

Boning up on Calcium

Why Plant Calcium is Best

Most people in developed countries have been brought up to believe that our teeth and our bones can only grow healthily if we drink cows' milk. Over the last three decades we have witnessed a barrage of marketing campaigns designed to reinforce the idea that only dairy milk can supply calcium in sufficient quantities to help us grow big and strong. But is it really good for you? An increasing amount of research challenges the outdated notion that cows' milk is best and in fact shows that our consumption of dairy products is doing us much more harm than good.

What is Calcium and Why Do We Need It?

Calcium is a soft grey metallic element. It is the fifth most abundant element in the earth's crust and occurs in compounds such as limestone, chalk and marble. Calcium is required for normal growth and development in animals. It is the most abundant mineral in the human body accounting for around two per cent of the total body weight. Calcium plays an important structural role in maintaining bone health and strength; in fact around 99 per cent of our calcium is deposited in the bones and teeth. The other one per cent is responsible for a range of important metabolic functions that regulate muscle contraction, heartbeat, blood clotting and functioning of the nervous system.

How Much Calcium Do We Need?

There is no international consensus on what the healthiest or safest amount of calcium we need is. In the UK, the reference nutrient intake value (RNI) is used; this is similar to the Recommended Daily Amount (RDA) used previously. The RNI value for a nutrient is the amount of that nutrient that is sufficient for 97.5 per cent of the people in a given group. The UK government currently suggests that the RNI value for calcium in adults aged between 19 and 50 years of age is 700mg per day (National Diet and Nutrition Survey, 2004).

In the US, the recommended daily intake is slightly higher at 1000mg per day (NIH Consensus Statement, 1994). However, in many countries such as India, China, Japan, Gambia and Peru the average daily intake of calcium can be as low as 300mg.

Where Do We Get It?

The body obtains calcium in two ways: either from our diet or our bones. When the diet does not provide sufficient levels, calcium is 'borrowed' (reabsorbed) from the bones in order to restore blood levels and maintain calcium-dependent biological functions. Calcium in our bones is reabsorbed and replaced continuously as old bone cells break down and new ones form. If adequate calcium is then supplied in the diet, bone levels are restored, but if the diet fails to supply enough calcium or causes calcium leaching from the bones, bone loss persists.

Calcium and Bone Health

The idea that cows' milk is the best source of calcium is deeply entrenched in the British psyche and is sustained by the government-sponsored dairy industry and the Milk Development Council who work with schools, dairies and LEAs to encourage more children to drink milk at school. However, a review of 37 studies on dairy products and bone health published in the official journal of the American Academy of Pediatrics challenged this misleading notion by concluding that there is no solid evidence that the consumption of dairy products improves bone health in children and young adults (Lanou *et al.*, 2005).

Another review of 15 studies on calcium intake and the risk of hip

fractures (Bischoff-Ferrari *et al.*, 2007) suggests that neither total calcium intake nor calcium supplementation is significantly associated with decreased hip fracture risk in women or men. As for calcium supplementation, the authors suggested that it might indeed increase the risk. The latest study of this type brought very similar results (Warensjö *et al.*, 2011). Over 60,000 women were followed for up to 19 years and when the data were analysed, it was found that calcium intake above 750mg didn't offer any protection from fractures and high calcium intakes increased the risk of hip fractures.

Harvard experts (Harvard School of Public Health, 2012) recently confirmed this when they highlighted that in countries such as India, Japan and Peru where average daily calcium intake is as low as 300 milligrams per day, the incidence of bone fractures is lower than in many western countries (including the UK). An increasing amount of evidence now suggests that cows' milk is not the best source of calcium at all and goes further to suggest that our bone health would benefit enormously if we switched to plant-based sources.

In addition, research suggests that physical exercise is the most critical factor for maintaining healthy bones, followed by improving the diet and lifestyle; this means eating plenty of fresh fruit and vegetables, cutting down on caffeine and avoiding alcohol and smoking.

