Vitamin and mineral requirements in human nutrition

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Foreword

In the past 20 years, micronutrients have assumed great public health importance. As a consequence, considerable research has been carried out to better understand their physiological role and the health consequences of micronutrient-deficient diets, to establish criteria for defining the degree of public health severity of micronutrient malnutrition, and to develop prevention and control strategies.

One of the main outcomes of this process is greatly improved knowledge of human micronutrient requirements, which is a crucial step in understanding the public health significance of micronutrient malnutrition and identifying the most appropriate measures to prevent them. This process also led to successive expert consultations and publications organized jointly by the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO) and the International Atomic Energy Agency (IAEA) providing up-to-date knowledge and defining standards for micronutrient requirements in 1973[1], 1988[2] and in 1996[3]. In recognition of this rapidly developing field, and the substantial new advances that have been made since the most recent publication in 1996, FAO and WHO considered it appropriate to convene a new expert consultation to re-evaluate the role of micronutrients in human health and nutrition.

To this end, background papers on the major vitamins, minerals and trace elements were commissioned and reviewed at a Joint FAO/WHO Expert Consultation (Bangkok, 21–30 September 1998). That Expert Consultation was assigned three main tasks:

- Firstly, the Consultation was asked to review the full range of vitamin and mineral requirements—19 micronutrients in all—including their role in

[1] *Trace elements in human nutrition. Report of a WHO Expert Committee*. Geneva, World Health Organization, 1973 (WHO Technical Report Series, No. 532).
[2] *Requirements of vitamin A, iron, folate and vitamin B_{12}. Report of a Joint FAO/WHO Expert Consultation*. Rome, Food and Agriculture Organization of the United Nations, 1988 (FAO Food and Nutrition Series, No. 23).
[3] *Trace elements in human nutrition and health*. Geneva, World Health Organization, 1996.

normal human physiology and metabolism, and conditions of deficiency. This included focusing on and revising the requirements for essential vitamins and minerals, including vitamins A, C, D, E, and K; the B vitamins; calcium; iron; magnesium; zinc; selenium; and iodine, based on the available scientific evidence.

- Secondly, the Consultation was asked to prepare a report that would include recommended nutrient intakes for vitamins A, C, D, E, and K; the B vitamins; calcium; iron; magnesium; zinc; selenium; and iodine. The report should provide practical advice and recommendations which will constitute an authoritative source of information to all those from Member States who work in the areas of nutrition, agriculture, food production and distribution, and health promotion.
- Thirdly, the Consultation was asked to identify key issues for future research concerning each vitamin and mineral under review and to make preliminary recommendations on that research.

The present report presents the outcome of the Consultation combined with up-to-date evidence that has since become available to answer a number of issues which remained unclear or controversial at the time of the Consultation. It was not originally thought that such an evidence-based consultation process would be so controversial, but the reality is that there are surprisingly few data on specific health status indicators on which to base conclusions, whereas there is a great deal of information relative to overt deficiency disease conditions. The defining of human nutrient requirements and recommended intakes are therefore largely based on expert interpretation and consensus on the best available scientific information.

When looking at recommended nutrient intakes (RNIs) in industrialized countries over the last 25 years, it is noticeable that for some micronutrients these have gradually increased. The question is whether this is the result of better scientific knowledge and understanding of the biochemical role of the nutrients, or whether the criteria for setting requirement levels have changed, or a combination of both. The scientific knowledge base has vastly expanded, but it appears that more rigorous criteria for defining recommended levels is also a key factor.

RNIs for vitamins and minerals were initially established on the understanding that they are meant to meet the basic nutritional needs of over 97% of the population. However, a fundamental criterion in industrialized countries has become one of the presumptive role that these nutrients play in "preventing" an increasing range of disease conditions that characterize affected populations. The latter approach implies trying to define the notion of

"optimal nutrition", and this has been one of the factors nudging defined requirements to still higher levels.

This shift in the goal for setting RNIs is not without reason. The populations that are targeted for prevention through "optimal nutrition" are characterized by sedentary lifestyles and longer life expectancy. The populations in industrialized countries are ageing, and concern for the health of the older person has grown accordingly. In contrast, the micronutrient needs of population groups in developing countries are still viewed in terms of millions experiencing deficiency, and are then more appropriately defined as those that will satisfy basic nutritional needs of physically active younger populations. Nevertheless, one also needs to bear in mind the double burden of under- and overnutrition, which is growing rapidly in many developing countries.

Concern has been raised about possible differences in micronutrient needs of populations with different lifestyles for a very practical reason. The logic behind the establishment of micronutrient needs of industrialized nations has come about at the same time as a large and growing demand for a wide variety of supplements and fortificants, and manufacturers have responded quickly to meet this market. This phenomenon could easily skew national strategies for nutritional development, with an increased tendency to seek to resolve the micronutrient deficiency problems of developing countries by promoting supplements and fortification strategies, rather than through increasing the consumption of adequate and varied diets. Higher levels of RNIs often set in developed countries can easily be supported because they can be met with supplementation in addition to food which itself is often fortified. In contrast, it often becomes difficult to meet some of the micronutrient needs in some populations of developing countries by consuming locally available food, because foods are often seasonal, and neither supplementation nor fortification reach vulnerable population groups.

Among the nutrients of greatest concern is *calcium*; the RNI may be difficult to meet in the absence of dairy products. The recently revised United States/Canada dietary reference intakes (DRIs) propose only an acceptable intake (AI) for calcium instead of a recommended daily allowance (RDA) in recognition of the fact that intake data are out of step with the relatively high intake requirements observed with experimentally derived values.[1]

Another nutrient of concern is *iron*, particularly during pregnancy, where supplementation appears to be essential during the second half of pregnancy.

[1] Food and Nutrition Board. *Dietary reference intakes for calcium, phosphorus, magnesium, vitamin D, and fluoride*. Washington, DC. National Academy Press. 1997.

Folic acid requirements are doubled for women of childbearing age to prevent the incidence of neural tube defects in the fetus. Conversion factors for carotenoids are under review, with the pending conclusion that servings of green leafy vegetables needed to meet *vitamin A* requirements probably need to be at least doubled. In view of this uncertainty, only "recommended safe intakes" rather than RNIs are provided for this vitamin.

Selenium is the subject of growing interest because of its properties as an antioxidant. The RNIs recommended herein for this micronutrient are generally lower than those derived by the United States Food and Nutrition Board because the latter are calculated on a cellular basis, whereas the present report relies on more traditional whole-body estimates.[1]

Are these "developments" or "new understandings" appropriate for and applicable in developing countries? The scientific evidence for answering this question is still emerging, but the time may be near when RNIs may need to be defined differently, taking into account the perspective of developing countries based on developing country data. There may be a need to identify some biomarkers that are specific to conditions in each developing country. There is therefore a continuing urgent need for research to be carried out in developing countries about their specific nutrient needs. The current situation also implies that the RNIs for the micronutrients of concern discussed above will need to be re-evaluated as soon as significant additional data are available.

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[1] Food and Nutrition Board. *Dietary reference intakes for vitamin C, vitamin E, selenium and carotenoids. A report of the Panel on Dietary Antioxidants and Related Compounds.* Washington, DC, National Academy Press, 2000.

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