

Human Health



IAEA Support for the Use of Stable Isotope Techniques to Assess Micronutrients

SUMMARY

1. Good nutrition calls for more than just carbohydrates, protein and fat. Humans may eat enough calories to live but still have a diet that fails to provide sufficient levels of crucial vitamins and minerals, also known as micronutrients, which allow them to be physically and mentally healthy.
2. In many low- and middle-income countries (LMICs), diets are largely plant-based. Besides nutrients, plant-based foods contain naturally occurring compounds that limit the absorption of micronutrients.
3. Capacity for assessing the absorption of minerals and vitamin A status is needed to determine diet quality and to design interventions to improve it.
4. The IAEA provides support in using stable isotope techniques to assess the absorption and retention of essential vitamins and minerals, such as vitamin A, iron and zinc.

INTRODUCTION

Micronutrients are a class of nutrients needed by the body in small amounts on a regular basis to ensure good health, growth and development. They are important ingredients in the utilization of the major nutrients (protein, carbohydrates and fat) by the body. Important bodily functions, such as red blood synthesis, enzyme function, bone strength development, immunity and vision, depend on micronutrients. Micronutrients include all vitamins, as well as some minerals, such as zinc, iron, chromium, copper, manganese and iodine.

A lack of essential vitamins and minerals often results in 'hidden hunger', where the signs of undernutrition



A child is dosed with vitamin A labelled with a stable isotope.

(Photo: A. Dhansay/South Africa)

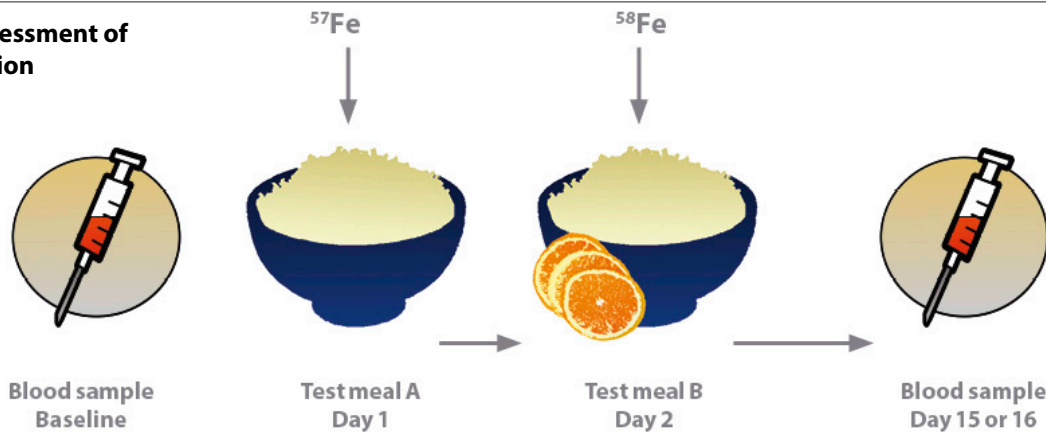
are less visible and people may not even be aware of it. Hidden hunger has been estimated to affect as many as two billion people globally¹.

Hidden hunger can impair the mental and physical development of children and adolescents and result in lower IQ, stunting and blindness; women and children in LMICs are especially vulnerable.

The IAEA supports countries in using stable isotope techniques to combat micronutrient malnutrition. These techniques can be used to assess diet quality in terms of micronutrient absorption and an individual's micronutrient status.

¹WORLD HEALTH ORGANIZATION, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Guidelines on food fortification with micronutrients (2006) apps.who.int/iris/bitstream/handle/10665/43412/9241594012_eng.pdf

Figure 1: Assessment of iron absorption



CHALLENGES

Maintaining diet quality involves eating a diversified, balanced and healthy diet, which provides energy and all the essential nutrients for growth and a healthy, active life. Diet quality also refers to food consumed, in terms of both the amount of nutrients and the use of specific nutrients from foods to support bodily functions.

However, there are considerable gaps in knowing how many people experience different forms of micronutrient deficiency in the world today².

Micronutrients are sometimes limited in human diets, largely due to high intakes of energy-dense, nutrient-poor staple foods. In LMICs, for example, many individuals do not have the resources to purchase, or cannot access, a wide range of nutritious foods, such as meat, eggs and fish, as well as fruit and vegetables, which are necessary to meet their nutritional requirements — and this leads to health risks.