In 2004 the Government's Food Standards Agency (FSA) looked at sources of calcium in the National Diet and Nutrition Survey and found that only 43 per cent of the mean intake of calcium in adults in the UK comes from milk and milk products. So despite the misconceived notion that milk is the best (or only) source of calcium the facts show that a large share of the calcium in our diets is derived from sources other than dairy foods. This is not surprising as most people in the world (around 70 per cent) obtain their calcium from plant-based sources rather than dairy products.

But Milk is a Natural Food... Isn't It?

Humans are mammals, and as with all mammals, we are designed to drink the milk of our mothers until we are weaned on to solid foods. We are the only mammals that continue to drink milk after weaning, and not just that, we are the only mammals to drink the milk of another species (apart from pets that we control). To state the obvious (but often overlooked fact) cows' milk has evolved to help turn a small calf into a cow in less than a year. That's why cows' milk contains around four times as much calcium as human milk; 118mg per 100g compared to 34mg per 100g respectively (FSA, 2002). This discrepancy is for a good reason; calves need a huge amount of calcium to promote the massive level of skeletal growth required over the first year of life. A human infant does not require such high levels of calcium; indeed the high mineral content of cows' milk puts a strain on the human infant kidney which is why most governments recommend children do not drink cows' milk in their first year.

Lactose Intolerance

Many people are unable to consume cows' milk and milk products

because they are unable to digest the sugar in milk called lactose. This sugar only exists in mammals' milk, including human breast milk. In order for lactose to be digested it must be broken down in the small intestine by the enzyme lactase. Most infants possess the enzyme lactase, and can therefore digest lactose, but this ability is naturally lost in most people after weaning (commonly after the age of two). Losing the ability to digest lactose at this age is a clear indication of how humans are not designed to drink milk as adults; it is not a natural food for us.

The frequency of lactose intolerance varies from around 90-100 per cent of Asians, 65-70 per cent of Africans, to 10 per cent of Caucasians (Robbins, 2001). In the absence of the enzyme lactase, lactose is fermented by bacteria in the large intestine but not digested, which leads to a build-up of gas. Symptoms of lactose intolerance include nausea, cramps, bloating, wind and diarrhoea. The treatment is straightforward: avoid lactose. This means cutting out all dairy foods and checking labels for lactose in bread, chocolate and other processed foods. Many lactose intolerant people obtain their calcium from plant-based sources.

Allergies

An allergic reaction to cows' milk is very different to lactose intolerance and can, in extreme circumstances, be fatal. An allergic reaction to milk occurs when the body's immune system perceives one of the proteins in milk (either whey or casein) as a foreign invader and launches an attack. Symptoms are generally more extreme than in lactose intolerance and include excessive mucus production resulting in a runny nose and blocked ears. More serious symptoms include eczema, colic, diarrhoea, asthma and vomiting. Casein is more difficult to avoid as it is often used in the production of bread, processed cereals, instant soups, margarine, salad dressings, sweets and cake mix.

Cows' Milk and Diabetes

Type I diabetes is an autoimmune disease where the immune system's 'soldiers', known as T-cells, destroy the body's own insulin-producing cells in the pancreas (insulin is the hormone necessary for correct sugar metabolism). Subsequently, the body can't produce insulin and is therefore unable to use sugar (glucose), which then builds up in the blood.

This reaction of the immune system is thought to involve a genetic predisposition (diabetes in the family) and short duration of breastfeeding coupled to an environmental trigger such as cow insulin or casein – both from cows' milk or cows' milk based formula.

In fact, there are three culprits in cows' milk: bovine serum albumin (BSA), casein and cow insulin.

When diabetic and healthy children were tested for BSA antibodies in their blood, all diabetics had levels as much as seven times higher than the healthy children. (Karjalainen *et al.*, 1992). Following studies have confirmed this (Hammond-McKibben and Dosch, 1997).

Another protein called casein is found in both human and cows' milk but about 30 per cent of human casein is different from cow casein and it is thought to be the reason why the immune system reacts to it and destroys it (Cavallo *et al.*, 1996; Becker *et al.*, 1995).

