.e. change in cell and tissue pH) is now a common problem in many industrialised societies, in part due to dietary imbalances of minerals such as magnesium deficiency and sodium and calcium excess that alters pH and compromises metabolic function of the cells.

Medical research agrees that there are a number of disease states that induce severe metabolic acidosis (e.g. renal disease) but some recognising a more subtle and insidious sub-clinical rise in acidity within the body tissues and fluids may be more appropriate when addressing chronic health issues. This mild but chronic state is believed to indicate higher than optimal levels of acidity in the body tissues and that, in turn, may negatively impact on cellular function and health through disruption of biochemical pathways.

This problem remains undiagnosed and even unrecognised by many in the medical profession but many health professionals can see that these changes to tissue and cellular pH may induce or aggravate biochemical and physiological changes from chronic tissue stress. This is the case in osteoporosis. Raised acid levels in the body tissues may lead to hypercalciuria (high concentrations of calcium in the urine). Since calcium is a strong alkaline mineral and bone contains the body's largest calcium store, low grade metabolic acidosis has been suggested to cause a release in calcium from bones, as well as reduce renal tubular calcium resorption.[18]

Some studies have also shown that in humans, metabolic acidosis can increase 1,25-(OH)2 Vitamin D and decrease parathyroid hormone levels, proposed to be part of the early homeostatic mechanisms employed in response to calcium imbalances.[19] This suggests that low grade metabolic acidosis may alter calcium levels and bone response in the body.

As a result of systemic calcium imbalance, osteoclastic (bone degrading) activity is thought to increase and osteoblastic (bone building) activity decrease. Some studies have shown that the net result of these changes is a reduction in bone density in order to neutralise the acidic environment of the body. The calcium stored in the bone is then excreted in the urine along with the acid it was mobilised to neutralise. These studies have shown this effect creates a negative calcium balance (i.e. more calcium is lost from the body than is replaced) and bone structure may be weakened as a result.[20,21,22,23]

One particular study showed a direct correlation between animal protein consumption, especially consuming more than 5 portions of red meat a week and bone fractures in women, in part due to the higher content of acid forming sulfur-containing amino acids found in animal proteins.[24]

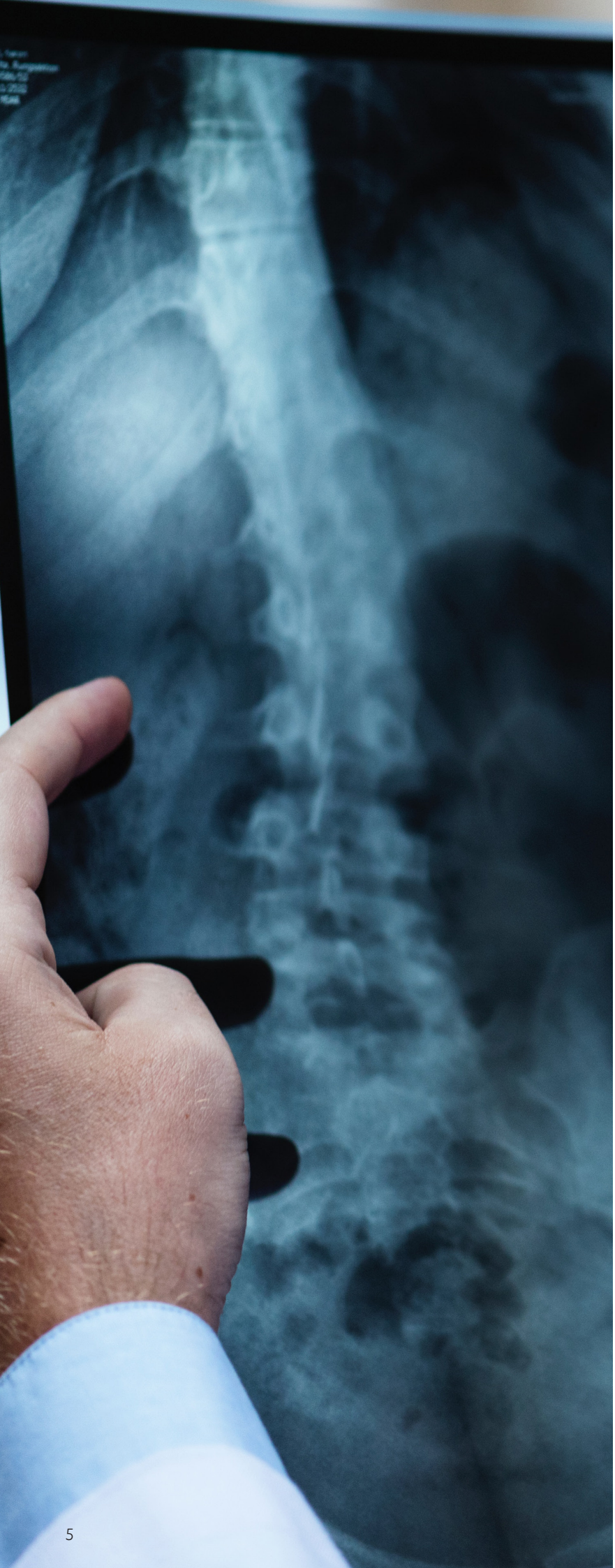
So simply increasing calcium in the diet is not necessarily going to help, and may even hinder, strengthening bone density.

THE PROBLEM WITH CALCIUM SUPPLEMENTS

So what about calcium supplements? Are they necessary to support bone health? To begin with, many supplements provide calcium in the form of calcium carbonate or dolomite, which contains calcium carbonate.[12] Calcium carbonate is an inorganic form of calcium which is poorly absorbed by our bodies when compared to the organic calcium citrate.[13] Furthermore, calcium carbonate can have a detrimental effect on stomach pH, which in turn can affect the absorption of many nutrients, including calcium and the other important cofactors and trace elements like magnesium, boron, manganese to name but a few. So why would you take a calcium supplement that your body can't effectively utilise and may even hinder absorption of other bone-supporting nutrients?

