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1. Introduction

A Joint FAO/WHO Consultation on the Preparation and Use of Food-based Dietary Guidelines was convened in Nicosia, Cyprus from 2 to 7 March 1995. The meeting was opened by Mr M. Christophides, Minister of Health of Cyprus.

The basic aim of the International Conference on Nutrition, convened by FAO and WHO in Rome in December 1992, was to identify and encourage the use of strategies and actions that improved nutritional well-being and food consumption throughout the world. It adopted the World Declaration and Plan of Action for Nutrition (*1*), which includes among its goals:

> ... to make all efforts to eliminate before the end of this decade:
>
> - famine and famine-related deaths;
> - starvation and nutritional deficiency diseases in communities affected by natural and man-made disasters;
> - iodine and vitamin A deficiencies.
>
> ... [and] to reduce substantially within this decade:
>
> - starvation and widespread chronic hunger;
> - undernutrition, especially among children, women and the aged;
> - other important micronutrient deficiencies, including iron;
> - diet-related communicable and noncommunicable diseases;
> - social and other impediments to optimal breast-feeding;
> - inadequate sanitation and poor hygiene, including unsafe drinking-water.

The Plan of Action includes among its strategies "promoting appropriate diets and healthy lifestyles" and calls on governments, *inter alia*:

> on the basis of energy and nutrient recommendations [to] provide advice to the public by disseminating, through the use of mass media and other appropriate means, qualitative and/or quantitative dietary guidelines relevant for different age groups and lifestyles and appropriate for the country's population.

The World Declaration and Plan of Action recognizes that the attainment of its goals requires the development of national action plans appropriate to each cultural context. That is, each country needs to identify public health issues related to local dietary patterns and to adopt local strategies for their resolution. The World Declaration and Plan of Action is notable for the absence of numerical targets for food and nutrient intakes, and thus marks a move in the thinking of nutritionists away from policies dictated by numbers towards those based on a consideration of the prevailing public health issues. The Plan of Action also calls for the dissemination of nutrition information through "sustainable food-based approaches that encourage dietary diversification through the production and consumption of micronutrient-rich foods, including appropriate traditional foods".

The overall purpose of the Consultation was therefore to establish the scientific basis for developing and using food-based dietary guidelines (FBDGs) to improve the food consumption patterns and nutritional well-being of individuals and populations. Its specific objectives were: to review the scientific evidence and epidemiology of diet-related health problems, including noncommunicable diseases and other forms of malnutrition; to review the existing literature on recommended nutrient intakes and develop a synthesis of current nutrient recommendations applicable to FBDGs; to review relevant dietary assessment methodologies; to review existing national dietary guidelines and their use in countries; and to make recommendations for the development and implementation of FBDGs.

The concept of disseminating information through FBDGs is inherently sensible, since consumers think in terms of foods rather than of nutrients. Equally, the concept of FBDGs can take account of considerable epidemiological data linking specific food consumption patterns with low incidence of certain diseases, while not requiring a complete understanding of the underlying biological mechanisms. For example, Sir James Lind, the Surgeon-General in charge of health policy for the British Navy in 1700, knew that sailors on long sea voyages did not develop scurvy if the sailors were encouraged to eat limes regularly. This "food-based dietary guideline" successfully addressed a specific health issue in the complete absence of any biochemical understanding. In the modern era, we observe a low incidence of certain diseases in specific communities with particular eating habits and, while we rightfully search for an explanation of biochemical mechanisms, dietary recommendations based on these food patterns are also warranted. An example is the association of high fruit and vegetable consumption with reduced risk of certain noncommunicable diseases, and the emerging awareness that several components of these foods and the diets containing them contribute to lower risk.

There is no doubt that, as our knowledge of mechanisms improves, opportunities in food technology will allow for alterations to be made to nutrient and non-nutrient intakes within prevailing food consumption patterns. We already recognize direct associations between certain single nutrients and single conditions (e.g. iron and anaemia, folic acid and neural tube defects, and certain saturated fatty acids and risk of cardiovascular disease), which make it possible for the nutritional properties of existing food supplies to be enhanced. Advances in food technology permit the production of both nutrient-fortified foods and products with lower contents of salt and saturated fats. Progress in biotechnology and genetic engineering will play an increasing role in this area in the future. None the less, FBDGs remain a valid strategy for public health nutrition.

The purpose of this report is to establish the scientific basis and recommended process for the development and evaluation of FBDGs in various regions of the world. Dietary guidelines differ from dietary goals and from recommended dietary intakes or recommended dietary allowances (see Box 1). The development of dietary goals re-

Box 1

Dietary guidelines in relation to other systems of nutritional recommendations and goals

- Recommended nutrient intakes (RNIs) are also known, in different countries, as recommended dietary allowances (RDAs), recommended dietary intakes (RDIs), dietary reference values (DRVs) or population reference intakes. They are authoritative, quantitative estimates of human requirements for essential nutrients, usually set out with different amounts (in weight/day) considered to be adequate to meet the known nutrient needs of practically all healthy people.
- Dietary guidelines are sets of advisory statements that give dietary advice for the population in order to promote overall nutritional well-being and to address all diet-related conditions. They have usually been expressed in technical nutritional terms, but some guidelines have been expressed as food groups. Dietary guidelines differ from RNIs in that the advice is more provisional, being based on a variety of information, including indirect evidence about the complex relationship of food components with health and disease. Dietary guidelines are broad targets for which people can aim, while RNIs indicate what should be consumed on average each day.
- Dietary goals are desirable food intakes that support optimal nutrition and health. Dietary goals can be used for planning, often over the long term, at the national level rather than as the basis for providing advice for individuals. They are usually expressed in terms of average national intakes.
- Dietary (or nutritional) targets are specific desirable points to be achieved along the path towards meeting national dietary goals in an overall health policy context. Dietary targets should be expressed in easily quantified terms so that monitoring of their achievement is possible.

flects an analysis of the health status of the population and the determination of goals that will improve the overall health of the population and reduce the risk of disease. Dietary goals may vary among subpopulations according to the prevalence of overnutrition or undernutrition.

The term "food-based dietary guidelines" is understood in this report to mean the expression of the principles of nutrition education mostly as foods. They are intended for use by individual members of the general public. Where they cannot be expressed entirely as foods they are written in language that avoids, as far as possible, the technical terms of nutritional science.

In addition to FBDGs in any country, a set of dietary guidelines expressed in scientific terms may also exist for policy-makers and health care professionals, with quantitative recommendations of nutrients and food components.

Adopting RNIs and dietary goals for a population may form part of the process of developing dietary guidelines. If guidelines are derived from nutrient targets or dietary goals, they should be translated into food-based guidelines so that they can be accepted by the population. Dietary guidelines represent the practical way to reach the nutritional goals of a population. They take into account the customary dietary pattern and indicate what aspects should be modified. They consider the ecological setting, socioeconomic and cultural factors, and the biological and physical environment in which the population lives.

FBDGs will vary among population groups. It is important for each region or country to recognize that more than one dietary pattern is consistent with health and to develop food-based strategies that are locally appropriate. A balanced diet is not the only component of a healthy lifestyle. Although this report focuses on diet, bodies responsible for developing dietary guidelines are encouraged to integrate these messages with other policies related to health promotion (e.g. those concerning smoking, physical activity and alcohol consumption).

2. Scientific considerations in the development of food-based dietary guidelines

2.1 Rationale

There is good scientific evidence that dietary patterns, i.e. the daily combination of foods and beverages, have specific results in terms of health or disease. For example, a diet may be apparently adequate in all other ways but still be deficient in vitamin A or iron, and this may lead to xerophthalmia or anaemia. Conversely, a diet high in saturated fat and energy is known, on a population basis, to lead to an increased likelihood of coronary heart disease.

The reasons for developing and using FBDGs are many, and often self-evident.

1. Foods make up diets, and are more than just a collection of nutrients.
2. Nutrients interact differently when presented as foods.
3. Methods of food processing, preparation and cooking influence the nutritional value of foods.
4. There is already good evidence from animal, clinical and epidemiological studies that specific dietary patterns are associated with a reduced risk of specific diseases. Diets rich in fruits and vegetables are associated with various positive outcomes such as a reduced incidence of lung cancer (*2*). Science has not been able to identify completely the specific nutrients involved. The protective effect could be due to a single nutrient, to a combination of nutrients or non-nutrients, or to the replacement of some other food in the diet when fruits and vegetables are consumed in large amounts (*3*).
5. Science has yet to identify the potential effects on health of some non-nutrient food components, hence the increasing attention being paid to such substances as flavonoids and phytoestrogens. If the focus is on a single nutrient, people may not appreciate the benefits of the ingestion of these compounds in foods.
6. Some food components may have biological functions that science has not yet identified.
7. Foods and diets have cultural, ethnic, social and family aspects that individual nutrients themselves do not have.
8. For certain micronutrients, evidence suggests that an intake higher than that recommended at present may help to lower the risk of noncommunicable diseases. FBDGs can encourage dietary patterns that include these nutrients.

FBDGs need to take into account: food/health patterns; the relative comprehensiveness of the food-based versus the nutrient-based approach; the practicality of suggested goals; the danger of nutrition labelling presenting the consumer with an oversimplified view of foods; and evolving understanding of the nutritional basis of disease and health (the biological effects of food and food patterns can be greater than the sum of their parts).

2.2 Relevant scientific areas

FBDGs need to be based on sound scientific principles and a knowledge of local conditions. A summary of the four main areas of science relevant to the development of FBDGs is provided below. A more detailed description is given in Annex 1.[1]

2.2.1 *Nutrition science: physiology and pathophysiology related to food components*

The study of energy balance and metabolism, and of macronutrient and micronutrient physiology, is well established and has now evolved to take account of non-nutrient components of food that are of biological significance. FBDGs can now take account both of the lower limits of energy intake and of the ways that energy balance can be achieved without restricting food intake. In cases of excess energy intake, the emphasis is now on strategies to achieve energy balance either by decreasing the energy density of the diet or by increasing energy expenditure. With this approach, concerns about both chronic energy deficit and excess body fat can be addressed through FBDGs by encouraging the use of foods of appropriate energy density.

Micronutrients are now recognized as having an important influence on communicable and noncommunicable diseases and classical deficiency disorders. The formulation of FBDGs for all food cultures, with varying health patterns, therefore merits consideration of non-energy nutrients.

