

Editorials

Dietary selenium: time to act

Low bioavailability in Britain and Europe could be contributing to cancers, cardiovascular disease, and subfertility

The essential trace element, selenium, which we largely obtain from bread and cereals, fish, poultry, and meat, plays a vital part in many metabolic functions. While new research increasingly suggests its relevance to disease prevention, evidence that dietary intake is falling in some parts of the world is giving cause for concern.

Selenium is a key component of a number of functional selenoproteins required for normal health. The best known of these are the antioxidant glutathione peroxidase enzymes, which remove hydrogen peroxide and damaging lipid and phospholipid hydroperoxides generated in vivo by free radicals and other oxygen derived species. If not removed, lipid hydroperoxides impair membrane structure and function¹ and cause blood clotting disturbances by decreasing the production of prostacyclin while increasing the production of thromboxane.² Furthermore, lipid hydroperoxides are not stable end products but, in the presence of transition metal ions, can decompose to give further reactive free radicals and cytotoxic aldehydes.³ Such secondary products may initiate more lipid peroxidation, promote atherosclerosis, damage DNA, and metabolically activate carcinogens.³

Selenium also plays an important role in the control of thyroid hormone metabolism. The iodothyronine deiodinases, which are responsible for the conversion of thyroxine (T4) to its active form, triiodothyronine (T3), are selenoenzymes.⁴ Selenium deficiency may cause reduced growth rates owing to a feedback response which lowers triiodothyronine mediated synthesis of growth hormone in the pituitary,⁵ while a combined deficiency of selenium and iodine exacerbates hypothyroidism.⁴

Selenium is important for proper reproductive performance. Sperm capsule selenoprotein is a structural selenoprotein found in the midpiece region of the sperm tail.⁶ In selenium deficiency, morphological anomalies in this region give rise to spermatozoa with impaired motility.⁷ Selenium is also needed for normal testosterone metabolism and testicular morphology, which may explain the presence of several other selenoproteins in the male gonads.⁷

The activity of these selenoproteins, and of others with as yet unidentified functions, depends on adequate selenium supply from the diet. Selenium enters the food chain through plants. Dietary intakes show a large geographical variation, mainly because of differences in selenium bioavailability, which is generally low in Europe. Areas of China where the soil is extremely low in selenium are associated with clear selenium deficiency diseases—an endemic cardiomyopathy (Keshan disease) and a deforming arthritis (Kashin-Beck disease).⁸ Less overt selenium deficiency has been shown in several studies to have adverse effects on susceptibility to many other disorders, including cardiovascular disease and cancers.^{3 8 9}

Evidence is accumulating that European intakes of selenium are falling. Some 22 years ago, selenium intakes in Britain were 60 µg/day,¹⁰ not high when compared with American intakes but very much higher than the 34 µg/day found in a survey undertaken for Britain's Ministry of Agriculture, Fisheries, and Foods in 1994¹¹ and at least approaching the British government's own defined reference nutrient intake of 75 µg/day for men and 60 µg/day for women. (The ministry has since commissioned further studies.)

Intakes and blood levels falling

This substantial fall in selenium intake can largely be explained by the drop in imports of selenium rich, high protein wheat for breadmaking flour from North America. Levies imposed on foreign imports when Britain joined the European Union, coupled with changes in breadmaking technology, have resulted in increased use of low selenium, lower protein European and British varieties. Parallel reductions in intake have occurred in other European Union countries for similar reasons; added to which, bioavailability of selenium may have fallen in areas subject to acid rain or excessive artificial fertilisation of soils, both of which reduce plant absorption of the mineral.

These falling intakes are reflected in diminishing serum and whole blood selenium concentrations^{12 13 14 15} (see figure 1). In a more recent British study, my colleagues and I found low mean serum selenium (50.8 (SD 17.3) µg/l) in third trimester healthy pregnant women in Oxford.² Similarly low values (47 (13) µg/l) were found in healthy Northern Irish pregnant women at delivery.¹⁶ While third trimester pregnancy accounts for an average fall of 28% in selenium concentrations (mean of nine European studies), these levels are nonetheless towards the lower end of a range of 21 world values measured at this stage in pregnancy (28-190 µg/l).

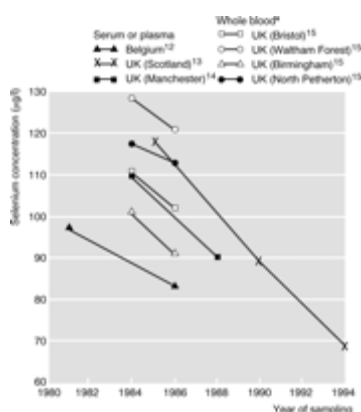


Fig 1 Decline in serum, plasma, or whole blood selenium concentrations with time. Whole blood concentrations are normally 10-25% higher than serum or plasma values; * measurements were made on same subjects in both years

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From a review of studies published between 1983 and 1993,¹² a mean value for serum selenium in seven European Union countries can be calculated as 79 µg/l, again towards the bottom of the range of study values (50-197 µg/l). Serum selenium values

of 100 µg/l are believed to be required for optimal activity of cytosolic glutathione peroxidase,¹⁷ an indicator of selenium repletion. Current values seem likely to be considerably below this threshold.

This reduced selenium status gives further cause for concern in the light of some new information. Beck and colleagues have shown that relatively harmless viruses can become virulent by passing through a selenium deficient host.¹⁸ This has been mooted as an explanation for the first appearance of HIV in Zaire, a country with a selenium deficient population, and for the appearance of new strains of influenza virus in China.¹⁸ A recent British study showed a significantly higher risk (P<0.005) of spontaneous abortions in women with low concentrations of serum selenium.¹⁹ Sperm motility improved from 17.5% to 35.1% (P<0.01) in subfertile men supplemented with selenium in a controlled double blind trial.²⁰ A recently completed study, which randomised 1312 patients to receive placebo or 200 µg of selenium a day, showed a 50% lower cancer mortality (P<0.002) in those receiving selenium.⁹

Is it not time to consider addressing the problem of low selenium intakes? In Britain virtually all farm animals get mineral supplements which have included selenium since 1978, when its efficacy in preventing animal disease was accepted. Should we humans be lagging so far behind? Perhaps it is time to consider measures such as those adopted in Finland, another country with low soil selenium, which has been adding sodium selenate to its fertilisers since 1984. Alternatively, addition of selenium to bread flour along with the statutory mineral additives of calcium and iron may be a possibility. In the meantime, judicious use of supplements (staying well below the toxic level of 800 µg/day) or a daily helping of Brazil nuts, the richest natural source of selenium, would seem our best option.

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