STEPS TO ENHANCE THE INTAKE OF MICRONUTRIENTS

- Deficiencies in micronutrients, especially in vitamin A, iron and zinc, can be addressed

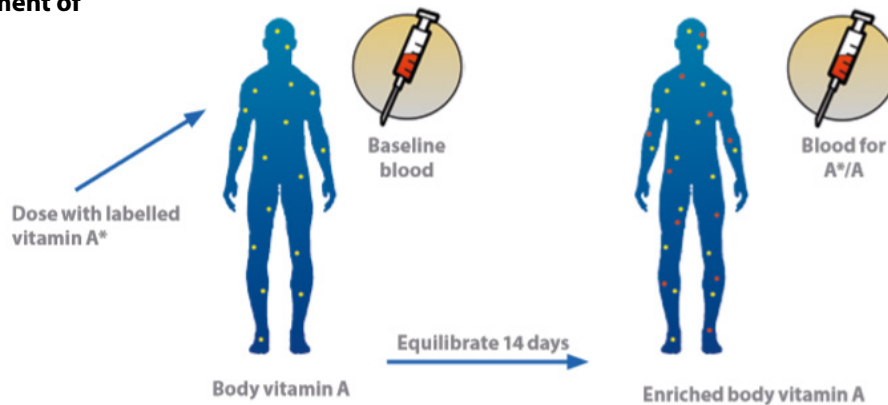
through public health interventions, including supplementation, food fortification, biofortification or switching to a more diverse diet.

- Micronutrient supplementation provides one or more micronutrients daily or periodically in liquid, tablet or capsule form. For example, high dose vitamin A supplements are given every 6 months to children between 6 and 59 months to prevent mortality in areas where vitamin A deficiency is prevalent.
- Food fortification focuses on adding micronutrients in recommended amounts to regularly consumed foods, such as cereal grains and cooking oil, during processing.
- Biofortification is the process by which the nutritional quality of staple crops is enhanced through breeding. Biofortified crops accumulate higher levels of minerals and vitamins in their seeds and roots during growth.
- Another effective strategy is the promotion of dietary diversification or consumption of a wide variety of foods from nutritionally distinct food groups.

It is imperative to be able to evaluate the effectiveness of such interventions in improving diet quality, especially with reference to micronutrient absorption.

²DEVELOPMENT INITIATIVES, Global Nutrition Report: Shining a light to spur action on nutrition (2018) globalnutritionreport.org/reports/global-nutrition-report-2018/.

Figure 2: Assessment of vitamin A status



STABLE ISOTOPES HELP TO ASSESS THE ABSORPTION OF MINERALS AND VITAMIN A STATUS

Techniques involving stable, i.e. non-radioactive, isotopes are highly specific and sensitive reference methods that can be employed to assess iron and zinc absorption from different foods or from mixed diets, to understand the conversion of pro-vitamin A to vitamin A in the body and to estimate quantitatively the total body vitamin A stores as a measure of vitamin A status. Stable isotope techniques can also be used to quantify how much breast milk is consumed by infants. When this information is combined with the micronutrient content of breast milk, the infants' micronutrient intake can be estimated.

For example, to assess iron absorption, a test meal is labelled with a stable isotope of iron (^{57}Fe). A blood sample is drawn before a person consumes the labelled test meal and another is drawn after the meal is consumed (see Figure 1).

Figure 1 illustrates a possible study design to compare iron absorption after consumption of a cereal-based meal and the same meal with an orange, which contains vitamin C — an enhancer of iron absorption.

The ratios of stable iron isotopes before and after consumption of the test meals are used to determine the amount of iron absorbed from the meals and fused into the red blood cells, thus revealing the effect

of factors present in the meals enhancing or inhibiting iron absorption.