When these milk proteins reach the small intestine, they are not fully digested and fragments are absorbed into the blood. The immune system recognises these fragments as foreign intruders and attacks them. Coincidentally, some fragments are identical in structure to the surface of the body's own insulin-producing cells in the pancreas (Karjalainen *et al.*, 1992; Martin *et al.*, 1991) and the body cannot distinguish between the two. Both pancreas cells and invaders are destroyed by the immune system and eventually diabetes results.

Finally, cow insulin presents a problem as well and is present even in formula milk (Vaarala *et al.*, 1999). The immune system of genetically susceptible babies given cows' milk formula reacts strongly to it by forming anti-insulin antibodies (Paronen *et al.*, 2000).

A study revealed that genetically susceptible children weaned too early and given cow's milk formula had a 13.1 times greater risk of type 1 diabetes than non-susceptible children breast-fed for at least

Food (and serving size)	Calcium (milligrams)
Cauldron Original Tofu (100g - a quarter of the pack)	318
Sesame seeds (25g - a small handful)	168
Sunflower seeds (25g - a small handful)	28
Broccoli (80g portion boiled in unsalted water)	32
Curly kale (80g portion boiled in unsalted water)	120
Watercress (80g portion raw)	136
Almonds (30g - a small handful)	72
Brazil nuts (30g - a small handful)	51
Alpro or Provamel Soya Milk, calcium enriched (200ml glass)	240
Dried Figs (100g - four to six pieces of fruit)	250
Tahini (10g - two teaspoonfuls generously spread on one piece of toast or stirred into a bowl of soup)	68
Granary bread (1 slice)	104

three months (Perez-Bravo *et al.*, 1996). A study in 40 different countries confirmed this and found that the more meat and milk in the diet, the higher the risk of diabetes - the more plant-based food in the diet, the lower the risk (Muntoni *et al.*, 2000).

The avoidance of cows' milk during the first few months of life may reduce the risk of type I diabetes. Infants who cannot breastfeed from their mothers would benefit more from taking a plant-based formula such as soya-based formula rather than one based on cows' milk.

Plant-Based Sources of Calcium

There are many plant-based sources of calcium. Good sources include non-oxalate (see next column) dark green leafy vegetables such as broccoli, kale, spring greens, cabbage, bok choy, parsley and watercress. Also rich in calcium are dried fruits, such as figs and dates, nuts (particularly almonds and Brazil nuts), and seeds including sesame seeds and tahini (sesame seed paste) which contains a massive 680 milligrams of calcium per 100 grams.

Pulses, including soya beans, kidney beans, chick peas, baked beans, broad beans, lentils, peas and calcium-set tofu (soya bean curd) provide a good source of calcium. Other fruit and vegetable sources include parsnips, swede, turnips, lemons, oranges, olives and molasses. A good additional source is calcium-enriched soya milk.

Calcium Uptake and Absorption

The amount of calcium present in a particular food is not the only important factor to consider. The bioavailability of the calcium should be considered when deciding which foods are a good source.

This means how much calcium is actually available for absorption into the body from the food.

The calcium in dairy products is not as well absorbed as that in many dark green leafy vegetables (Lanou *et al.*, 2005). For example, calcium absorbability from kale was demonstrated to be considerably higher than that from cows' milk (Heaney and Weaver, 1990). While spinach contains a relatively high amount of calcium, it is bound to a substance called oxalate which hinders calcium absorption (Heaney *et al.*, 1988) so it is important to obtain calcium from low-oxalate green vegetables.

Grains, nuts and seeds contain a substance called phytic acid which was also considered to hinder calcium absorption but it's been shown that it only has a minor influence (Hurrell, 2003). Caffeine and smoking have been shown to reduce calcium absorption (Barger-Lux and Heaney, 1995).

Vitamin D

The body requires vitamin D to absorb and retain calcium in the bones. Vitamin D is either obtained from the diet or it is synthesised in the skin following exposure to sunlight. But recent concerns about skin cancer have encouraged us to cover up and avoid the sun. Subsequently people in the UK could be at risk of vitamin D deficiency if they get too little sun exposure year round.