Food chemistry is extraordinarily complex, and it is becoming clearer that states of health previously not regarded as nutrition-related may actually be determined by the intake of non-nutrient substances contained in foods, such as certain flavonoids from plants and phytoestrogens from certain legumes. It is therefore essential that dietary guidelines be based on foods and not simply on nutrients, while taking account of the fact that sound scientific evidence about foods should be the foundation of any recommendations.

2.2.2 *Food science and technology*

Food science and technology are creating a new framework for FBDGs, principally in the areas of:

- food physicochemistry
- methods of food storage and preservation

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[1] Annex 1 was prepared during the meeting, on the basis of the background papers and subsequent discussions, by a working group appointed by the Consultation.

- changes in food preparation
- opportunities for the use of formula foods where energy intake is low or regular food cannot be eaten
- nutrient restoration and fortification of foods
- the development of health-focused "designer" and functional foods (see page 87).

2.2.3 *Educational, behavioural and social sciences*

Both the practicality of FBDGs and their consequences require analysis through the educational, behavioural and social sciences. Even though substantial knowledge exists in these areas, it is not commonly utilized by nutrition and food policy-makers. For example, FBDGs that neglect basic methods of promoting behavioural change may be scientifically sound but totally ineffective in improving dietary intakes. Some of the major areas of concern are set out in Annex 1.

2.2.4 *Agricultural and environmental sciences*

The agricultural and environmental sciences are part of the scientific basis of FBDGs. There is evidence that even existing dietary guidelines in certain developed countries, such as Australia and the USA, cannot be easily achieved in the short term without increasing fruit and vegetable production. Even more difficult may be the pressure on the world fish supply, because of increasing appreciation of the importance of long-chain ω3 fatty acids from fish in the human diet. The need for sustainable food production using existing natural resources is becoming more and more apparent.

2.3 Scientific evidence for the relationship between food, nutrients and health

No single food, other than breast milk for infants, provides all the required nutrients. For optimal growth, health and avoidance of disease, a range of nutrients is needed in amounts that change throughout life. The various diets that people eat, made up of many different foods in a variety of national patterns and combinations, have proved over the ages to be able to provide adequate nutrients.

Many countries have adopted RDIs, which are customarily defined as the intake of energy and specific nutrients necessary to satisfy the basic nutritional requirements of a group of healthy individuals. While the criteria for estimating requirements have changed over time, the three main methods of investigation still remain: (a) a clinical approach; (b) the study of typical consumption patterns of healthy populations; and (c) the study of functional indicators of nutritional status. A detailed comparison of the relative merits of each is beyond the scope of this report, but additional information may be found elsewhere (*4*).

More recently, the concept of "optimal nutrient intake" has evolved and is influencing both scientists and the public alike. The question as to what is "optimal" is usually answered by the suggestion that diet or specific nutrients can lay the basis for improved physical and mental performance or for longer and healthier life. This concept is too broad. The preferred approach is to define clearly the function that is of interest in relation to the intake of a specific nutrient or a given food. The selected function should be of relevance to health or to disease prevention.

A growing body of scientific evidence supports the relationship between dietary patterns and health. This evidence is derived from several types of study.

Epidemiological studies examine population-based data with a view to associating disease patterns or health outcomes with food patterns. Such studies can be prospective or retrospective. Several factors determine the strength of any association concluded, including the consistency, strength, specificity and biological plausibility of the association. Epidemiological observations are, in principle, not sufficient to confirm cause-and-effect relationships between individual nutrients and health outcomes; they do, however, provide valuable information about the food patterns to be considered in FBDGs.

Clinical research is designed to determine whether modifying or supplementing the diet with selected nutrients can intervene in the disease process or modify one or more risk factors for disease. These studies can confirm that the foods or nutrients in question do indeed contribute to the health or disease outcomes of interest. The research is typically conducted in individuals who are known to be at risk for a certain disease; although the findings may be relevant to the general population, it is important to keep the limitations in mind when extrapolating from these studies to the general population (for example, in trying to draw general conclusions from diets very low in fat).

Experimental studies are designed to determine the effect of foods and food components on cell metabolism or physiology, and thereby to understand the basic mechanism by which specific nutrients modify disease. These studies are essential to establish the plausibility of the diet–health relationship. They are often conducted in animal models, however, and it can be difficult to extrapolate from one species to another.

An example of the need to integrate epidemiological, clinical and experimental data is the recent evidence associating a lower relative risk of age-related blindness due to macular degeneration with the consumption of dark green leaf vegetables, particularly spinach and collards (5). While it may be that zeaxanthin and lutein in these foods protect against macular degeneration, establishing this relationship will require extensive experimental and clinical research. In the meantime an increased intake of dark green leaf vegetables is a justifiable FBDG, especially in view of other support for this recommendation.

2.4 Nutritional quality of dietary patterns

Dietary patterns vary in different geographical areas and socioeconomic groups, and also over time. Such variation depends on agricultural practices and on climatic, ecological, cultural and socioeconomic factors, all of which determine the foods that people demand or expect and that are generally available.

Given the variety of food combinations that can provide a healthful diet, it is impossible to define the ranges of intake for all foods that could be combined to provide a nutritionally adequate diet. Although a large set of food combinations that are compatible with nutritional adequacy could be identified, they could hardly be extrapolated to cover every different ecological and social setting. An alternative approach to defining the nutritional adequacy of diets has therefore evolved, based on a scientific understanding of the biochemical and physiological basis of human nutritional requirements in health and disease. This approach has permitted the definition of essential nutrients and the establishment of RNIs.

As an instrument and expression of food and nutrition policy, FBDGs should be based directly on diet and disease relationships of particular relevance to the individual country. Priorities in addressing the dietary guidelines will depend on whether the relevant public health concerns are related to dietary insufficiency or excess.

Four possible approaches are useful in assessing the nutritional quality of diets for the development and evaluation of FBDGs.

2.4.1 *Food patterns*

One way of evaluating the nutritional soundness of any approach to dietary guidelines is to assess a particular food pattern that is usually associated with good health. This will most likely involve the traditional food patterns of people with longevity, low morbidity and low perinatal and infant mortality rates, such as Scandinavian, Japanese or Mediterranean populations. In most of these populations, other factors such as health care, education, safe water and socioeconomic development also play important roles. Negative effects following changes in dietary patterns might also indicate food patterns to be avoided.

To date, most evidence on which to base FBDGs has been obtained by tracking health indices in populations in accordance with food intake patterns. Some examples are given in Annex 1.

2.4.2 *Food variety indices*

While the value of varying the diet either to ensure essential nutrition or to reduce the risk of food toxicity has been understood for some time (*6*), the use of variety as a predictor of health outcome is a relatively recent approach (*7*, *8*). Nevertheless, enough evidence is available to justify promoting food variety through FBDGs as a means of reducing morbidity and mortality, while further scientific evidence is awaited on how exactly it works.

In deriving indices of food variety, account must be taken both of categories of foods and of the time over which variety in food choice is achieved.

2.4.3 *Nutrient requirements and recommendations*

These have been the subject of reports from both FAO and WHO (*2*, *9–16*) and many countries have established their own recommended requirements. The values given in these reports for the different nutrients vary somewhat, although the implications of these differences for the establishment of dietary guidelines are small. Countries that have the technical capacity may develop their own RNIs; otherwise a review of existing recommendations can be used to define those that are most suited to a given national situation. FBDGs should be structured to enable the population to meet RNIs that are critical for reducing diet-related public health problems.

The Consultation recommended that FAO and WHO undertake a review of existing reports for all relevant nutrients (the last time this was done was in 1974 (*12*)).

2.4.4 *Use of nutrient densities in establishing and evaluating guidelines*

Using nutrient densities to evaluate dietary quality involves expressing existing RNI values per unit of energy (usually 4.2 MJ, equivalent to 1000 $kcal_{th}$) provided by the diet. The conditions for this model are that if a diet provides the energy needs of individuals, it will also satisfy the RNIs for all essential nutrients. This approach permits the simplification of age- and sex-related RNI figures, since the values differ minimally when these figures are expressed per unit of energy. Therefore, for the purpose of establishing dietary guidelines for the general population, precise sex- and age-specific RNIs are not needed. The figures presented should provide a way to assess dietary quality.

Individuals within a family group usually form the basic unit for food consumption. Thus, if there is enough food at the family or household level, all members can consume a diet with the recommended nutrient densities and meet their specific RNI. The problem of distribution within the family needs to be considered, since women and children may not receive an adequate proportion of foods of higher nutrient density. This should be considered in establishing both general dietary guidelines and those specifically addressing the needs of vulnerable groups in the community.

Relevant non-energy nutrients of global public health concern are addressed in Annex 1, where their need is not expressed as an absolute requirement but as nutrient density per 4.2 MJ (1000 $kcal_{th}$). This should not be interpreted as a physiological relationship between the specific nutrients and energy requirements, but as a way of defining the adequacy of a given diet to meet the needs for specific nutrients if sufficient energy is consumed.

If adolescents or adults consume less than 8.4 MJ (2000 $kcal_{th}$) per day, they will have difficulty in meeting their vitamin and mineral needs. Thus, adequate energy intake is a prerequisite for maintaining nutrient status, and a sedentary lifestyle should be discouraged. Children below 2 years of age need a different diet and require specific dietary guidelines.

In using nutrient densities to establish dietary goals and guidelines, both the quantitative and the qualitative aspects of the food supply should be considered. The quantitative aspects include an estimate of the amount of nutrients and the relative proportion of nutrient in the food sources that will meet nutritional needs in practice. The qualitative aspects relate to the biological quality of the nutrients in the food source and the potential for interaction of nutrients and non-nutrient components, which may enhance or inhibit the biological quality of a given source if ingested simultaneously. The recommended nutrient densities should refer to the total diet available and not to individual foods.

Energy RNIs should be treated separately, since age- and sex-specific as well as activity-specific RNIs are necessary to define the adequacy of energy intake and to validate proposed dietary guidelines.

2.5 Reorientation from nutrients to foods in formulating food-based dietary guidelines

The starting point in devising FBDGs is the relevance to a public health issue rather than an existing gap between the prevailing nutrient intake and a numerical recommended intake for a nutrient. This can be illustrated by comparing calcium intakes in China and the USA. In the USA, the average calcium intake per person is about 600 mg/day, while in China it is about 400 mg/day. The international range of RDAs for calcium is 500–1200 mg/day. On that basis, China has a larger calcium intake gap than the USA; in reality, however, whereas osteoporosis in the elderly is a major public health problem in the USA, it is apparently not so at present in China (*17*). Even when a public health problem exists (e.g. high rates of mortality from cardiovascular diseases) and a difference also exists between the numerical dietary goal (e.g. 10% energy from saturated fatty acids) and the prevailing intake of the target nutrient (e.g. 16–18% energy from saturated fatty acids, as in northern Europe), the FBDGs should be based on what can realistically be achieved in the socioeconomic context rather than on an attempt to eliminate in one step the entire difference between the desired and actual intakes.

