

## **MICRONUTRIENTS**

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During the last decade, the international nutrition community has focused on eliminating or reducing three micro-nutrient deficiencies. At the World Summit for Children in 1990, followed by the Ending Hidden Hunger conference in 1991 and the International Conference on Nutrition in 1992, agencies and governments pledged to eliminate iodine and vitamin A deficiencies by 2000 and to substantially reduce iron deficiency anemia. As a result, about 70 percent of all salt is now iodized and half the countries in the world have vitamin A capsule distribution programs reaching a high percentage of women and children under 5 years. Efforts to reduce anemia have been less successful, but iron-folic-acid supplements are available to millions of pregnant women.

The international nutrition community focused on these three micronutrient deficiencies for logical reasons--they allowed relatively simple, inexpensive solutions with far-reaching health benefits. Iodine deficiency adversely affects intelligence, motor development, and pregnancy outcomes. Common in both industrialized and developing countries, this deficiency can be prevented by salt iodization. Interest in alleviating vitamin A deficiency increased in the 1980s, when researchers found that periodic high doses of vitamin A to young children in developing countries substantially reduced their risk of dying from measles. Iron deficiency is thought to be the most common nutrient deficiency in the world, and iron deficiency anemia slows mental and motor development and reduces work performance and physical activity. Progress in combating iron deficiency has been hindered by technological limits on iron fortification of staple foods and the need to supply iron supplements on an almost daily basis for them to be effective.

### **FOCUSING ON OTHER MICRONUTRIENT DEFICIENCIES**

The focus on these three micronutrients partly explains why relatively little attention has been paid to other, "neglected" micronutrients. Poorer populations, however, usually suffer also from inadequate intakes of zinc, riboflavin, vitamin B-12, vitamin B-6, and calcium because they consume few animal products (meat, fish, poultry, eggs, or dairy products). Poor diets may also contain few fruits and a limited variety of vegetables and, therefore, low amounts of B-carotene (provitamin A), folic acid, and vitamin C. Surveys show that many individuals--especially women and children--are consuming lower than recommended amounts of the neglected micronutrients. But there have been relatively few studies of the prevalence of these micronutrient deficiencies or of how they cluster in specific populations. Limited data show that zinc, riboflavin, and vitamin B-12 deficiencies tend to cluster with vitamin A and iron deficiencies.

**Zinc.** No good indicators of zinc status exist, although plasma zinc concentrations fall if deficiency is sufficiently severe and/or prolonged. Interest in zinc was stimulated when zinc supplements given to short children and failure-to-thrive infants in the U.S. city of Denver improved growth. Many investigators then mounted zinc intervention trials with children, because intakes of absorbable zinc are often low and growth-stunting occurs nearly universally during the first two years of life in underprivileged populations. Diarrhea also causes the body to lose zinc. An analysis of 27 such trials concluded that zinc supplements are likely to improve the height gain of the most stunted children and to improve the weight gain of those with low plasma zinc concentrations. In recent intervention trials, zinc supplements reduced the prevalence of pneumonia and malaria in children, shortened the duration of acute and persistent diarrhea, and improved neuropsychological performance. Zinc supplements improved birth weight in one U.S. study, although in Bangladesh and Peru they did not.

**Riboflavin.** In the relatively few studies of riboflavin the prevalence of deficiency has been alarmingly high. Almost all the pregnant and lactating women studied in The Gambia, the majority of lactating women and elderly in Guatemala, and most Chinese adults were reported to be deficient. A high seasonal prevalence of clinical symptoms of deficiency has been reported in Iran. The adverse

consequences of riboflavin deficiency are not yet well understood, although the reduced absorption and use of iron for hemoglobin synthesis reported in several studies suggests that riboflavin deficiency may contribute to the global prevalence of anemia. Riboflavin deficiency also may cause night blindness and muscle weakness.

Vitamin B-12. Because vitamin B-12 is found only in animal products, many poor populations, or those that avoid animal products for religious or other reasons, consume little or no vitamin B-12. Low serum B-12 concentration is associated with a higher risk of potentially irreversible harm to memory, cognitive function, and nerve conduction, as well as a higher risk of megaloblastic anemia. Studies among low-income people in Guatemala, Mexico, Nepal, Venezuela, and other countries show that 25 to 50 percent of individuals are deficient. Inadequate B-12 during pregnancy and/or lactation can cause breast milk to have such a low concentration of the vitamin that the infant grows too slowly and is developmentally delayed.

In addition to a diet low in animal products, risk factors for vitamin B-12 deficiency include infection with the bacteria *Helicobacter pylori* (a very common infection in populations living in poor sanitary conditions) or the parasite *Giardia*, and an overgrowth of bacteria in the upper intestine. Given that about 25 percent of the elderly in the United States have vitamin B-12 deficiency, a very high percentage of the elderly in developing countries must be deficient in this vitamin.

