CALCIUM — AN UPDATE

By Pamela Mason, PhD, MRPharmS

According to United Kingdom dietary guidelines, it is difficult, though not impossible, to achieve an adequate calcium intake without consuming dairy produce. This article provides an update on this important mineral, detailing its functions and benefits together with the potential adverse effects of having too little or too much

Calcium is an essential mineral, accounting for 1–2 per cent of a person's body weight. About 99 per cent of this is found in bones and teeth where it has a structural and strengthening role. An adequate calcium intake is therefore important throughout life for optimising bone density and protection of the skeleton. The remaining 1 per cent, which is found in the blood and tissues, is crucial for muscle contraction, nerve transmission, blood clotting, enzyme activation and hormone function.

HOW MUCH DO WE NEED?

The United Kingdom's Department of Health last issued general recommendations for calcium intake in 1991 and dietary reference values (DRVs) are based largely on judgements of desirable rates of calcium accretion and retention. They vary by age, gender and life stage. Table 1 shows figures for the most frequently used DRV: reference nutrient intake (RNI).

TABLE 1: UK REFERENCE NUTRIENT INTAKES FOR CALCIUM

Age	mg/day
0-12 months	525
1-3 years	350
4-6 years	450
7-10 years	550
11-18 years (male)	1,000
11-18 years (female)	800
19-50 years	700
50+ years	700

Pregnancy, No increment
Lactation, +550mg/day

Contrary to what might be expected, UK RNIs are not set higher for pregnant women and the elderly, although there is some controversy about calcium requirements in both these groups. In pregnancy, additional requirements are partly offset by an increase in absorption, and in old age, additional calcium cannot entirely prevent the inevitable loss of bone mineral, but it can retard losses. Lactation results in the secretion of 200–250mg of calcium each day into breast milk, and much of this requirement is borrowed from the mother's bone. This loss does not seem to be prevented by supplementation with calcium and vitamin D[1], but a post-lactation anabolic phase allows recovery of bone density. However, whether this recovery is complete in all women is not known.

The European Union recommended daily amount (the figure used on dietary supplement labels) is 800mg. This is set at a level to represent the requirement of an average adult. The National Osteoporosis Society has produced separate recommendations, which are somewhat higher than the UK RNIs, advising, for example, that adults between the ages of 20 and 45 years should have a daily intake of 1,000mg and those over 45, 1,500mg (unless it is a woman on hormone replacement therapy, when the recommendation is for an intake of 1,000mg).

In the United States, recommended intakes are also higher than ours, with an adequate daily intake for a 19–50 year old set at 1,000mg, while for an individual over 50, the figure is 1,200mg. United States recommendations, which have increased over the years, have been criticised on the basis that the calcium intake of much of the world's population (eg, in Asia and Africa) is much lower, yet these populations develop and perform well without obvious signs of deficiency and osteoporosis is not as prevalent. However, bone mass is influenced by a number of variables other than calcium intake (eg, genetics, nutrition and other lifestyle factors), which may influence whether and when osteoporosis develops.

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WHAT IS CALCIUM INTAKE IN THE UNITED KINGDOM?

In the United Kingdom, average daily calcium intakes are about 900mg for men and 750mg for women, but evidence from national diet and nutrition surveys shows that some groups of the population, in particular, schoolchildren and older people, fail to achieve the RNI.

WHAT HAPPENS IF CALCIUM INTAKE IS INADEQUATE?

Calcium is a unique nutrient in that poor intakes do not normally compromise its biochemical functions (eg, muscle contraction, nerve transmission and blood clotting). This is because blood levels, and hence biochemical functions, are well protected by the calcium reserves in the skeleton and by the action of parathyroid hormone. If blood levels dip, parathyroid hormone directs the kidneys to excrete less calcium in the urine, stimulating production of the active form of vitamin D to increase calcium absorption from the intestine and also releasing some calcium from bone. However, low dietary intakes of calcium during adolescence and young adulthood may prejudice attainment of peak bone mass, which is usually achieved some time during the third decade of life.

WHAT ARE THE MAIN DIETARY SOURCES OF CALCIUM?

Milk products are the best sources of calcium in the British diet (see Panel 1). One glass of milk (whole, semi-skimmed or skimmed), a small pot of yoghurt or 40g of hard cheese each provides about 300mg of calcium.

Increasingly, many individuals stop consuming milk in the belief that they are allergic or intolerant to it. For the approximately 5 per cent of United Kingdom adults with lactose intolerance, milk products cause bloating, flatulence and diarrhoea. However, most people with this condition can consume small amounts of dairy produce

PANEL 1: DIETARY SOURCES OF CALCIUM

Excellent sources	
One glass of milk (whole, semi-skimmed or skimmed)	300mg
One glass of calcium fortified soya milk	200–300mg
50g Cheddar or Cheshire cheese	350mg
One glass of calcium-fortified orange juice	250-350mg
50g tofu	300mg
Good sources	
50g Brie or Camembert	200–250mg
50g canned sardines with bones	250mg
One tablespoon of sesame seeds	150mg
Other sources	
Two slices of white bread	70mg
Two slices of wholemeal bread	35mg
One serving of broccoli, spinach or other green vegetables	50–100mg
One serving of cooked beans (eg, baked beans, lentils, kidney beans, chick peas)	50–100mg
One orange	50mg

(eg, up to half a pint of milk a day), and there are also a growing number of lactose free milks on the market.