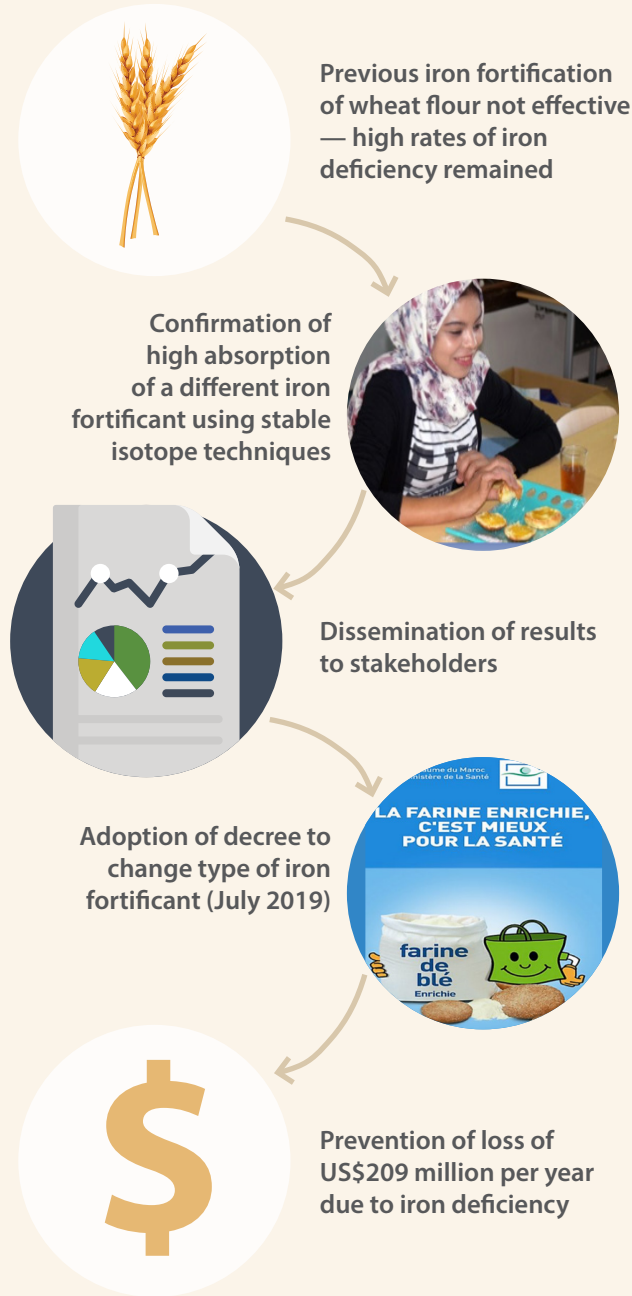
To assess total body vitamin A stores, a dose of vitamin A labelled with a stable isotope is administered after a baseline blood sample has been collected. A period of equilibration of the dose with the unlabelled vitamin A already present in the body is necessary before the follow-up blood sample is taken for analysis using mass spectrometry. From the dilution of the precisely measured dose of isotope-labelled vitamin A, it is possible to calculate the total amount of vitamin A present in the body. Figure 2 illustrates this principle.

IAEA SUPPORT

The IAEA seeks to foster the development and widespread use of stable isotope techniques in Member States. The IAEA builds and strengthens capacities for evidence-based nutrition programming using stable isotope and related techniques. It further supports research on stable isotope techniques through coordinated research projects. It assists Member States in, for example, using stable isotope techniques to assess diet quality and its impact on health.

Data generated through IAEA-supported studies have been used to inform national staple food fortification programmes and to assess the efficacy and effectiveness of interventions addressing micronutrient deficiencies.

Figure 3: Supporting government policy in Morocco to address micronutrient deficiencies



SNAPSHOT OF ACHIEVEMENTS

An IAEA project in Thailand has demonstrated the value of assessing vitamin A stores in the body using a stable isotope technique. Children who consumed rice fortified with iron, zinc and vitamin A had significantly increased total body vitamin A stores, which would not have been detected with other methods.

An IAEA-supported study in Morocco (2016–2017) confirmed the selection of the most absorbable form of iron to be used in the national wheat flour fortification programme to effectively reduce iron deficiency. These results will contribute to solving the iron deficiency problem in Morocco, where a decree to change the type of iron fortificant in wheat flour was signed by the Head of Government in July 2019 (see Figure 3).

AREAS WHERE MEMBER STATES MAY BENEFIT FROM IAEA ASSISTANCE

- Better understanding the role of stable isotope techniques in micronutrient studies.
- Building capacity through training on how to use these techniques to evaluate and improve national nutrition programmes.
- Participating in IAEA research projects to assess micronutrient absorption and status.
- Establishing effective and sustainable strategies and interventions based on locally available, fortified and biofortified foods to prevent and combat micronutrient deficiencies.

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