This is not to say that calcium supplements are never recommended to support bone density and cases of osteoporosis. Organic calcium citrate can play an important role in supporting levels, especially in post-menopausal women, but this nutrient needs to be combined with other bone-supporting nutrients such magnesium.

So low bone density is not usually so much of a calcium deficiency issues as a calcium misplacement issue. Solely increasing calcium to support bone structure and density is not the whole picture, especially if using an inorganic supplement form such as calcium carbonate that will reduce stomach acid, affect digestion and may affect cardiovascular health. Besides, many dietary sources of calcium, including dairy, contribute to acid load within the body thereby placing greater burden on the homeostatic mechanisms of the bone to retain calcium. So it's wise to consider a variety of different nutrients when considering bone health.



A NUTRITIONAL APPROACH TO BONE HEALTH

Diet plays an integral role in the alkaline balance of the body. Foods that are typically high in acid load include animal proteins including meat, grains and cheese. We have previously discussed that bones leach calcium as part of the body's homeostatic mechanism to maintain a slightly alkaline pH so diets high in acid load foods may contribute to bone thinning over time.

Diets rich in plant matter, including green leafy vegetables, broccoli, cauliflower, are high in alkaline load (i.e. alkalising minerals like magnesium and calcium) and should be incorporated in a nutrition plan to support bone health. One of the best ways to alkalise the body, i.e. addressing low grade metabolic acidosis that may cause calcium misplacement within the body, is achieved by drinking ½ litre of fresh green juice comprised of greens powder like spirulina alongside fresh greens like spinach, kale, cucumber, celery, parsley etc. This will deliver about 2000mg of alkalinity in the form of a variety of alkalising mineral compounds.

Green leafy vegetables are also rich in vitamin K, which is also important for bone density. One study reports that nurses eating their green leafy vegetables, broccoli and other green vegetables every day had almost half the amount of hip fractures compared to nurses eating their greens only once a week or less.

Dietary sources of calcium also include nuts and seeds, and avoid the need for high levels of dairy intake and the impact this can have on digestive health, absorption of nutrients and body pH as well as dairy products being a poor source of dietary magnesium. Animal protein like eggs and lean meat contain sulphur proteins that also support healthy bones so it's about achieving a balance and ensuring that vegetables form a significant part of your daily food intake.

INCLUDE

- A good variety of vegetables and salads, of varying colours but highlighting greens. Choose organic where possible, and make sure they make up at least two thirds or your meals. Also get into the habit of regular vegetable juicing.
- Plenty of nuts and seeds.
- At least 2 vegetarian days a week, and at least 1 vegetarian meal a day – ensure you have complete proteins by combining legumes with grains, seeds or nuts.
- A daily walk.

AVOID/REDUCE

- Dairy, damaged fats, table salt, sugar, aspartame
- Fizzy drinks, caffeine, alcohol
- You may also benefit from avoiding wheat, or perhaps gluten (wheat, rye and barley).

In any case, grains, pulses, nuts and seeds should be rinsed well and soaked overnight in water. This will reduce phytates and deactivate any enzyme inhibitors, so you can make the most of the nutrients they contain.

MENU SUGGESTIONS

You may find the following meal suggestions useful as part of a nutrition plan to support body pH and bone health.

BREAKFAST:

Wheat-free muesli (soaked overnight in water) with almond milk.

Superseed smoothie – with almond milk, pumpkin seeds, sunflower seeds, sesame seeds, plus avocado or banana to thicken and raw honey or berries if you need to sweeten it.

Quinoa or rice porridge with ground nuts and seeds.

Soft poached egg on a bed of rocket and baby spinach with a lemon and flaxseed oil dressing.

LUNCH/DINNER:

Chicken or tempeh stir fried in coconut oil with mixed vegetables.

Broccoli and almond soup.

Quinoa salad with watercress, grated carrot, pumpkin seeds and spring onions.

Green salad with warm lentils and tahini sauce.

Fresh, wild, oily fish and salad.

Lentil and kale daal with shortgrain brown rice.

TO DRINK:

Water – gradually increase to 1.5-2 litres daily, best at room temperature and between meals, and never more than 1 litre in the space of an hour, so don't gulp it down.

Herbal teas - nettle tea is rich in silica.

A glass of fresh vegetable juice – invest in a good masticating juicer if you can.

SUPPLEMENTS

This will vary from person to person, but you may want to supplement with essential fatty acids, especially omega 3, as well as magnesium citrate, Vitamin D3 and other supporting nutrients.

As a general support for bones of all ages you could supplement with a multiformulation that is rich in magnesium citrate, while also delivering a full range of B vitamins and trace minerals together with some omega 3 oils, such as a good quality flaxseed oil, fish or krill oil, and plenty of sunshine.

For those at higher risk, you should consider a formula that supplies a good balance of magnesium citrate and calcium citrate in a 2:1 ratio in favour of magnesium. This formula should also deliver a balanced blend of Vitamin E, zinc, Vitamin C, manganese, boron, copper, chromium, Vitamin K2, folic acid (in methylfolate form) and Vitamin D3. Alongside a multiformulation always add in in omega 3 fatty acids such as krill oil or fish oil to support healthy bones.

If you have any questions then please contact the Nutrigold team on 0800 233 5675 or email talk2us@nutrigold.co.uk

This education article was co-written by Dr Elisabeth Philipps PhD with Nutrigold.

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