Once the public health problem has been identified, the first step should be to ascertain the extent to which it may be attributable to non-nutritional factors. Those non-nutritional factors then have to be considered together with, or even in advance of, any nutritional intervention. Such specific factors as infection, safe food and water, physical activity and smoking may have to be addressed in order for nutrition strategies to be fully successful.

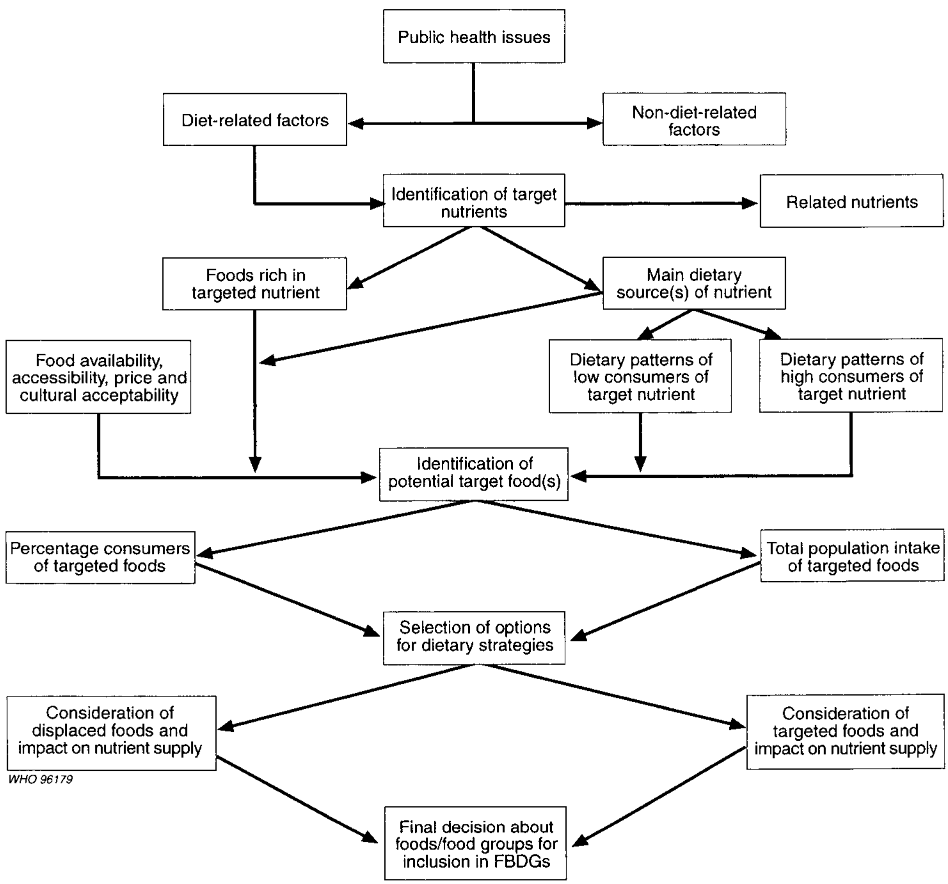
Since all FBDGs are issued in a specific context, it is essential next to consider the likelihood of an intervention's success based on food-specific guidelines within the social, economic, agricultural, supply and cultural contexts. For example, the traditional Cretan diet contains about 50 g of olive oil per day, and thus some 8 million tonnes of olive oil would be needed to allow all citizens of the European Union (EU) to enjoy this amount. Even supposing the EU possessed the agricultural capacity to produce that amount, the impact of doing so on other aspects of agricultural production would be prohibitive.

If the available information indicates that nutrition is relevant to addressing a public health issue, a transition needs to be made from the nutrients involved to food-based strategies that are likely to be successful. The following four steps are useful in this transition (see also Fig. 1).

2.5.1 *Step 1: consideration of associated nutrients prior to intervention*

Having identified the nutrient relevant to the public health issue in question, one should try to determine whether any other nutrient or non-nutrient might be confounding the targeted nutrient. For example, if the objective is to increase carotenoid intake, one needs to know whether the level of fat in the diet is adequate to ensure caro-

Figure 1
Reorientation from nutrients to foods in formulating FBDGs



tenoid absorption; and, even though the intake of fat may appear adequate, whether the fat and carotene are usually consumed at the same time.

2.5.2 *Step 2: identifying foods to be included in the guidelines to modify the intake of a specified nutrient*

Different approaches may be used here, depending on the available data.

- Foods with high levels of the target nutrient can be identified. This information may be sufficient to formulate an FBDG, but one should be cautious about assuming that a food rich in a nutrient is one that is likely to make a significant contribution to the dietary intake of a given population group.
- The main dietary sources of the target nutrient may be determined. In some instances, it will be found that the nutrient has a very wide distribution across food groups, in which case altering the intake of the nutrient might be difficult. In such cases, one might decide which of these equally important food groups, in terms of their supply of the targeted nutrient, should be selected to define an FBDG. The basis for such selection should include price, likely consumer acceptability, coincident benefit for other FBDGs, or other factors critical to implementation. In other instances, it may be found that the nutrient is provided largely by one food source, in which case one should consider whether the intakes of non-targeted nutrients might be detrimentally affected were that food to be strongly promoted.
- Where food and nutrient intake data are available, it is possible to develop FBDGs based on the food consumption patterns of population subgroups that achieve a particular nutritional goal. This allows one to discriminate between subgroups with high and low intakes of a target food or nutrient. Such foods or nutrients are often not those that would be predicted on the basis of their contribution to the actual average intake of the target nutrient. Thus, it is important to determine patterns of food intake not only on the basis of the population average but also for subgroups or even individual consumers. It is possible for two subpopulations to have equal average intakes but to differ in terms of the proportion of consumers and their different intake levels.

Any or all of these approaches, or indeed others, may be used to ensure that the foods and derived ingredients are likely to be effective and will not create confounding adverse effects.

2.5.3 *Step 3: possible sociocultural and economic factors*

Whereas steps 1 and 2 above may help to identify, in nutritional terms, an ideal set of FBDGs, many other factors may work against their being heeded and may mitigate their impact. These are considered in section 4.

2.5.4 *Step 4: possible nutritional consequences of implementing guidelines*

If, for some public health issue, a given dietary guideline were to advise, for example, an increased intake of pulses, one should consider the possible consequences. One consequence might be that pulses replace meat, with subsequent nutritional implications. Another might be that pulses do not replace meat but replace vegetables, again with nutritional consequences. Consideration of a variety of possible scenarios may help to tailor the FBDG so as to minimize adverse effects or, more importantly, may help those charged with delivering messages about FBDGs to communicate more clearly.

FBDGs offer signal opportunities to alter the dietary habits of populations in a direction that reduces the risk of noncommunicable diseases or prevents nutritional deficiencies. The above steps and other pertinent considerations should ensure that the right foods are targeted and that no adverse effects arise.

3. Methods of monitoring food and nutrient intake

The purpose of this section is:

- to provide an overview of methods of assessing food consumption;
- to give examples of rapid methods of collecting additional dietary data;
- to address issues involved in converting food intake to nutrients;
- to discuss the analysis of food intake data by foods, food groups and eating practices;
- to elaborate on approaches to monitoring the effectiveness of established dietary guidelines.

3.1 Methods of assessing dietary intake

Food consumption data may be collected at the national, household or individual level. Although data collected at the level of the individual are the most useful for assessing dietary adequacy and adherence to FBDGs, food supply and household data provide information that is useful for many other purposes.

3.1.1 *National food supply data*

Food supply data at the national level, such as food balance sheets or food disappearance data (*18*), provide gross estimates of the national availability of food commodities. These data may also be used to calculate the average per capita availability of energy and macronutrients. A major limitation of national supply data is that they reflect food availability rather than food consumption. Other uses, such as for animal feed and in industrial applications, as well as losses due to cooking or processing, spoilage and other types of waste, are not easily accounted for. Despite these limitations, national food supply data are useful for tracking trends in the food supply and for determining the availability of foods that are potentially good sources of nutrients or of food groups targeted for dietary guidance. Food supply data are not useful for evaluating individual adherence to dietary reference values or for identifying subgroups of the population at risk of inadequate nutrient intake.

3.1.2 *Household data*

Information regarding food availability at the household level may be collected by a variety of methods (*19*). Such data are useful for comparing food availability among different communities, geographical areas and socioeconomic groups, and for tracking dietary changes in the total population and within population subgroups. However, these data do not provide information on the distribution of foods among individual members of the household.

3.1.3 *Individual data*

The five general methods for assessing dietary intake for individuals are described below, along with their major strengths and limitations (*20–23*) (these methods are described in greater detail in section 3.6).

Food records

Food records, also called food diaries, require that the subject (or observer) report all foods and beverages consumed for a specified period (usually 1–7 days). Amounts of each food item may or may not be recorded, depending on the objectives of the study. If nutrient intakes are to be calculated, the amounts consumed should be estimated as accurately as possible. Amounts may be determined by weighing or by estimating volumes. In some situations, only those foods of particular interest are recorded. For example, to estimate the intake of a food component found only in animal products, food records might be limited to foods containing meat, poultry, fish, eggs or dairy products. If total energy intake is required, however, the food record should include all foods consumed.

Dietary recall, 24-hour

The 24-hour dietary recall consists of a listing of foods and beverages consumed the previous day or in the 24 hours prior to the recall interview. Foods and amounts are recalled from memory with the aid of an interviewer trained in methods of soliciting dietary information. The interview is usually conducted face to face, but may also be conducted by telephone. In some situations, the recall is self-administered by the subject, but this approach may not yield sufficiently reliable data. A brief activity history may be incorporated into the interview to facilitate probing for foods and beverages consumed.

