Iron supplements in the fight against lead

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Less lead in the blood: Moroccan schoolchildren benefit from iron fortified biscuits. (Photograph: www.pixabay.com, CC0 Public Domain)

Targeted iron supplements in biscuits can achieve a striking reduction in the level of lead in children's blood in regions with high exposure to this toxic heavy metal. This has been demonstrated for the first time by an ETH-led research group in a study of schoolchildren in Morocco.

Lead is a toxic heavy metal that was added to petrol for use in cars until as recently as 25 years ago. It is particularly harmful to the developing brains of infants, children and teenagers, and the damage it does is irreversible.

The situation becomes significantly worse if people are exposed to a

high level of lead at the same time as they are suffering from iron deficiency. In the small intestine, lead and iron bind to the same transport protein, which absorbs the metals into the bloodstream. If someone consumes too little iron with their food, the transporter increases its activity, and can carry lead into the bloodstream instead, leading to increased levels of the toxic heavy metal in the body and brain.

450 Moroccan schoolchildren examined

A team of researchers led by ETH professor Michael B. Zimmermann from the Laboratory of Human Nutrition have now shown in a study that fortifying food with iron produces a striking reduction in blood lead concentration in children exposed to high levels of the metal.

This is the result of a trial involving over 450 children carried out by Zimmermann's former doctoral student Raschida Bouhouch and colleagues in southern Morocco. It is the first controlled prospective study to investigate the connection between iron deficiency and lead poisoning and to demonstrate that iron fortification can reduce blood lead levels. The study came about within the framework of a North-South project conducted by ETH Zurich and the University and University Hospital of Marrakesh.

Mining in the surrounding area meant that children of preschool and school age were exposed to an increased quantity of lead. At the same time, the level of iron in their blood was relatively low, placing them in a high-risk group.

Biscuits with iron

Depending on their weight, the children were given several white-flour

biscuits on a daily basis for a period of four and a half months. The biscuits were fortified with different iron preparations: some received biscuits containing a specific quantity of iron sulphate, while others received biscuits with sodium iron EDTA or sodium EDTA without iron. To test the effect of the iron supplements, some children received only placebo biscuits containing no additional iron.

EDTA, which stands for ethylene diamine tetraacetic acid, forms stable complexes with iron, aiding its uptake into the bloodstream from the intestines, but it is not absorbed itself. EDTA can also bind to lead in the intestines, reducing its absorption. In Europe, the compound is approved as food additive E385 in emulsified sauces and foods preserved in tins and jars. Sodium iron EDTA has already been used for iron fortification in foodstuffs for many years.

The researchers measured the children's blood lead concentration and iron status before and after the trial, as well as conducting tests to determine how well the children could solve cognitive tasks.

A positive effect on lead concentration

The researchers were delighted to find that the biscuits fortified with iron did indeed reduce the level of lead in the blood - specifically, by a third with sodium iron EDTA complexes and by a quarter with EDTA and iron sulphate.

Before the study began, the children's blood contained on average 4.3 micrograms of lead per decilitre. Biscuits with added sodium iron EDTA facilitated a reduction in blood lead concentration to 2.9 micrograms per decilitre. The biscuits also brought about an improvement in the children's iron status. On the other hand, the reduction in lead concentration had no effect on cognitive performance, as the researchers discovered during the corresponding tests.

Nevertheless, Zimmermann is very happy with the study's results: "The finding - that you can reduce blood lead concentration in exposed individuals with just a short intervention - is hugely significant for public health services," says the ETH professor.

Although, contrary to the researchers' expectations, the children's blood lead concentration before supplementation with iron was in line with the worldwide average at 4.3 micrograms per decilitre of blood, it was still possible to achieve a considerable reduction by administering the biscuits.

Zimmermann attributes the lack of improvement in cognitive performance to the fact that lead leaves behind lasting damage that cannot be reversed by administering iron. "Nevertheless, it definitely makes sense to use iron fortification to prevent brain damage in exposed sectors of the population," says the nutrition specialist. Iron supplementation may even provides foetuses in the womb with effective protection against subsequent brain damage.

As the base level of lead in the schoolchildren in the study corresponds to the worldwide average, Zimmermann says the results offer good transferability to other regions and population groups.

The tool of choice: NaFeEDTA

Based on these findings, he recommends using sodium iron EDTA to fortify foodstuffs in areas where lead poisoning and iron deficiency are common, and iron fortification is already used in food. "This is the most effective way to reduce the level of lead in the bloodstream." Although it is more expensive than iron sulphate, it also works better.

Lead contamination of food and water is still a serious problem in mining and heavy industry areas in Africa, India and China, but the issue

is not yet resolved even in industrialised Western countries. The discussion has flared up in Flint, Michigan (USA), where the drinking water is contaminated with lead because inhabitants are supplied with water that flows through lead pipes. The pipes should have been replaced a long time ago.

More information: R. R. Bouhouch et al, Effects of wheat-flour biscuits fortified with iron and EDTA, alone and in combination, on blood lead concentration, iron status, and cognition in children: a double-blind randomized controlled trial, *American Journal of Clinical Nutrition* (2016). DOI: 10.3945/ajcn.115.129346

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