

Death in small doses

Exploring the dangers of bioaccumulation

Pulling off a successful Arctic expedition is difficult. In the 1590s, it was even harder – and one notorious mission to Novaya Zemlya, an archipelago to the north of Russia, wasn't helped by an unusual malady. It affected three men particularly gorily: they were “exceeding sicke”, wrote Dutch officer Gerrit de Veer, “and we verily thought that we should have lost them, for all their skins came of [sic] from the foote to the head”.

The cause of the crew's skin loss (or 'desquamation') was their dinner. Owing to a shortage of supplies – and their inability to catch one of the seals near the camp – the men had killed a polar bear and unsuspectingly cooked and eaten its toxic liver. It's long been known that polar bear livers aren't safe to eat, but it wasn't until 1943 that the researchers Rodahl and Moore identified the problem as the livers' exceptionally high vitamin A content.

Vitamin A is fat-soluble and is chiefly stored in the liver. Too little of it in our diets can cause serious eye problems, including blindness, and an impaired immune system. Too much, and we're at risk of a long list of symptoms that includes desquamation, bone pain and an increased sensitivity to sunlight.

Most serious clinical cases of vitamin A overdose involve consuming a large amount in a short time. The effects of less drastic but long-term over-consumption are harder to judge, but a 2012 review of the evidence noted that vitamin A supplements in Western diets were “significantly associated with increased mortality”.

Heavy metal

“Most of us should have more fish in our diet,” says the NHS Choices website. However, it adds, “there are maximum recommended amounts for oily fish, crab and some types of white fish”, particularly for pregnant or breastfeeding women. Why? Because of mercury.

Mercury is one of several toxic heavy metals that can accumulate in human soft tissues such as fat. Mercury poisoning primarily affects the central nervous system. It kills neurons and glial cells, causing problems with sight, speech, hearing and coordination. At worst, it can end in coma or death.

Fish consumption guidelines specifically address pregnant or breastfeeding women – or, in some cases, all women who might want children one day – because mercury especially affects developing fetuses and infants. A small child's body is less able than an adult's to handle the mercury in a serving of fish, and mercury can cross the placenta and affect fetuses in the womb.

ABOUT THIS RESOURCE

This resource first appeared in 'Big Picture: Fat' in January 2016. Published by the Wellcome Trust, a charity registered in England and Wales, no. 210183.

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How does mercury get into fish? Initially, mercury (or, more accurately, the form of mercury known as 'methylmercury') is present in the water. It's absorbed by algae, which is eaten by small fish; the small fish are eaten by larger fish higher up the food chain. Because of so-called biomagnification, larger fish are likely to contain a higher concentration of mercury in their bodies.

Methylmercury has a half-life of about 70 days and the fish don't excrete it, so it accumulates in the predator species. Modern shrimp, for example, [contain](#) an average of 0.1 parts per million (ppm) methylmercury, mackerel about 0.3 ppm and sharks more than 1.0 ppm.

Evidence for the harmful effects of mercury on people comes from disasters like the Japanese Minamata Bay poisoning of the 1950s, which began when the Chisso chemical plant dumped wastewater contaminated with mercury into the bay. This mercury entered the food chain and accumulated in higher predators.

The larger fish were then eaten by people. Many women in the region developed symptoms of mercury poisoning, although these were mostly minimal. But their children had serious neurological problems and were diagnosed with so-called 'Minamata disease' – essentially severe heavy metal poisoning.

REFERENCES

- ['The Polar Regions' by John Richardson \(1861\)](#)
- [The vitamin A content and toxicity of bear and seal liver \(1943\)](#)
- [Antioxidant supplements for prevention of mortality \(2012\)](#)
- [NHS Choices: Fish and shellfish](#)
- [University of Minnesota: Health effects of mercury exposure](#)
- [Food and Agriculture Organization: Food additives](#)
- [The toxicology of mercury \(2002\)](#)

QUESTIONS FOR DISCUSSION

- Animals with high levels of vitamin A in their livers include polar bears, arctic foxes, bearded seals and glaucous gulls. What else do these animals have in common?
- Prenatal methylmercury exposure has been linked to lower childhood IQ in several studies – but oily fish are the most widely available source of long-chain omega-3 fatty acids, so it's recommended pregnant or breastfeeding women eat them to help the baby's nervous system to develop. Do you think pregnant and breastfeeding women should eat oily fish? If so, how much?
- DDT (dichlorodiphenyltrichloroethane), like mercury, is a fat-soluble substance that biomagnifies. Look up DDT on the internet and compare the two: how else are they similar, and how are they different? Which do you think is more dangerous for humans?

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