Food frequency questionnaire

A food frequency questionnaire (FFQ), sometimes referred to as a "list-based diet history", consists of a structured listing of individual foods or food groupings. For each item on the food list, the respondent is asked to estimate the frequency of consumption based on specified frequency categories, which indicate the number of times the food is usually consumed per day, week, month or year. FFQs are generally self-administered but may also be administered by the interviewer. The numbers or types of food item may vary, as well as the numbers or types of frequency category. FFQs may be unquantified, semi-quantified or fully quantified. The unquantified questionnaire does not specify sizes of servings, whereas the semi-quantified tool provides a typical serving size as a reference amount for each food item. A quantified FFQ allows the respondent to indicate any amount of food typically consumed. Some FFQs include questions on the usual method of preparing food, trimming of meats, use of dietary supplements, and identification of the most common brand of certain types of food such as margarines or ready-to-eat cereals. The answers to these questions are then incorporated into the calculation of nutrient intake.

FFQs are commonly used to rank individuals by intake of selected nutrients. Although FFQs are not designed for estimating absolute nutrient intakes, the method may be more accurate than others for estimating the average intake of those nutrients having large day-to-day variability and for which there are relatively few significant food sources (e.g. alcohol and vitamins A and C). Brief FFQs may focus on one or several specific nutrients. Comprehensive FFQs designed to estimate a large number of nutrients generally include between 50 and 150 food items.

Diet history

The meal-based diet history is designed to assess usual individual intake. It consists of a detailed listing of the types of food and beverage commonly consumed at each eating occasion over a defined period, which is often a "typical" week. A trained interviewer probes for the respondent's customary pattern of food intake on each day of the typical week. The reference time frame is often the past month or the past several months, or may reflect seasonal differences if the time frame is the past year.

Food habit questionnaire

Such questionnaires may be designed to collect either general or specific types of information, such as food perceptions and beliefs, food likes and dislikes, methods of preparing foods, use of dietary supplements, or social settings surrounding eating occasions. This type of information is frequently included along with that obtained by the other four methods, but food habit questionnaires may also be used as the sole data collection method. These approaches are commonly used in rapid assessment procedures. The questionnaires may be either open-ended or structured, may be self- or interviewer-administered, and may include any number of questions depending on the information required. The use of food habit questionnaires is further discussed in section 3.4.

Combined methods

Different types of dietary assessment method may be combined to improve the accuracy and facilitate the interpretation of the dietary data. Methods may also be combined for practical reasons. For example, in past surveys of the United States Department of Agriculture, food records have been combined with 24-hour recalls to make the best use of resources. An FFQ focused on selected nutrients was used in addition to the 24-hour recall in the Third National Health and Nutrition Examination Survey (NHANES III). A 24-hour recall is frequently used to help establish the typical meal plan for conducting a diet history (*24*), and an FFQ may be used as a cross-check for the other three types of method (Table 1).

It is becoming increasingly common to use another more valid (and often more costly) method of dietary assessment on a random subsample of the study population. Comparison of the results from the two methods permits adjustment of mean intake values obtained from the primary method. For example, if an FFQ is the primary method used, a more detailed method, such as multiple recalls or food records, is also used in a subset of survey participants. The more

Table 1
Summary of dietary assessment methods

Type of method	Major strengths	Major limitations
Food record	Does not rely on memory Easy to quantify amounts Open-ended	High participation burden Requires literacy May alter intake behaviour
24-hour dietary recall	Little respondent burden No literacy requirement Does not alter intake behaviour	Relies on memory Requires skilled interviewer Difficult to estimate amounts
Food frequency questionnaire	Relatively inexpensive Preferable method for nutrients with very high day-to-day variability Does not alter intake behaviour	Relies on memory Requires complex calculations to estimate frequencies Requires literacy Limited flexibility for describing foods
Diet history (meal-based)	No literacy requirement Does not alter intake behaviour Open-ended	Relies on memory Requires highly trained interviewer Difficult to estimate amounts
Food habit questionnaire	Rapid and low-cost Does not alter intake behaviour Open-ended	May rely on memory May require trained interviewer

detailed method, along with the FFQ, is expected to provide more accurate estimates of intake distributions. Results from the sub-sample are then used to adjust the mean estimates from the FFQ for the total population.

3.2 Selecting the most appropriate method of collecting dietary data

The following considerations will aid in selecting the method that will best meet survey objectives:

- the foods or nutrients of primary interest;
- the need for group versus individual data;
- the need for absolute intakes versus relative intake estimates;
- population characteristics (age, sex, motivation, education/literacy, cultural diversity);
- the time frame of interest;
- the level of specificity needed for describing foods;
- available resources including food composition data if nutrients are to be calculated.

It is important that statistical expertise be included in designing the survey and that the questions to be answered are clearly stated and analysable. Statistical resources are available in most countries and should be utilized for both survey design and data analysis.

When absolute versus relative estimates of nutrient intake are required, the food record and 24-hour dietary recall are clearly the methods of choice for estimating mean intakes. These are the only methods that provide data on foods actually eaten, since both the FFQ and the diet history are based on long-term subjective perception of a participant's typical eating habits. A single day of intake per study participant is adequate for estimating group means, and a representative balance of all of the days of the week should be included in the data collection, if possible. If the distribution of usual individual intakes within the groups is also needed, at least two non-consecutive days of intake per individual are required to permit estimation of within-person day-to-day variability. The combination of days of the week for each individual should be randomly assigned.

If usual intakes of each individual are required for meeting the survey objectives, the number of days of intake depends on the within-person variability for the foods or nutrients of interest and the level of precision required. A minimum of 3–4 days of intake is generally required for characterizing usual individual intake of energy and macronutrients. If seasonal variability is a concern, collection of several days of intake in each season of the year is recommended.

For food components with very high within-person day-to-day variability, such as cholesterol, vitamins A and C and alcohol, estimation of usual individual intake may require from 20 to more than 50 days of intake, which becomes impracticable. For those highly variable nutrients contributed by relatively few food sources, an FFQ focusing on the selected nutrients is likely to be the most accurate method of assessment.

3.3 Rapid methods of collecting dietary data

As a basis for documenting and understanding the food intake for developing FBDGs, rapid methods of dietary assessment can be very helpful (*25*). A rapid assessment procedure (RAP) survey usually involves focus group interviews with community leaders and for selected target groups, to gather information on food beliefs, behaviours and intakes. The trained interviewer works without preconceived ideas with the informant to create a knowledge base with minimal bias. A particular advantage of RAP methods is that they allow a more relevant food usage list to be developed for a community, which may then be used along with other more quantitative methodologies, such as for cross-checking food records or recalls or for developing FFQs. Thus, RAP methods, which are low in cost, may be used as the primary method for collecting data on which to base dietary guidelines, or may be used to enhance the validity of more quantitative methods.

The management of RAP databases has been greatly facilitated by the development of computer software. Of particular note here is the NUDIST program, developed by social scientists at La Trobe University, Melbourne, Australia, which is used widely for organizing sociological and anthropological data sets and which can be applied to food beliefs and habits.

Another approach to rapid assessment of food intake involves the use of a qualitative 24-hour recall to identify family and individual intakes. This method has been used in many countries, particularly in Africa for assessing infant and family feeding practices, and can be implemented by personnel with minimal training. The foods consumed the previous day by the infant, young child and mother or family are analysed according to the age of the young child (e.g. 0–2, 3–5, 6–8, 9–11, 12–17, 18–23 and 24–35 months). The services of a statistician to plan the study are recommended. The number of times each major food and food group are consumed per day is calculated. From this, one can deduce the main staples and other components in the common family diet, and whether all such components (e.g. foods of animal origin, legumes, dark green leaf vegetables) are consumed by the young children as well or only by older children and adults. The age at which various foods are introduced into the diet can also be derived.

By linking the food intake data collection with the weighing and measuring of children and the mother (to derive her body mass index from a standard table) and with questions on the occurrence of illness in the past two weeks, one can gain an overall picture of the nutritional status of the children and adults in the community, and whether the basic problems may be related more to feeding practices, to illness or to general food shortage. If there are marked seasonal changes, the studies should be repeated during other seasons.

This method also provides much valuable information quite easily and rapidly where resources are scarce. Culturally based dietary restrictions are identified without the need for direct questions; it is nevertheless useful to follow up (e.g. through focus groups) to identify the reasons for such restrictions and how they could be circumvented. The survey thus provides a basis for drawing up locally adapted dietary guidelines, especially for young children (*26*).

Another use of rapid assessment methods involves assessing common practices in a population, such as a high intake of tea in a country in which iron intake is low. The tea, which is regularly consumed by everyone, including children, is taken immediately after meals and thus interferes with iron absorption. To address this issue as a "food-based guideline", it would be helpful to explore whether the general population would be willing to postpone tea drinking for 2–3 hours after meals. Such information might be easily obtained from a number of short focus group interviews conducted among the major cultural subgroups of the population.

There is often a tendency to collect more information than is needed to answer a special question. Collecting additional data may initially appear advantageous, but experience indicates that such data are often not analysed and are therefore of little or no use. An attempt should be made to collect no more data than required to answer carefully formulated questions based on well defined needs for the information.

3.4 Conversion of food intake to nutrient intake data

Converting food consumption data to nutrient intakes requires both a food composition database and, ideally, computer programs for nutrient calculation. Developing a food composition database is very expensive, owing to the cost of chemical analysis for many foods and nutrients. Available regional food composition data should be carefully evaluated for the relevance of foods and food descriptions, as well as for the accuracy and completeness of the food and nutrient data. Professionals using the compositional data need to make separate judgements for each of the values to ensure appropriate interpretation and use. Any missing data on foods consumed by the population or missing nutrient values for the nutrients of interest should be added to the database. If the missing values are for foods that are frequently consumed by the target population, those foods should be chemically analysed. Nutrient values for foods eaten after cooking should reflect the cooked nutrient values. If only the raw nutrient values are included in the database, the software should be programmed to account for differences in yield and nutrient losses due to cooking.

Computer software should be used for nutrient calculations that are tedious and prone to error if done manually. Quality control procedures for data entry should be carefully adhered to. Such software already exists in many countries, and some of the programs may be linked to other nutrient databases. Developing and testing software is time consuming and expensive, and it is thus worth trying to locate and evaluate existing software for nutrient calculation. Software should be carefully evaluated, both for program features such as ease of data entry, reporting capabilities and hardware requirements, and for the quality of the nutrient database. Recipes and other methods of food preparation should be adequately accounted for in the nutrient calculations.