Other B vitamins. The prevalence of other B-vitamin deficiencies is unknown. Due to thiamin (vitamin B-1) fortification programs, this vitamin deficiency is no longer common in populations whose staple food is polished white rice. Poor vitamin B-6 status has been reported among Indonesian schoolchildren and in the Vietnamese population. In an Egyptian study, breast-milk concentrations of this vitamin were low, indicating that lactating women were deficient; mothers and infants both had abnormal behaviors associated with B-6 deficiency. In general, mothers with low stores or intakes of the B vitamins secrete inadequate amounts of these vitamins in their milk to support optimal child health and development.

Folic acid. The global prevalence of folic acid deficiency is uncertain. Folate consumption by the poor in developing countries actually may be better than in industrialized countries because legumes and many leaves are rich sources of this nutrient. Folic acid has long been included in iron supplements for pregnant women in developing countries, based on limited evidence that folic acid improved hemoglobin response to iron in Africa and India. Subsequent trials, however, failed to show that adding folic acid improved anemia more than iron alone. Folic acid supplements for pregnant women can reduce the risk of infants' having neural tube defects, but only if the supplements are taken by susceptible women around the time of conception. Recent evidence suggests that poor maternal folate status is also associated with a higher risk of abnormal pregnancy outcomes, including eclampsia, premature delivery, and birth defects such as club foot and cleft palate. Consuming more folic acid from supplements or folate from foods can also lower plasma homocysteine and potentially lower the risk of cardiovascular disease in adults and dementia in the elderly.

Calcium, vitamin D, and selenium. The extent of calcium, vitamin D, and selenium deficiency in developing countries is uncertain. Calcium consumption is extremely low in many locations where dairy products and fish are not eaten, but humans have the capacity to absorb calcium more efficiently in these situations. Very low calcium consumption does not seem to impair children's growth, but may reduce their bone mineralization. Low dietary calcium may be the explanation for non-vitamin D rickets in Nigeria, South Africa, and several other countries. Calcium deficiency is certainly a risk factor for osteoporosis in later life. Vitamin D deficiency, which is caused primarily by low exposure to ultraviolet light, is common in more northern and southern latitudes and in regions where infants and women are heavily clothed for cultural or religious reasons. In Europe and China, where few foods are fortified with vitamin D, infants born at the end of winter commonly show evidence of vitamin D deficiency. Selenium deficiency is localized in specific but large geographic regions, including China and parts of Africa, where it can exacerbate the symptoms of iodine deficiency and interfere with the anti-goiter benefits of iodine supplements.

Focusing on the elimination or reduction of iodine, vitamin A, and iron deficiencies has motivated many agencies and governments to work together and has demonstrated the benefits of intervention programs. Clearly, efforts are also needed to assess the prevalence of other micronutrient deficiencies. Several ongoing trials will evaluate the impact of providing multiple micronutrients to children and women in developing countries. The addition of other micronutrients adds relatively little to a supplement's price, most of which reflects the cost of packaging and distribution. The same obstacles to lowering the prevalence of iron deficiency, however, will plague the effectiveness of multiple-micronutrient programs.

### **SUSTAINABLE SOLUTIONS**

The sustainable solution to multiple micronutrient deficiencies must be the discovery and implementation of innovative, affordable ways to improve poor people's diets. This probably will require consumption of more animal products, where these are culturally acceptable. Fortified foods are another logical strategy. Even in the United States, flours and cereal products are enriched with iron, riboflavin, niacin, folic acid, and sometimes calcium. The importance of food-based strategies to reduce micronutrient malnutrition is recognized by agencies and governments; however, there has been little effective communication between the nutrition community and agricultural producers. The latter group tends to believe that the answer to good nutrition is to produce more income-generating crops, when it would be more effective to consider the impact of agricultural products themselves on the nutritional needs of populations. Additional interaction is needed to bridge the gap between food production and nutrition security.

Failure to address the problem of these neglected nutrients will mean that a high proportion of the world's population--especially infants, children, women of reproductive age, and the elderly--will continue to suffer the consequences of micronutrient deficiencies. When the potential improvement in human capital is considered, investing in the prevention of micronutrient deficiencies is indeed cost-effective.

For further reading see L.H. Allen, "Nutritional Influences on Linear Growth: A General Review," *European Journal of Clinical Nutrition* 48 (Suppl. 1, 1994): S75-89; R.E. Black, "Zinc for Child Health," *American Journal of Clinical Nutrition* 68 (1998): 409S-516S; and U. Ramakrishnan, "Micronutrients and Pregnancy Outcome: A Review of the Literature," *Nutrition Research* 19 (1999): 103-159.

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