Without sufficient vitamin D, calcium deficiency can occur even if the diet provides enough calcium. The consequences may be serious, resulting in rickets or osteomalacia (softening of the bones). Over the last few years there have been cases of vitamin D deficiency in some large UK cities (Shaw and Pal, 2002). Vegans obtain vitamin D from sunlight and fortified foods such as soya milks, cereals and margarines. It is important to get the balance right between being cautious about exposure to the sun and aware of the need for some exposure. It is recommended to spend at least 15-20 minutes a day outside with exposed face and hands to give the skin a chance to make enough vitamin D for our daily needs and it is now advised by the UK government that we apply sun block only after 10 to 15 minutes exposure to the sun. The skin reacts to daylight even when it's cloudy so the weather doesn't need to be sunny for your skin to do its job.

Magnesium, Potassium, Vitamins A, B group, C and K

Magnesium, potassium, vitamins A, B group, C and K are all required for good bone health. A healthy diet that includes at least five servings a day of fruit and vegetables should optimise the intake of these and other micronutrients required (Nieves, 2005).

Animal Protein and Osteoporosis

Bones consist of a thick outer shell and a strong inner mesh filled with a protein called collagen, calcium salts and other minerals. Osteoporosis (meaning porous bones) occurs when too much calcium is lost from the bones and they become more fragile and prone to fracture.

This debilitating condition tends to occur mostly in postmenopausal women due to a lack of the hormone oestrogen, which helps to regulate the incorporation of calcium into the bones. However, osteoporosis affects men as well.

Osteoporosis is sometimes called the silent disease as there are often no symptoms until a fracture occurs. Although the whole skeleton is usually affected, fractures mostly occur in the wrist, spine and hip. One in two women and one in five men in the UK will suffer a fracture after the age of 50; in fact every three minutes someone has a fracture due to osteoporosis (NOS, 2012). However, osteoporosis has been diagnosed in people as young as 20.

The dairy industry has responded to this health scare by promoting the consumption of milk, cheese and yogurt directly to teenage girls. However, British and Scandinavian women are among the biggest consumers of calcium in the world yet they have one of the highest levels of osteoporosis (Frassetto *et al.*, 2000). African Bantu women, on the other hand, eat almost no dairy products at all; they have a relatively low calcium intake, mainly from vegetable sources, and typically have up to 10 children each. Yet osteoporosis is virtually unknown among Bantu women (Walker *et al.*, 1972).

It seems that the more dairy produce we consume, the higher our risk of fracture. The Harvard Nurses' Health Study examined whether higher intakes of milk can reduce the risk of osteoporotic fractures. The study observed over 77,000 women for 12 years and concluded that increasing milk consumption did not have a protective effect against hip or forearm fracture. In fact the report showed that for women consuming two or more glasses of milk a day, the risk of hip fracture was 1.5 times bigger than for women who consumed less (Feskanich *et al.*, 1997).

It has been shown that calcium loss from the bone is promoted by a high intake of animal protein. One study of 1,600 older women examined the level of bone loss and found vegetarians had only 18 per cent less bone mineral compared to omnivores who had lost 35 per cent bone mineral by the age of 80 (Marsh *et al.*, 1988). Another study of 1,035 elderly women found that women with diets high in animal and low in plant protein had an almost four times higher rate of bone loss and their risk of hip fracture was 3.7 times that of women who consumed the least animal protein (Sellmeyer *et al.* 2001). In a similar study that analysed the incidence of hip fracture in relation to the consumption of animal

and vegetable protein in 33 countries it was concluded that the higher the consumption of animal products, the higher the rate of hip fractures (Frassetto *et al.*, 2000).

Similarly, an analysis of data on protein intake and fracture rates from 16 countries revealed strong links between a high animal protein diet, bone degeneration and hip fractures (Abelow *et al.*, 1992).