Computer software for international use in food-to-nutrient conversion is limited for the purpose of calculating population estimates of intake or exposure. The very large number of nutrient analysis programs worldwide commonly have limited database management or substitution functions. Most programs are designed for the local dietetics market, which make them difficult to adapt to large-scale food intake surveys or for planning government interventions. Professionals can select from several systems that do offer these functions, and choice will depend on the specific functions required by local objectives.

If FFQ data are often to be converted to nutrients, customized software may need to be developed to meet specific calculation requirements, where the answers to certain questions require modification of the nutrient content. For example, the answer to a question about trimming meats will require modification of the nutrient profiles for meat items.

Examples of sources that may be used for regional purposes are listed in Box 2. Some of the publications and documents may not be in print at present and may be available only through reference services.

3.5 Analysis of food intake data

Food intake data may be analysed in many ways other than by conversion to nutrients. The possibilities for analysis by individual foods, food groups, meal patterns and various eating practices are unlimited. The kind of analyses selected will depend on the questions of interest and the data available. In this section examples are provided of various types of analysis based on foods, food groups and eating habits that might be considered in developing or monitoring FBDGs.

3.5.1 *Analysis by individual foods*

In developing guidelines, it is often helpful to know which foods are most commonly eaten (i.e. consumed by the most people), as well as the foods eaten most frequently in a population. Information regarding the proportion of the population consuming the foods may be obtained from any one of the four general types of individual dietary data collection method, as well as from RAP methods. Household food consumption data may also be used to provide information on the foods most commonly consumed, although the results will relate

Box 2
Sources of regional food composition data

Australian food composition tables
National Food Authority, Canberra, Australia

Chilean food tables
Institute of Nutrition and Food Technology (INTA), Santiago, Chile

Chinese food composition tables
Chinese Academy of Preventive Medicine, Beijing, China

CTA–ECSA (Technical Centre for Agricultural and Rural Cooperation — Food and Nutrition Cooperation) database for East Africa
Tanzanian Food and Nutrition Institute, Dar-es-Salaam, United Republic of Tanzania

Ethiopian food composition tables
Ethiopian Nutrition Institute, Ministry of Health, Addis Ababa, Ethiopia

FAO regional food tables for Latin America, Africa, Near East, East Asia
FAO, Rome, Italy

Food composition and nutrition tables
Ministry of Food, Agriculture and Forestry, Bonn, Germany

Food composition data for West Africa
Data-processing Centre for Food Quality (CIQUAL), Paris, France

Food composition tables for Slovakia
Food Research Institute, Bratislava, Slovakia

Food composition tables for use in the English-speaking Caribbean
Caribbean Food and Nutrition Institute, Kingston, Jamaica

Food tables for Malaysia
Institute of Medical Research, Kuala Lumpur, Malaysia

McCance and Widdowson's "The composition of foods"
Royal Society of Chemistry and Ministry of Agriculture, Fisheries and Food, London, England

Nutrient data system
Nutrition Coordinating Center, Minneapolis, MN, USA

South African food composition tables
Medical Research Council, Tygersberg, South Africa

Standard reference database (Handbook No. 8)[1]
US Department of Agriculture, Washington, DC, USA

World food mini-list
University of California, Berkeley, CA, USA

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[1] The source most used by national database developers in complementing local food composition tables.

Table 2
Intakes of yoghurt by British men who eat yoghurt, by social class (N = 1127)

Social class	Mean population intake (g/week)	Percentage of the male population who eat yoghurt	Intake among consumers (g/week)
I & II	90	30	298
III-a	37	22	254
III-b	45	14	313
IV & V	31	12	247

Source: J. Gregory et al. (*27*). Reproduced by permission of the Office for National Statistics, London (Crown copyright).

to frequency of consumption by the entire household rather than by individuals. Knowledge of the proportion of the population consuming specific foods is useful in developing FBDGs aimed at increasing or reducing the intake of those foods.

It is important to recognize that, with the exception of staple foods, food intake data tend to be heavily skewed. For example, in some circumstances a large proportion of the population may consume a small amount of a food, while a small proportion of the population may consume a large amount. Unless population subgroups are identified, the range of intakes will be hidden by an "average consumption figure", which in turn may erroneously be assumed to represent the intake of every individual. This is illustrated in Table 2, where the differences in yoghurt consumption in the United Kingdom by men of different social classes (range 31–90 g/week) are due both to the different percentages of men in each social class who consume yoghurt, and the different mean intake of yoghurt of each group of consumers (*27*).

It is important to keep in mind that an estimate of usual individual intake is needed for determining the proportion of individuals consuming a given food with a given frequency. If food records or 24-hour dietary recalls are used for this purpose, multiple days of intake per individual are required, owing to day-to-day variability in food intake among individuals. FFQs may provide a more accurate picture of the proportion of consumers of a given food.

3.5.2 *Analysis by food groups*

Foods are often classified according to a limited number of groupings to facilitate dietary guidance and education of the population. Dietary recommendations may then be based on proportional quantities of each food group. Individual or household food intake data may be analysed by food group to evaluate the overall quality of the diet. Examples of food groupings used for dietary guidance and evaluation in several countries are given in Annex 2.

A food grouping scheme should be based on the typical eating patterns of each country and the common ways of describing foods in that population. To facilitate education and intervention, the grouping should also correspond to nutrition-related concerns of the particular country. Food grouping schemes also facilitate analysis of food intake data, both with and without conversion of foods into nutrients. If nutrient data are available, it is useful to know which food groups are the major contributors to nutrients of particular concern. In the absence of nutrient data, food intakes may be analysed by distribution of intake among the food groups.

3.5.3 *Analysis by meal patterns*

In some countries, analysis of food intake patterns through meals is possible because of the regularity with which meals are eaten and the relatively narrow range of foods that constitute the meals. In the urban areas of developed countries, meal patterns generally vary both in time of day and in the foods eaten. In such countries, the term "eating occasion" may be preferable to "meal" or "snack", since the definition of each of the latter is highly subjective. Eating occasions can be so close together that it many become difficult to know whether one is dealing with one or two separate occasions. Notwithstanding these difficulties, characterizing meal patterns or eating occasion patterns may provide useful data for developing and evaluating dietary guidelines.

Meal-based analyses provide data on the types of food that are often eaten together. Such information should be taken into account in developing guidelines to ensure, for example, that promoting an increase in the consumption of one food or food group does not result in a change in intake of other foods that may have a negative impact on the total diet.

3.6 Approaches to monitoring the effectiveness of established guidelines

A number of methods may be used to monitor the effectiveness of an established dietary guideline. Agreement among several different types of data increases confidence in the results of the evaluation. For example, a guideline designed to increase calcium intake may be based on the results of a national survey of individual food intakes, indicating that mean calcium intake is less than 50% of the recommended level, coupled with observations of a high incidence of hip fractures and osteoporosis. The "food-based guidelines" might stipulate, for example, that all healthy people should consume at least three servings of dairy products daily and three servings weekly of dark green leaf vegetables. Subsequent monitoring of this guideline might involve comparison of the baseline calcium intake with mean calcium intake, using data from a recent national survey of individual intakes. Owing to the high cost and time involved in conducting a national survey, however, it is unlikely that such data would be available when they are needed. Another approach might therefore be to look at national food disappearance or household food consumption data with respect to changes in the availability of the targeted foods. Similar changes might also be noted in production trends and in market research data. Finally, changes in health outcomes, such as a reduction in hip fractures or the incidence of osteoporosis, would be monitored.

In other circumstances, appropriate biomarkers, such as urinary sodium and iodine concentrations, can be used as indirect but objective measures of dietary intake for both monitoring and assessment purposes.

Evaluation of the effectiveness of a specific guideline should also include an assessment of possible negative impacts on other dietary factors. In the case of the example of calcium given above, one would also look at the impact of increasing the intake of dairy products on fat intake, if that were also a concern in the population. Common food preparation practices should also be taken into consideration in evaluating the effectiveness of a particular guideline. For example, increasing rice consumption might also increase fat intake if rice is commonly prepared or eaten with a substantial amount of added fat.

Another aspect of evaluating a dietary guideline is the proportion of the population meeting the guideline. Such data can be obtained only from dietary surveys of individuals. Collecting data on at least two days of intake per individual will allow one to estimate the distribution of usual individual intakes within the population. Identification of the characteristics of those furthest from meeting the guideline may be helpful in targeting future efforts to promote the message.

4. Development and implementation of food-based dietary guidelines

This section provides guidance on how a country can develop and implement FBDGs. This guidance is provided in two main parts:

the first concerns the development of the guidelines; the second provides advice on how they can be used to improve dietary practices.

In preparing FBDGs, countries should keep in mind that guidelines are always subject to change, and that many factors have to be taken into account in preparing them. Many different sources of information should be reviewed and considered before FBDGs can be developed, and countries should base their review on the available local, regional or international information. As additional scientific information on the effects of the guidelines becomes available, further consideration might be given to changes or adjustments in the FBDGs. Also, in the review process leading to these guidelines, a wealth of food, nutrient and health information should be reviewed and synthesized; this in turn may lead to additional recommendations to policy-makers and technical experts, which will supplement the FBDGs.

In developing guidelines, countries may wish to set high goals such as a greatly improved food supply and a healthy and well nourished population. FBDGs are an important part of achieving such long-term goals, but the guidelines should be practical, dynamic, flexible, and based on the existing situation and what can be achieved in the short to medium term. The guidelines will be an important part of a country's overall plans to reach these goals, especially national plans of action to improve nutrition in response to the World Declaration and Plan of Action for Nutrition (*1*) and other major agricultural, health and educational policies and plans.

4.1 Forming a working group or committee

The Consultation considered that an interdisciplinary working group would be needed to prepare FBDGs. In order to begin the process, policy-makers such as ministers of agriculture and of health should be made aware of the beneficial uses of dietary advice with regard to food supply planning, better health status, reduced health care costs, and improved work, growth and learning capacities for different population groups.

Groups of concerned individuals, and others working in the areas of health, agriculture, education and communication, need to take action to increase awareness of the importance of developing and implementing FBDGs, so that government policy-makers will appreciate the value of this work as part of the overall move towards improving nutrition. Appropriate briefing papers, seminars and public information, using various channels of communication, may all be helpful in encouraging the formation of a national working group to prepare FBDGs.

Countries with agencies concerned with policies affecting food and nutrition may already have dietary guidelines, largely expressed in the technical terms of nutritional science. Recommendations such as "no more than 10% of energy as saturated fatty acids (12:0 to 16:0)" tend to be meaningless or confusing to the majority of people who have not made a special study of nutritional biochemistry and who do not have their own set of food tables. To make dietary guidelines more practical and better understood, and to increase their impact on food habits, they need to be translated from nutrient-based dietary guidelines into FBDGs.

