

## Chapter 1

# Introduction

A Joint Food and Agriculture Organization of the United Nations/World Food Organization of the United Nations (*FAO/WHO*) expert consultation on human vitamin and mineral requirements was held in the FAO Regional Office for Asia and the Pacific, Bangkok, Thailand, from 21 to 30 September 1998. The purpose of the consultation was to complement the information, which had been provided through previous consultations for different nutrients, in order to provide current knowledge on all essential nutrients as the first step towards the production of a new edition of the *manual on human nutritional requirements*.

### Background

The Secretariat of the FAO and WHO organized the *joint FAO/WHO expert consultation on human vitamin and mineral requirements* to review the FAO/WHO micronutrient requirements and to develop recommended nutrient intakes. The report of the Expert Consultation (this report) is being published as a technical document, and this will later serve as the basis for developing a revised edition of the *FAO/WHO handbook of human nutrition*.

Consultations such as this one are part of a continuing commitment by both FAO and WHO to promote a reliable, nutritious, and safe food supply and to provide scientifically sound nutritional advice to Member Nations. This commitment was recently reaffirmed by the World Food Summit in November 1996 in Rome.

Written documents providing the criteria that were used in the past to develop the FAO/WHO RNIs were made available to the experts. These documents included the 1974 *FAO/WHO handbook on human nutritional requirements*, the 1988 *FAO/WHO expert consultation report on the requirements for vitamin A, iron, folate, and vitamin B<sub>12</sub>*, and the 1996 *WHO/FAO/IAEA report on trace elements in human nutrition and health*.

For the purpose of preparation of the background papers, the following working definition of a recommended nutrient intake (RNI) was used. The RNI is the intake level sufficient to meet the daily nutrient requirements of most individuals in a specific life-stage and gender group and is based on an estimated average nutrient requirement (EAR) plus two standard deviations above the mean:  $RNI = EAR + 2SD_{EAR}$ .

### Terms of reference and process

The terms of reference for the Expert Panel were the following:

- To review the full scope of vitamin and minerals requirements, including their role in normal human physiology and metabolism and in deficiency disease conditions. To focus on the requirements of the essential vitamins and minerals, including vitamins A, C, D, E, and K; the B vitamins; calcium; iron; magnesium; zinc; selenium; and iodine.
- To draft and adopt a report which would provide recommended nutrient intakes for vitamins A, C, D, E, and K; the B vitamins; calcium; iron; magnesium; zinc; selenium; and iodine. The report would provide practical advice and recommendations which will constitute an authoritative source of information to all those from member countries who work in the area of nutrition, agriculture, food production and distribution, and health

promotion. This report will form, in large part, the basis for a new edition of the FAO/WHO Handbook on Human Nutritional Requirements, which was published in 1974 and last re-issued in 1980.

- To identify key issues for future research and make preliminary recommendations for the handbook.

The presentations addressed changes in the science base for each of the essential vitamin and mineral nutrients from the time of the most recent FAO/WHO review of those nutrients. The Expert Panel made recommendations for the nutrient requirements, identified key issues for future research, and made preliminary recommendations for the handbook.

### **Definitions of terms used**

The following definitions relate to the nutrient intake from food (including water) that is required to prevent deficiency conditions. Upper limits of nutrient intake are defined for specific vitamins and minerals where there is a potential problem with excess.

#### ***Requirement***

A requirement is an intake level, which will meet specified criteria of adequacy, preventing risk of deficit or excess. These criteria include a gradient of biological effects related to the nutrient intake. This dose response will be assumed to have a Gaussian distribution unless it is known to be otherwise. A risk function (a probability of 0 to 1) of deficiency and excess can be derived (*Figure 1*).

The relevance of the biological effects starts with the most extreme case, that is, the prevention of death. For nutrients where sufficient data on mortality are not available, the nutrient intake that prevents clinical disease or sub-clinical pathological conditions, identified by biochemical or functional assays, is used. The next sets of biomarkers that are used to define requirements include measures of nutrient stores or critical tissue pools. Intakes to assure replete body stores are important when deficiency conditions are highly prevalent. Presently, approaches to define requirements of most nutrients use several criteria examined in combination, functional assays of sub-clinical conditions are considered the most relevant. These biomarkers ideally should be sensitive to changes in nutritional state while at the same time be specific in terms of identifying sub-clinical deficiency conditions. The use of nutrient balance to define requirements has been avoided whenever possible. However, in the absence of other criteria it has been used. In most cases, balance based on input-output measurements are greatly influenced by level of intake, that is, subjects adjust to high intakes by increasing output, conversely they lower output when intake is low. Thus, if sufficient time is provided balance can be achieved at multiple levels of intake. The same can be said of nutrient blood levels, they usually will reflect level of intake and absorption rather than functional state. Unless balance or plasma level is related to abnormal function or disease conditions, they are inadequate for use as a criteria to support the definition of requirements. Where relevant, requirement estimates should include allowance for variations in bio-availability.