In Professor T. Colin Campbell's extensive 'China Study' (the largest study in the world of the effects of diet on health) Campbell observed that in rural communities where animal protein made up just 10 per cent of the total protein intake (the other 90 per cent coming from plant-based sources) the bone fracture rate was one-fifth of that in the US, again indicating a link between animal protein and bone degeneration.

A study of a high animal protein and low carbohydrate (Atkins-type) diet showed that after six months on the diet, people excreted 50 per cent more calcium in their urine compared to the starting point (Westman *et al.*, 2002). Later on, Campbell and Tang (2010) warned that high protein diets emphasising animal products lead to bone loss and decreased bone density.

But what is the mechanism for this process? As food is digested acids are released into the blood and the body attempts to neutralise the acid by drawing calcium from the bones. This calcium is then excreted in the urine and only a small fraction can be returned back into the bones. Animal protein has a particularly bad effect because of the greater amount of sulphur-containing amino acids it contains compared to plant protein. As the sulphur content of the diet increases so does the amount of acid it creates in the body and the amount of calcium used to neutralise it (most of which is later lost in the urine).

Studies reveal that diets based on animal products confer an increased risk for uric acid stones (Breslau *et al.*, 1988). Furthermore the animal protein-induced calcium losses in urine may be a risk factor for the development of osteoporosis. The traditional Inuit diet is made up almost entirely of animal protein. Inuits potentially have one of the highest calcium intakes in the world (up to 2,500mg a day) depending on whether they eat whole fish, including the bones, or not. They also have a high rate of osteoporosis, even higher than white Americans (Mazess and Mather, 1975; Mazess and Mather, 1975; Pratt and Holloway, 2001).

Although plant protein also produces acid, there is less of it and alkaline salts produced during the metabolism of fruits and vegetables also neutralise the acidity during digestion. So consumption of fruits and vegetables that produce alkaline salts, such as carbonates and citrates, reduces the need for the bones to provide part of the buffer system (Burns *et al.*, 2003).

The overall effect of most fruit and vegetables (including citrus fruits) is to alkalinise the blood; whereas the overall effect of cows' and goats' milk, cheese, both red and white meat, fish and eggs is to acidify.

For a detailed list of the effect of foods (acid or alkaline) on your body see the *Break Free* report: www.viva.org.uk/health/Breakfree.

An extensive review by Lanou (2009) resulted in a conclusion that: 'bones are better served by attending to calcium balance and focusing efforts on increasing fruit and vegetable intakes, limiting animal protein, exercising regularly, getting adequate sunshine or supplemental vitamin D and getting 500mg Calcium per day from plant sources.'

And as Sahni *et al.* (2009) showed, long-term intake of carotenoids (antioxidants found only in fruit and vegetables) is beneficial for bone health and can help prevent osteoporosis.

There are many factors linked to bone health that may even be more important than calcium. For example, when the bone density of 80 young women was monitored over a 10-year period, it showed that exercise was more important than calcium intake (Lloyd *et al.*, 2004). In older people, a 15-year investigation into whether low calcium intake was a risk factor for hip fractures concluded that cutting back on dairy did not increase the risk and that physical activity provided better protection (Wickham *et al.*, 1989). The discovery of 18th-century human bones under a

London church revealed that today's women lose far more calcium than our ancestors (Lees *et al.*, 1993). This may be attributed to a lower degree of physical activity. This research supports an increasing amount of evidence that physical activity is a key factor in reducing osteoporosis risk.

To promote bone health and reduce the risk of osteoporosis it is important to avoid acid-producing animal products, eat plenty of fruit and vegetables, get enough vitamin D, reduce caffeine and alcohol intake and not smoke. Many studies suggest exercise is the most important determining factor. The best type of activity for bone health is weight bearing exercise; this includes walking, stair climbing and dancing.

Summary

- Children and young adults do not need dairy foods for good bone health; they do need exercise and a healthy plant-based diet to ensure strong bones.
- Diets loaded with dairy products are associated with an increased risk of many diseases including osteoporosis, cancer, heart disease, obesity and diabetes.

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