The process may be initiated by criticism that current nutrient-based dietary guidelines are impractical and ineffective. Such concerns may be expressed by consumer groups, journalists, sociologists and others concerned with nutrition education, who may persuade the ministries most concerned (typically those of health, education and agriculture) to set up a working group to develop FBDGs. Realization of the need for dietary guidelines may originate in the health sector because of the drain on resources of increasing morbidity from noncommunicable diseases, some of which are related to diet.

Countries with limited resources, and that have few professional nutritionists, may not yet have dietary guidelines. In such cases, the most appropriate guidelines would take into account both traditional food habits and changing practices where imported and newly produced foods have become common.

Some guidelines may already be part of national policies, aimed at improving nutrition, some of which may be supported by funding from FAO, UNICEF and/or WHO. These may include, for example, national action plans for nutrition, the control of iodine deficiency disorders and breast-feeding. Governments in general favour dietary guidelines because they are not costly to prepare, do not require imported machinery or expensive staff, and aim to reduce expenditure on noncommunicable diseases.

Someone, inside or outside government, must start the process, generate some enthusiasm among other key players, and press the appropriate ministry to set up a working group. The food sector has usually accepted and even welcomed dietary guidelines because they reduce confusion about nutritional goals and help with forward planning.

Some countries may seek technical help to develop guidelines by asking FAO or WHO to provide a temporary adviser with appropriate experience to assist in the work. When neighbouring or similar countries have already produced dietary guidelines, these can be utilized and adapted to form part of the basis of the new guidelines. In using guidelines from other countries, however, it is important that they be modified for suitability, acceptability and compatibility, and to address the disease problems and the preferences for and availability of food in each country.

When the decision is taken to form a national working group all countries, whether developed or developing, must ensure representation of all major groups, including senior representatives from the ministries of agriculture, health and education, from the nutritional science and food science sectors of academia, from consumer groups and other pertinent nongovernmental organizations, and from the food industry. Having broad representation on the working group is important to ensure that all points of view are considered, and to provide communication with, and feedback from, all sectors concerned. FBDGs should be based on the realities in each country and on what can be achieved over time. The information needed, whether scientific, sociological, technical or trade-related, can only be obtained by such a broad approach.

When the working group is formed, it will have to organize and carry out a wide variety of work leading to the development of FBDGs. Box 3 sets out the tasks to be performed, and the following sections give more detail about this work.

4.2 Developing the guidelines

The issues to be considered in the process of developing FBDGs are presented in this section. The steps and actions are not given in order of priority, thereby allowing individual countries to adapt them to their own requirements. Some activities described in each step could run simultaneously. The guideline development working group should coordinate all the steps, and should consult as extensively as possible to ensure a successful outcome.

4.2.1 *The information review stage*

Step 1. Review of diet-related health patterns, diseases and mortality
Information will be needed on the conditions of concern and whether those conditions are related to diet and nutrition (see Annex 1 for details).

The nutrition problems of public health significance, such as overnutrition and undernutrition, should be identified, using information on anthropometry and biochemical indicators where available.

Box 3
Suggested steps for developing FBDGs

- A working group or committee is formed, comprising representatives of agriculture, health, food science, nutritional science, consumers, the food industry, communications and anthropology.
- Appropriate technical focal points provide data on nutrition-related diseases and on food availability and food intake patterns in the country. Members of the group are invited to suggest nutritional objectives.
- The working group or committee identifies, after full discussion, a set of major nutrition-related health problems for which dietary guidelines could be useful. The group also evaluates the general food production and supply situation by considering current practices, subsidies and other governmental policies and problems, to see whether FBDGs can be implemented in the present situation.
- A set of draft FBDGs is formulated.
- Background statements for each FBDG are prepared, and each statement is circulated to all group members.
- The working group or committee meets again and each background statement is critically reviewed and revised. The wording of guideline statements is pilot tested with consumer groups, revised as needed and carefully checked.
- The background statements are finalized, consolidated and sent to interest groups in the country (and possibly also to international advisers) for comment.
- The working group or committee meets again to consider changes in view of the comments received.
- Finally, the secretary of the group puts together a draft of the final report. The group finalizes and adopts the draft and publishes and disseminates the final report.

The magnitude and severity of these problems should be estimated by looking at morbidity and mortality rates as well as costs and trends.

Age groups and specific population groups affected by the different problems should be distinguished.

An attempt should be made to determine the probability, magnitude, severity and cost–benefit relationship of diet-related diseases in order to begin listing them in order of priority.

Descriptions of most of the health indicators and their use, cut-off points and global distribution can be found in various WHO documents and publications (see, for example, references *28–44*).

Other sources of diet-related health data include local health statistics on mortality and morbidity and nutrition surveillance data, national action plans on child development and nutrition, and special studies by universities, research organizations, government agencies, food manufacturers, etc.

Step 2. Review of food consumption patterns

Food intake patterns should be examined, including changes or trends over time. If information on food consumption patterns is not available, one should determine whether there is a need for a survey or data collection on food and/or nutrition and, if so, the method that should be used (see section 3 for details on methodology). Other useful information can be obtained from food balance sheets, household expenditure surveys, etc. (see section 3 for details on methods of data collection and use of such information).

Food intake patterns for population subgroups, such as infants, young children, pregnant and lactating women, the elderly and ethnic groups, should be identified, as should food preferences and other factors influencing food consumption patterns, such as culture, tradition, religion and taboos. Desirable traditional or other current food patterns and practices that could be reinforced should also be sought.

An assessment should be made of food availability throughout the country, taking into account seasonality, market prices and availability, household food production, imports and exports, processing, overall production and availability (such as how much food is eaten by people rather than animals) and food fortification.

Sources of local food data include agriculture surveys, FAO national food balance sheets, FAO nutrition country profiles (covering 104 countries) and national household expenditure surveys. Additional sources of useful data include the country reports from the International Conference on Nutrition and various multicountry risk factor studies such as the WHO Integrated Programme for Community Health in Noncommunicable Diseases (INTERHEALTH) (*45*) and the International Study of Electrolyte Excretion and Blood Pressure (INTERSALT) (*46*).

Step 3. Links between diet and health

Conclusions should be reached on the likely magnitude of links between diet, health and disease and the degree to which the problem is diet-related. Nutrient and/or food intakes should be evaluated in comparison with available reference values (see Annex 1), noting dietary deficits, excesses, imbalances and interactions, etc. in defined groups.

Nutrient and/or food intakes should be evaluated in comparison with established food–nutrient–disease relationships (see Annex 1). Priority diet-related diseases should be identified, taking into account internal and/or external concerns. For example, hypertension might be a priority concern in the country (internal concern) while donor funds might be available for addressing iodine deficiency diseases (external concern).

The desirable and attainable nutrient intake levels should be determined, and the methodology for converting nutrient guidelines to food-based guidelines should be decided on (see section 2).

Step 4. Consistency with relevant national policies

Health policies affect nutrition through their influence on the sociocultural and physical environments and demography. An important aspect of health policy is the need to reduce disparities in health and nutritional status and inequities in access to health and nutrition services. Vulnerable population groups, such as urban slum dwellers, women of childbearing age, refugees and displaced persons, are particularly at risk of malnutrition, and directing health policies and programmes to meet their needs could significantly protect and promote their nutritional well-being.

Agricultural policies have an impact on nutrition, on the level and stability of food production, and frequently on the income of nutritionally at-risk households, food prices, the time women spend on household tasks, and the nutrient content of foods. Increasing the production of traditional food crops, such as roots and tubers, pulses and legumes, by small producers would directly improve food supplies for nutritionally vulnerable groups.

Nutritional well-being ultimately depends on society's capacity to manage the interaction between human activities and the physical and biological environments in ways that safeguard and promote health and do not threaten the integrity of natural systems. The physical environment has a major influence on human health not only through soil, water, air and climate, but also through its interaction with the biological environment.

Education policies play a key role in promoting healthy diets and lifestyles. While the content and emphasis of educational messages vary according to lifestyle, culture and access to natural or processed foods, the goal of nutrition education is the same: to preserve healthenhancing dietary behaviour that contributes to good health. In addition, such social factors as housing policy have an effect in the sense that inadequate shelter, poor ventilation, lack of facilities for solid waste disposal, air and noise pollution and overcrowding will always have negative consequences for health and nutrition.

The implications of population policies on nutrition are significant, particularly in countries with a food deficit where rapid population growth and urbanization continue. As with environmental issues, addressing population concerns is fundamental to improving nutrition. In addition, considering the relatively poor state of maternal health and the important role women play in family welfare and often in food production, strong policies in favour of maternal health services, including family planning, are important.

Macroeconomic policies, such as those relating to exchange rates, wages, prices and foreign trade, may affect the nutritional status of different population groups. Macroeconomic policies can adversely affect nutrition if they discriminate against the food and agricultural sectors and rural areas, and against poor and vulnerable groups, or if they curtail such social services as health, education or targeted food subsidies, particularly in developing countries undergoing structural adjustment.

Finally, consideration must be given to how the change in food pattern being advocated will affect the total diet.

Step 5. Defining the problem

The situation (e.g. good or bad health, disease pattern, nutrient deficiency or excess, dietary practice, or food supply and marketing practice) that warrants the development of FBDGs should be determined, as should the food groups of primary interest (see section 3 for details on conversion from nutrient data to foods). All interested parties should be consulted after steps 1–4 and the priorities modified as necessary.

Step 6. Defining the content of and target groups for FBDGs

The following questions need to be considered:

(a) Is a single set of guidelines needed or are multiple sets required, e.g. for urban and rural populations?

(b) Are the guidelines to include children, infants and other vulnerable groups?

(c) Are the guidelines compatible with the potential food supply?

(d) Are the guidelines environmentally sustainable?

(e) Should the guidelines be made available in the different languages used in the country?

(f) How many food groups are needed, and how will they be named?

(g) Should branded, packaged foods be included in the food groups?

(h) How should different cuisines and religious requirements be accommodated?

(i) How should the wide range of nutrients between individual foods in food groups be accommodated?

(j) How can allowance be made for the wide range of energy requirements between different subgroups and individuals?

(k) How can recommendations be expressed on specific food components in the food groups such as protein, fats, fibre, salt and sugar?

(l) Should water and other drinks be included in the guidelines?

