



By Dr Justine Butler

# 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 cow's milk. Over the last three decades we have witnessed a barrage of marketing campaigns designed to reinforce the idea that only milk can supply calcium in sufficient quantities to help us grow big and strong. But is milk really good for you? An increasing amount of research challenges the outdated notion that cow's milk is best and in fact shows that our consumption of dairy products is doing us much more harm than good.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 on 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, heart beat, 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 700 mg per day (1). In the US, the recommended daily intake is slightly higher at 1000mg per day (2). However, in many countries such as India, China, Japan, Gambia and Peru the average daily intake of calcium can be as low as 300 mg.

### 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, bone loss persists.

### Children, Young Adults and Bone Health

The idea that cow's milk is the best source of calcium is deeply entrenched in the British psyche and is sustained by the government-sponsored dairy industry and Milk Development Council who work with schools, dairies and LEAs to encourage more children to drink milk at school. However, a recent review 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 very little evidence to support increasing the consumption of dairy products in children and young adults in order to promote bone health (3). This review examined the effects of dairy products and total dietary calcium on bone integrity in children and young adults and found that out of 37 studies, 27 showed no relationship

between dairy or dietary calcium intake and measures of bone health. In the remaining studies the effects on bone health were either small or results were confounded by the fortification of milk with vitamin D. An increasing amount of evidence now suggests that 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, and for young adults 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 (1). 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 onto 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) cow's milk has evolved to help turn a small calf into a cow in less than a year. That's why cow's milk contains around four times as much calcium as human milk; 118mg per 100g compared to 34mg per 100g respectively (4). 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 cow's milk puts a strain on the human infant kidney which is why most governments recommend children do not drink cow's milk in their first year. Indeed the mineral content of cow's milk is so out of balance with human biochemistry that it is difficult for human adults to absorb the optimum amounts required for health (5).

### Lactose Intolerance

Many people are unable to consume cow's 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 lost in many 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 (6). In the absence of lactase, lactose is fermented by bacteria in the large intestine, this 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 cow's 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 commonly used in the production of bread, processed cereals, instant soups, margarine, salad dressings, sweets and cake mix. People with milk allergies tend to obtain their calcium from plant-based sources.

### Cow's 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 beta cells in the pancreas. This type of response is thought to involve a genetic predisposition (diabetes in the family) coupled to an environmental trigger such as cow insulin or casein – both from cow's milk. Research shows that some infants may be more vulnerable to type I diabetes later in life if exposed to cow's milk formula while very young. A Finnish study of children (with at least one close relative with type I diabetes) examined whether early exposure to insulin in cow's milk formula increased the risk of type I diabetes. Results showed that infants given cow's milk formula at three months old had immune systems which reacted far more strongly to cow's insulin (7). This raises concerns that exposure to cow's insulin plays a role in the autoimmune process leading to type I diabetes.

Another environmental trigger in cow's milk is thought to be a protein called casein (8). Casein is similar in shape to the insulin producing cells in the pancreas. Because the body may see casein as a foreign invader and attack it, it may also start to attack the pancreas cells having confused them for casein; again leading to diabetes.

A review of the clinical evidence suggests that the incidence of type I diabetes is related to the early consumption of cow's milk; children with type I diabetes were more likely to have been breast-fed for less than three months and to have been exposed to cow's milk protein before four months of age (9). The avoidance of cow's 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 cow's milk.

### Plant-Based Sources of Calcium

There are many plant-based sources of calcium. Good sources include non-oxalate (see below) 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

Food (and serving size)	Calcium (milligrams)
Cauldron Foods Organic Plain Tofu (one pack - 250g)	500
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)	51
Brazil nuts (30g - a small handful)	87
Alpro Soya Milk (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

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 (3). For example, calcium absorbability from kale was demonstrated to be considerably higher than that from cow's milk (10). While spinach contains a relatively high amount of calcium, it is bound to a substance called oxalate which hinders calcium absorption (11) so it is important to obtain calcium from low-oxalate green vegetables. Grains, nuts and seeds contain a substance called phytic acid which until recently was also considered to hinder calcium absorption, now phytic acid is believed to have only a minor influence (12). Caffeine and smoking have been shown to reduce calcium absorption (13).

### 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 (14). Without sufficient vitamin D, calcium deficiency is likely to 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 (15). 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 now advised by the UK government that we apply sun block after 10 to 15 minutes exposure to the sun, this is so that we can synthesise vitamin D in the skin.

### Magnesium, Potassium, Vitamin C and Vitamin K

Magnesium, potassium, vitamin C and vitamin 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 (16).

### 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 calcium is lost from the bones and they become more fragile and prone to fracture. This debilitating condition tends to occur mostly in post-menopausal women due to a lack of the hormone oestrogen, which helps to regulate the incorporation of calcium into the bones. Osteoporosis tends to occur mostly among postmenopausal women aged between 51 and 75. It can occur earlier, or later and not all women are at equal risk of developing osteoporosis.

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 (17). 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, American women are among the biggest consumers of calcium in the world yet they have one of the highest levels of osteoporosis (18). 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 (19).

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 75000 women for 12 years and concluded that increasing milk consumption did not confer a protective effect against hip or forearm fracture. In fact the report suggested that an increased calcium intake from dairy foods was associated with a higher risk of fracture (20).

It has been suggested that calcium loss from the bone is promoted by a high intake of animal protein. One study of 1600 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 (21). Another study of 1035 elderly women found that women with a high ratio of animal to vegetable protein intake had a greater risk of hip fracture than those with a low ratio (22). 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 moderating the consumption of animal food might protect against hip fracture (23). Cross-cultural studies summarising data on protein intake and fracture rates from 16 countries compared industrialised and non-industrialised lifestyles and revealed strong links between a high animal protein diet, bone degeneration and the occurrence of hip fractures (24). 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 where a much higher ratio of animal to vegetable protein is consumed (25), again indicating a link between animal protein and bone degeneration.

But what is the mechanism for this process? As food is digested acids are released into the blood, the body attempts to neutralise the acid by drawing calcium from the bones. This calcium is then excreted in the urine (the calciuric response). 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 level of calcium in the urine. Studies reveal that an animal protein diet (with the same total quantity of protein as a vegetarian diet) confers an increased risk for uric acid stones (26). Furthermore the animal-protein induced calciuric response may be a risk factor for the development of osteoporosis. The traditional Inuit (or Eskimo) diet is made up almost entirely of animal protein. Inuits potentially have one of the highest calcium intakes in the world (up to 2,500 mg 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. (27, 28, 29).

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 (30). 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 (31). The discovery of 18th-century human bones under a London church revealed that today's women lose far more calcium than our ancestors (32). 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 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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