#### ***Recommended nutrient intake***

Recommended nutrient intake (RNI) is the daily intake, which meets the nutrient requirements of almost all (97.5 percent) apparently healthy individuals in an age and sex-specific population group. Daily intake corresponds to the average over a period of time. Criteria to establish requirements used in this report will be nutrient specific. The estimation of RNI starts with the definition of the criteria for requirement and adds corrections for physiologic and dietary factors. The average requirement value obtained from a group of individuals is then adjusted for inter-individual variability. If the distribution of values is not

known, a Gaussian distribution is assumed, that is, a mean plus 2 SD is expected to cover 97.5 percent of the population. If the SD is not known, a value based on each nutrient's physiology is used. In most cases a variation in the range of 10-12.5 percent was assumed; exceptions are noted within chapters. The definition of RNI used in this report is equivalent to that of recommended dietary allowance (RDA) as used by the Food and Nutrition Board of the US National Academy of Sciences (1).

### ***Apparently healthy***

Apparently healthy refers to the absence of disease based on clinical signs and symptoms and function, normally assessed by routine laboratory methods and physical evaluation.

### ***Upper tolerable nutrient intake level***

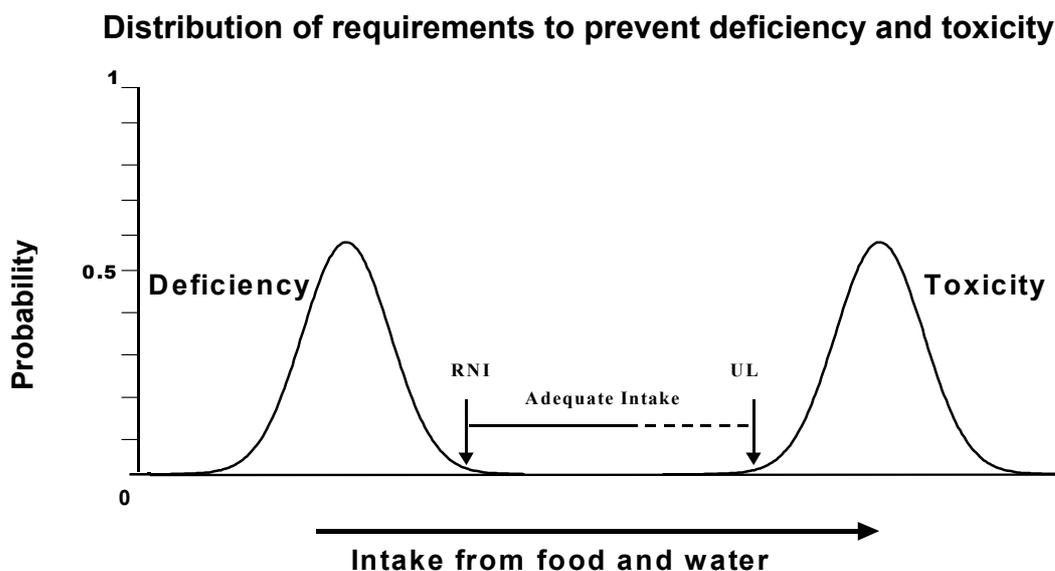
Upper tolerable nutrient intake levels (ULs) have been defined for some nutrients. ULs are the maximum intake from food that is unlikely to pose risk of adverse health effects from excess in almost all (97.5 percent) apparently healthy individuals in an age and sex-specific population group. ULs should be based on long-term exposure from food, including fortified food products. For most nutrients no adverse effects are anticipated when they are consumed as foods, because their absorption and or excretion are regulated. The special situation of consumption of nutritional supplements which when added to the nutrient intake from food may exceed the UL will be addressed in the specific chapters. The ULs as presented here do not meet the strict definition of no observed effect level used in health risk assessment by toxicologists because in most cases a dose-response curve for risk from total exposure to a nutrient will not be available. For more details on how to derive ULs, see the model presented in Nutrition Reviews (2).

The range of intakes encompassed by the RNI and UL should be considered sufficient to prevent deficiency while avoiding toxicity. If no UL can be derived from experimental or observational data in humans, the UL can be defined from available data on upper range of observed dietary intake of apparently healthy populations.

### ***Protective nutrient intake***

The concept of protective nutrient intake has been introduced in some cases to refer to an amount greater than the RNI, which may be protective against a specified health or nutritional risk of public health relevance (e.g., vitamin C intake with a meal to promote iron absorption or folic acid to lower the risk of neural tube defects). The text will indicate when existing data provide justifiable differences between RNI values and protective intake levels. These intakes are expressed as a daily value or as an amount to be consumed within a meal.