(m) Should the guidelines address issues of food and water safety and sanitation, including the safety of complementary foods for young children?

(n) Should the guidelines address weight, exercise and other lifestyle factors?

Step 7. Defining the purpose, goals and targets of the guidelines

When drawing up the guidelines, the following points should be considered:

- The target groups selected and the broad strategy adopted may have a major influence on the form and content of the guidelines as well as on the mode of dissemination.
- The guidelines are part of general health advice, which includes statements that relate to other lifestyle factors such as exercise and smoking.
- A statement should be included in the guidelines to the effect that they provide advice to the healthy general population about food choices, in order that the usual diet will contribute to a healthy lifestyle and reduce the risk of developing diet-related diseases.
- The guidelines should address the total diet and not just individual foods or the basic or core diet.

- The groups to which the guidelines apply should be identified. This will usually be adults, but specific guidelines may be targeted to other special groups such as infants and young children.
- It must be emphasized that the guidelines are to be used as a complete set and that no one guideline is to be used in isolation.
- The order in which the guidelines are set out is optional, but it must be clear and country-specific. Priorities may differ between different subgroups and may change with time.
- The guidelines must be consistent with nutritional reference values (see Annex 1).

4.2.2 *The drafting stage*

A drafting group should be formed, and responsibility allocated for preparing statements on the rationale and justification for each guideline. The draft should be circulated to relevant groups, including consumers, nutritionists and professionals in the health and agricultural sectors and the food industry. The guidelines should then be reviewed, taking into account feedback from all interested parties. The review process can include seminars or other types of meeting.

The guidelines should then be evaluated for wording, content, etc. to ensure that they are appropriate for the general public. Ideally, this requires the services of a nutrition educator and/or communication expert (see section 4.3). The guidelines can then be published and implemented.

4.3 Implementation

Dietary guidelines have become an almost universal tool in food and nutrition policy development and nutrition education. Merely having a set of dietary guidelines, however, will not guarantee an effective nutrition policy or that the population will follow the advice given. Attention should be paid to communicating dietary guideline information effectively to the public. In fact, two guideline documents might be produced, one of a more quantitative nature for policy-makers and health professionals and a more qualitative version for the general public. It is difficult for one document to serve well two different purposes, i.e. public policy and nutrition education.

The purpose of this section is to describe the important factors to consider in the process of implementing a dietary guideline for the general public.

As emphasized throughout this report, FBDGs should be scientifically sound. However, there are a number of other factors that should also be considered. To make the guidelines meaningful to the general public, they should be short, simple, clear, easily remembered, culturally appropriate and communicated well through a variety of media. Ideally, they should be multimedia and multisectoral, address all relevant community groups and ages, and complement existing community programmes. Important content issues are set out below.

4.3.1 *Practicality*

The guidelines should be practical; otherwise the general public will not use them. The recommended foods or food groups should thus be affordable, widely available and accessible to most people in the country, taking into account geographical variation. In addition, the guidelines should be flexible: they should be suitable for people of different ages and energy requirements, and take into account physiological states such as pregnancy and lactation.

4.3.2 *Comprehensibility*

Dietary guidelines will fail if they are not understood by the general public. In industrialized countries, the reading level should be equivalent to 4–5 years of primary education whenever possible. In many other countries, much lower levels of literacy or even illiteracy should be assumed. In addition, the terminology should represent both everyday usage and scientific meaning, and this can pose problems. For example, the public may misinterpret words such as "fat" (perhaps presuming that it comprises only visible fats in foods or does not include oil), or such terms as "too much", "moderation", "avoid too much" and "eat less of" (*47*). If the public does not understand the guidelines, they will either dismiss them or misapply the advice because of misconceptions (see Table 3).

If food groups are incorporated into the dietary guidelines, the groupings should make sense to the public. In the past, many foods have been grouped according to nutritionists' schemes, such as energy foods, body-building foods and protective foods (*48*), but the public may not consider that some of the foods grouped together, such as seaweed and mango or rice and sugar, "belong" together. Food groupings in dietary guidelines or accompanying educational materials should therefore complement the food classification systems used by the target population.

Similarly, visual materials used to illustrate the guidelines should be readily understood. Concrete rather than abstract illustrations should be used (*49*). For example, interlocking hexagons used in several versions of the dietary guideline brochures produced in the USA were

Table 3
Percentages of women and men with misconceptions about fat and cholesterol at first interview

Misconception	Women	Men
Fat-related		
The amount of fat consumed can be changed by switching to oil or margarine	44	8
Fat clogs arteries	23	10
Saturated fat has more fat and/or calories than unsaturated fat	21	25
Fat is not a nutrient	21	10
Saturated fat has more cholesterol than unsaturated fat	12	3
Saturated fat is less efficiently used than unsaturated fat	6	20
Cholesterol-related		
Cholesterol is found in fatty foods	52	35
Cholesterol is needed in the diet	35	12
Cholesterol is found in plant foods	27	25
Cholesterol is a fat or a component of fat	23	18
A reduction in dietary fat reduces dietary cholesterol	21	0
Fish and chicken are low in cholesterol	19	35

Adapted from: G.W. Auld et al. (*47*). Used by permission of Gordon and Breach Publishers, Lausanne, Switzerland.

not understood or remembered by consumers (*50, 51*). Recently, the food guide pyramid (*52*) has become a popular teaching tool and is better understood by the public.

In summary, comprehension of the guidelines by the public is critical to their success. Field testing for comprehension should be a requirement before the guidelines are released.

4.3.3 *Cultural acceptability*

Dietary guidelines will fail if the public finds them culturally unacceptable. The most important factors influencing acceptability are current food habits and the specific recommendations or examples given in the guidelines (*53*). For example, guidelines or food groupings that promote meat will clearly be rejected by vegetarian populations. Recommendations that run counter to religious views or that propose radical changes in current practices will also be rejected. Recommendations on small changes and on familiar foods will be better accepted. The size of portions, the number of recommended servings and traditional food preparation techniques should also be considered. In terms of presentation, language or dialect, illustrations (such as the ethnicity of people shown) and choice of colour (such as those that represent certain political parties or other associations) can also affect the acceptability of recommendations.

The method of communication may also be more or less culturally acceptable. The choice of who conveys the message (e.g. their credibility) and how they deliver the message (e.g. whether it is readily accessible and accepted) should also be considered in a cultural context. Variations in educational level and rural versus urban needs may also need to be addressed. Again, testing of the guidelines in the target population and their revision as necessary are essential to meet cultural acceptability.

4.3.4 *Who should be involved*

The FBDG working group should recognize that many factors will affect implementation of the guidelines and should adopt a cooperative partnership with experts involved in the promotion of better nutrition and health. Communications experts can be called on to draft messages in an appropriate and appealing form and to devise effective means of conveying them to the general public. Nutritionists should check the content of the messages to ensure their technical correctness and validity.

Priority should be given to disseminating the information to current food distribution, food service and nutrition programmes. Such programmes, whether sponsored or supervised by nongovernmental organizations, the public sector or private enterprise, should be encouraged to adopt the proposed guidelines and to spearhead their immediate and practical application. The working group should also seek the participation of educators, health professionals, social workers, extension agents, nurses and others in disseminating the information widely.

Key people and trainers involved in the dissemination process should be encouraged to acquire the background information necessary for interpreting the messages. Workshops and seminars can be designed to help these people fully comprehend the broad concepts and specific messages presented in the guidelines.

5. Transforming the guidelines into messages and slogans

This section describes the translation of the draft guidelines into materials suitable for the public. Brochures, posters and 10-, 30- and 60-second "sound bites" for radio and television can also be produced. This process will involve many revisions of the guideline statements.

5.1 Multiple versions

In general, countries should limit the number of versions of the guidelines to one, and certainly to as few as possible. Multiple versions may increase confusion among the public, making communication more complicated and costly. In some countries, however, there may be populations with such different food beliefs, food patterns and health status that several sets are needed. Other countries might consider separate guidelines for infants and young children or for pregnant and lactating women. If a country has no guidelines at present, it is suggested that only one set be developed at first; any additional sets needed can be developed later.

5.2 Testing the guidelines

It has been suggested that the working memory deals successfully with no more than seven concepts (*54*). Each guideline should therefore contain a maximum of seven messages.

The validity or credibility of the guidelines should first be checked with nutritionists as well as consumers' representatives, such as schoolteachers, community leaders and the general public. They can be asked simply to read the guidelines and use a checklist to rate credibility, meaning, affordability, acceptability, etc. The guidelines should then be revised accordingly. Mock-ups can then be made of the proposed form of distribution to the public, such as brochures or posters. Artists and communication experts need to work with nutrition experts to ensure such presentations are accurate as well as appealing. In other words, the goal is to draw the public's attention to the guidelines and effectively communicate their content.

Such products can then be tested on the general public, using focus groups to determine the appropriateness and cultural acceptability of the content and visual presentation. Focus groups should comprise 8–15 people, and enough groups should be consulted to yield a fair representation of the variability of the population by geographical area, religion and/or education. This procedure does not require scientific sampling; three focus groups per region may be sufficient. Andrien (*55, 56*) provides further information on the methodology of testing.

The next step is to conduct a more in-depth evaluation of consumers' understanding of the guidelines. Brochures, posters or sound bites can be given to representative individuals to read or listen to as appropriate. These individuals should then be interviewed to ascertain how they interpret the words and advice given in the guidelines (see Annex 3 for a sample interview protocol). Consumers can also be asked how they would apply this advice in their own lives. Between 10 and 20 interviews should be conducted with each special audience group (*55, 56*). The interviews need to be transcribed (by hand, if necessary) for analysis. Analysis procedures are qualitative and should focus on the identification of misconceptions that are common across the data set; isolated misconceptions cannot be dealt with. On the basis of these data, the materials should again be revised; this step may need to be repeated several times to ensure that the revisions are properly understood by the target audience(s).

Finally, the validity of the content should be rechecked by experts to ensure that the final statements are still consistent with the science behind their development.

5.3 Educational materials

Educational materials and programmes can be developed to support the dietary guidelines and documents published in each country. The purpose of these is further to explain and develop the content, application and implications of the guidelines in people's everyday lives. For example, instructional materials can address in detail issues such as size of servings, traditional foods, and packaged and branded versus home-produced foods. One can also address such issues as: food fortification; designer and functional foods; hard-to-categorize foods including mixed dishes; imported foods; different cuisines, languages and dialects; how to adapt advice to different ages, physiological needs and special audiences (see Annex 2). For example, a single set of dietary guidelines could be translated into a variety of languages, with the food lists and illustrations suitably adapted to the culture in question. Relevant discussion about food preparation techniques could also included.