Other reasonable sources of calcium include canned sardines or canned salmon (with bones) and some nuts and seeds. Calcium is also found in green, leafy vegetables such as broccoli, kale and spring greens, and in oranges, although fairly large quantities of these foods are needed to achieve the RNI if no milk products are consumed. A growing number of food products have calcium added, including some brands of orange juice, bottled water, breakfast cereals and soya milk.

The calcium bioavailability of different foods varies to some extent, with phytate in wholegrain cereals and oxalates in green vegetables binding calcium and rendering it unabsorbable. Vitamin D increases absorption of calcium, but for those with limited exposure to sunlight (the main source of vitamin D in the United Kingdom), particularly older people, those with dark skins, and during pregnancy and lactation, a supplement providing 5–10µg daily is advisable. Infants and young children from the age of six months up to at least two years of age should also receive supplementary vitamin D in the form of paediatric vitamin drops.

ARE CALCIUM SUPPLEMENTS BENEFICIAL?

Calcium supplements are widely marketed for bone health, and there is some evidence that they may reduce the risk of osteoporosis. A recent review[2] of 139 studies published since 1975, which investigated the relationship between calcium intake and bone health, indicated that of the 37 randomised controlled trials (RCTs) involving adults, 35 showed that increasing calcium through diet or supplementation can reduce age-related bone loss or osteoporotic fractures. All 15 RCTs in children and adolescents showed that bone gain was greater in calcium-supplemented individuals than controls. This review also examined the role that high calcium intakes can play in individuals with already depleted skeletons. Although supplemental calcium cannot usually restore lost bone, it can act as an adjuvant to other therapy, such as hormone replacement therapy.

However, other researchers[3] have expressed doubts about the value of high calcium intakes for the treatment or prevention of osteoporosis or reduction in the frequency of fractures, partly because a large proportion of the world's population consumes low calcium diets without suffering excessive rates of fracture. The amount of calcium required to reduce the risk of osteoporosis and fracture is therefore controversial, and this is likely to be due to the interaction of the various factors that influence bone health. Those that have a positive effect include physical activity, oestrogen, vitamin D and vitamin K and at least one study has shown a strong positive correlation between bone mineral density in older men and women and fruit and vegetable intake.[4] Excessive intake of alcohol, caffeine, protein and sodium can increase calcium loss, a concern when calcium intakes are poor or marginal. Genetics also play a role and differences in the loss of bone density at the femoral neck in postmenopausal women have been shown to be associated with vitamin D receptor genotype.[5]

Calcium supplementation has also been shown to lower blood pressure. A meta-analysis of 33 RCTs[6] concluded that calcium (800–2,000mg daily) may lead to a small reduction in systolic blood pressure. Another meta-analysis of 22 RCTs[7] showed that supplements of 500–1,000mg daily produced a significant decrease in systolic but not diastolic blood pressure, but the authors concluded that the effect was too small to support the use of calcium supplements in hypertension.

Calcium supplementation may reduce the risk of colorectal cancer, but evidence is both weak and conflicting. High calcium intake (1,200–1,400mg daily) has been linked with reduced colon cancer risk in epidemiological studies and with reduced recurrence of adenomatous polyps. However, other studies have shown no effect of calcium supplementation on colorectal cell proliferation in subjects at high risk of colorectal cancer. There is preliminary evidence that calcium supplementation (1,000–2,000mg daily) can reduce menstrual symptoms, particularly pain.[8]

IS THERE A SAFE LIMIT FOR CALCIUM INTAKE?

The European Federation of Health Product Manufacturers and the United Kingdom Council for Responsible Nutrition have set an upper safe level for supplemental calcium at 1,500mg daily, which could be taken on a long-term basis. This figure has been established on the basis that a typical European diet is consumed. For comparison, the Food and Nutrition Board of the United States National Academy of Sciences has set a tolerable upper intake level of 2,500mg daily and recommends that intakes from food and supplements combined do not exceed this amount.

Adverse effects are unlikely at total intakes lower than 2,500mg. Indeed, calcium metabolism is under such tight control that accumulation from excessive intakes and hypercalcaemia is almost unknown. In the past, high calcium intakes were linked with kidney stones on the basis that if large amounts of calcium went into the urine, calcium oxalate stones could be formed. In fact, unabsorbed dietary calcium can bind to oxalate in the gut preventing oxalate absorption and thus lowering concentration in the urine. Although dietary oxalate accounts for less than a quarter of renal oxalate load, any reduction in this will decrease the risk of calcium stone formation.

Calcium interacts with many minerals in ways that may influence bioavailability. Thus, supplemental calcium can reduce iron and zinc absorption, but this is usually of little practical significance unless intakes of these minerals are inadequate. In general, it is not a good idea to take large quantities of any mineral on its own, but if, for example, both a calcium and iron supplement are used, it is best to take them a couple of hours apart to make sure that absorption of neither mineral is impaired.

There is some concern that high calcium intakes may increase the risk of prostate cancer. This is because a few studies[9] have associated high intake of dairy products with cancer. However, others have not[10] and on current evidence there is no reason to reduce calcium consumption or milk products in men on the basis of prostate cancer risk.

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