Figure 1



### Report of the consultation

In welcoming the participants, Dr Nath, Assistant Director General, Regional Office for Asia and the Pacific, (FAO), recalled the previous Consultation and publication on this subject from 1974. That and the present Consultation are part of a long series of such expert consultations, which have as a primary objective; a) the review of the state of knowledge on the role of various nutrients in the human diet; and, b) the formulation of practical recommendations where interpretation is needed or controversy exists. The most recent in this series was the *joint FAO/WHO expert consultation on carbohydrates in human nutrition* held in Rome in 1997.

Dr Nath spoke of the increasing evidence for the important role which vitamins and minerals play in preventing disease and promoting overall health. Indeed, the understanding of the role of micronutrients in foods and nutrition has significantly increased over the past 24 years. For many years the basic assumption – which still may be the best assumption – on which nutritionists make their projections has been that all nutrients can be obtained from a diet containing a variety of foods from a variety of sources. Some of the challenges to this assumption rest in the complexities and diversity of worldwide realities, culture, and traditions.

Dr Nath pointed out that for many people with access to an adequate energy intake, an extensive freedom of choice exists in the selection of food. However, the existence of widespread poverty in the majority of the UN member countries precludes the opportunity to consume adequate energy let alone a diet balanced in micronutrients. He observed that the increase in the availability of a wide variety of foods and especially “fast foods” in almost every country in the world, coupled with the increasing pace of urban lifestyles across all cultures and countries, does not necessarily result in adequate vitamin and mineral intake.

The existence of the dichotomies in lifespan was also mentioned by Dr Nath. In different parts of the world and in different segments of society within the same countries, there are broad ranges of life spans in part due to nutritional adequacy. Especially in urban populations, as lifespan increases as a result of nutritional adequacy and despite improved

access to health care, an increase in obesity, diabetes, some forms of cancer, and cardiovascular disease has been recorded in all regions of the globe. Although epidemiological studies do not provide us with cause-and-effect explanations, they do provide impetus for future research into the role of vitamins and minerals in the prevention and management of some non-communicable diseases.

Dr Nath reminded the participants that they had been invited to the Consultation as independent experts and that their participation in the Consultation was to be in their individual capacity and not as a representative of any organization, affiliation, or government. He underscored the importance of drawing conclusions and making recommendations based on science, which is traceable to studies conducted largely in humans. This is necessary for correct food labelling and relevant health claims and for the better use of foods in the dietary management and prevention of non-communicable diseases. These issues have economic implications for agricultural production, the food industry, and public health policy.

Dr Sultana Khanum, Regional Adviser/Nutrition, SEARO (South-East Asia Regional Office), WHO, added her welcome on behalf of the Director-General of WHO, Dr Gro Harlem Brundtland, and the Regional Director for South-East Asia Region, Dr Uton Muchtar Raffle. Dr Khanum noted that the choice of South-East Asia as the site of the Expert Consultation was significant because some of the most tangible successes and achievements have occurred within this geographical region in the realm of identifying, preventing, reducing, and eliminating many forms of malnutrition.

Dr Khanum noted that the FAO and WHO have a long history of collaboration at the country, regional, and global levels towards combating food and nutritional problems. She underlined the importance of using science as the basis of the standard setting process, which took place during the consultation.

Dr Graeme Clugston, Director, WHO Nutrition Programmes, added his welcome to the participants on behalf of the Director-General of WHO. Dr Clugston pointed out that the formulation and implementation of science-based dietary guidelines have become a central issue for the nutritional sciences as well as a major challenge for governments world wide, especially since the *International Conference on Nutrition* held in Rome, December 1992.

Dr Clugston expressed confidence that this Expert Consultation would lead to scientifically sound up-to-date recommendations for vitamin and mineral requirements in human nutrition. FAO and WHO would then ensure that these recommendations would be passed on to all Member States world wide, providing them with the best possible guidance for developing their own appropriate dietary guidelines for health promotion, good nutrition, and disease prevention.

The Consultation elected Dr Donald McCormick as chairperson and Professor Chen Chunming as vice-chair. Dr Glenville Jones and Dr Colin Mills were appointed jointly as rapporteurs. Dr McCormick in his response indicated the importance of this Consultation and outlined the scope of the issues that would be discussed and on which the two agencies, FAO and WHO, were seeking expert guidance from the Consultation.

### ***Recommended nutrient intakes***

***Appendix 1*** at the end of the report provides two composite tables summarising the recommended nutrient intakes (RNIs) for each of the vitamins and minerals. For the purposes of preparing these tables the recommendations made by the experts were adjusted so that the tables could be based on common body weights and age groups. Details are provided in the footnote at the bottom of the tables.

**REFERENCES**

1. **Food and Nutrition Board, Institute of Medicine.** 1997. *Dietary Reference Intakes*: Washington, DC, National Academy Press.
2. **Anonymous.** 1997. A Model for the Development of Tolerable Upper Intake Levels. *Nutr. Revs.*, 55: 342-351.