In translating FBDG messages into educational materials, all relevant stakeholders should be involved. Representatives of the food industry, religious and community leaders, dietitians, health care workers, consumer representatives, teachers, extension workers and other educators should be encouraged to develop and/or implement educational materials and programmes. Partnerships among these groups should be promoted to ensure the quality of the materials, and that they reach the target audience(s).

5.4 Media strategies

A multimedia approach to education is to be encouraged. When the same message is communicated and reinforced by a variety of media and settings, the impact is likely to be greater. The educational packages should therefore ideally include poster and print materials, other visual products and activities that individuals can either perform alone (e.g. a shelf inventory of home food supplies) or in groups.

In either case, people will learn best if they have the opportunity to practise applying the guidelines, preferably with supervision and feedback on their performance. Lesson plans should be included for groups. If a mass media campaign is to be conducted, the educational materials should be coordinated with it. For example, a dietary guideline curriculum and learning activities should already be in place and taught in local schools when a national radio campaign begins.

5.5 Time

The more time given to nutrition education, the more people will learn. Dramatic increases in learning and application can be noted when cumulative instruction increases from 15 minutes to 2 hours to 15 hours per year. However, the maximum learning period in any one session is 20 minutes, especially with young people. Educational sessions should not last more than an hour for any audience, because attention will be lost and learning efficiency and effectiveness will decline. It is worth noting, too, that many secondary school teachers are reluctant to add nutrition to the curriculum because of time constraints, a problem that may be overcome by developing better curricula.

5.6 Curriculum development

A curriculum is a planned, sequential set of lessons, whereby each lesson ideally builds on the knowledge provided in the previous lesson. Nutrition education has often made the mistake of being repetitive. In the USA, for example, children are often taught the basic food groups in the first, third, fifth, eighth and twelfth years of school (at about, 6, 8, 10, 13 and 17 years of age, respectively). Through such repetition they may become bored and pay no attention. The approach should rather be to order all the relevant concepts from simple to complex and teach them sequentially, matching the level taught to the students' understanding, whatever their age. For example, third-year students may be able to learn only a set of food group names and some of the foods in each. Fifth-year students may learn the number of recommended servings and serving sizes. Older students may be able to learn something about the nutrients in each food group and thereby learn the rationale for the groups, but only if they have already mastered the simpler information.

5.7 Training

Most educational programmes need to prepare teachers and trainers to ensure proper implementation and instruction. Such preparation should be planned during the development of teaching materials.

6. Monitoring and evaluation

The effectiveness of mass media and other campaigns, as well as educational programmes, needs to be evaluated. Two major types of evaluation are discussed below.

6.1 Process evaluation

The purpose of process evaluation is to assess how a message or programme was disseminated or implemented in the field. This information places the results of outcome evaluation in context and informs project managers and policy-makers why a programme does or does not work. These results can then be used to modify or adjust the campaign to improve its outcome. This type of evaluation poses questions on such topics as how many messages were broadcast, how often, at what time, to whom and by whom. It may also assess the acceptability and credibility of the message to the target audience. For educational programmes, process evaluations typically ask how many lessons were taught, in what order, to whom, who taught the lessons and how much time was spent on each. The most important question in any process evaluation is designed to determine whether the communication campaign or educational programme was implemented as it was designed and intended.

Process evaluations are generally conducted by survey (personal interview, telephone or mail) at one or more points during the implementation phase. Focus groups can also be used. Sample sizes are relatively small, but it is important to try to sample a full range of responses. If conducted early in the campaign or programme, the results can be used to make adjustments; if conducted later, they can be used to plan the next campaign or programme.

6.2 Outcome evaluation

The purpose of outcome evaluation is to assess the results or impact of the campaign or programme at its completion. In communications campaigns, it is usual to measure awareness and any change in knowledge, attitude and, if appropriate, behaviour or practice. Sample sizes should be sufficiently large to detect statistical changes. Behaviour should not be the only outcome measure, especially if the change in behaviour sought is large relative to the effort made in the campaign. For example, it may be unrealistic to expect women to change breast-feeding practices on the basis of one radio message per day, but realistic for one message per day to increase awareness and discussion of the issue within a community.

Evaluation methodologies rely primarily on surveys. Open-ended questions have the advantage of capturing answers in the respondent's own vocabulary, but the data may be more difficult to analyse. Closed questions (e.g. multiple-choice questions or those a simple yes or no) are easier to analyse, but their validity may be questioned. It is beyond the scope of this report to describe how to construct such surveys, but some expertise is required to produce high-quality results. Training or consultation in this area is therefore highly recommended if the expertise is not already available.

Other methodologies should not be overlooked. As stated earlier, focus groups may also be used. In addition, changes in household or commercial food production, consumption trends and dietary intake can also be monitored and evaluated to determine programme impact (see section 4 for a more elaborate description of these methodologies).

Health outcomes, including biochemical indicators, may be appropriate in assessing dietary guideline programmes in some circumstances.

7. Recommendations

1. FAO and WHO should periodically review the present report in the light of the experience of those who have used it to guide their activities.
2. FAO and WHO should, to the extent possible, assist governments in developing, implementing and monitoring FBDGs.
3. FAO and WHO should continue to encourage relevant research and should disseminate information on the development and implementation of FBDGs, so as to promote cost-effective approaches to improving health and nutrition.
4. The FAO/WHO recommended dietary intakes from 1974 (*12*) should be revised and updated. A number of other FAO and WHO publications providing recommendations on nutrition (*9–14*) should also be updated.
5. FAO is encouraged to assist in further developing, updating and disseminating food composition data for countries and regions.

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Annex 1

The scientific basis for the relationship between diet, nutrition and health[1]

1. Introduction

Dietary patterns have varied over time depending on agricultural practices and climatic, ecological, cultural and socioeconomic factors that determine the foods available. At present, most naturally occurring dietary patterns satisfy or even exceed the nutritional needs of most individuals, except where agricultural and socioeconomic conditions limit food availability and food purchasing capacity or cultural practices restrict the choice of foods.

The quantitative definition of nutrient needs, and efforts to express them as RNIs, have received the attention of international bodies and of nutrition scientists in many countries. This nutrient-based approach is commonly misapplied, however, and has led to considerable confusion among policy-makers in both the food and health sectors, as well as among nutrition educators and consumers.

FBDGs can serve as an instrument of nutrition policies and programmes, and should be based directly on diet and health relationships of particular relevance to the individual country. In this way, priorities in establishing dietary guidelines can address the relevant

[1] This annex was prepared, on the basis of the background papers and subsequent discussions, by a working group appointed by the Consultation. The working group comprised Dr A. Aro, Dr J. Blumberg, Dr I. Darnton-Hill, Dr C.F. Mills and Dr M.L. Wahlqvist.

public health concerns, whether they are related to dietary insufficiency or to dietary excess.

In this context, the first step in the process of setting dietary guidelines is to define the significant diet-related public health problems in a given community. Once these are defined, the diet component is evaluated, including the assessment of the adequacy of the food supply and consumption pattern. A comprehensive strategy to attack the problem should be defined, including the development of dietary guidelines. In this setting, RNIs can assist in assessing whether the proposed diet is likely to meet nutritional needs and provide a basis for consumer information about the nutritional quality of foods.

Dietary goals should be specific for a given ecological setting. Their purpose is to promote overall health, control specific nutritional diseases whether induced by deficiency or excess of nutrient intake, and reduce the risk of multifactorial diet-related diseases. Dietary guidelines represent the practical way to reach the nutritional goals for a given population. They take into account the customary dietary pattern and indicate which aspects should be modified. They consider the ecological setting, the socioeconomic and cultural factors, and the biological and physical environment in which the population lives.

2. Rationale

No single food — except breast milk in the first 4–6 months of life — provides all the required nutrients. A range of nutrients is needed, in amounts that change throughout life, for optimal growth, health and avoidance of disease. A great variety of diets and foods is consumed in various combinations. Over the ages, many national and local dietary patterns have shown themselves capable of providing adequate nutrients and supporting good health.

There is good scientific evidence that dietary patterns, i.e. the daily combination of foods and beverages generally consumed, have specific health or disease outcomes. For example, a diet may be apparently adequate in all ways but still be deficient in, say, vitamin A or iron and this will lead to a specific disease outcome. Conversely, a diet high in saturated fats and energy is known, on a population basis, to lead to an increased likelihood of certain noncommunicable diseases.

Consequently, FBDGs need to take into account: food and health patterns; the relative comprehensiveness of the food-versus the nutrient-based approach; the practicality of suggested goals; the limits of nutrition labelling (which may direct the consumer to an oversimplified view of foods); and evolving understanding of the nutritional basis of disease and health (the biological effects of food and food patterns can be greater than the sum of their nutrient and non-nutrient parts). Such guidelines should also be based on some of the following generally established principles.

- Food availability is the first requisite for the application of dietary guidelines that address food choice.
- Sufficient food diversity is required for acceptable macronutrient intakes, quite apart from optional or preferred intakes.
- Measures of food diversity are required in the next generation of dietary guidelines.
- The cultural context in which foods are produced, prepared and eaten should be taken into account for the satisfactory structuring of dietary guidelines in relation to macronutrients and other nutrients.

While the main report generally takes an untraditional approach by looking at foods, the review of current scientific evidence in this annex considers nutrients: macronutrients, including water and alcohol; micronutrients, including vitamins and minerals; and non-nutrient food components, including the nutritional implications of novel or "functional" foods (see page 87).

3. Use of nutrient densities rather than absolute RNIs in the development and evaluation of dietary guidelines

The traditional approach to providing dietary guidance and evaluating the nutritional adequacy of diets has focused on RNIs or RDAs for specific nutrients. This approach is commonly misapplied and has proved inadequate for developing effective nutrition education programmes. An alternative approach to traditional RNIs, and one that can better address issues of "optimal" nutrient intakes, is the use of the nutrient density concept applied to the total diet.

The concept of nutrient density was originally developed to compare the contribution of a food or diet to the intake of essential micronutrients and protein, in relation to the energy that it provides. Thus, a food that is a good source of micronutrients or protein would have a high nutrient density because the food would make a greater contribution to the intake of an essential nutrient than to meeting total energy needs. The concept is especially useful when energy intake is low, and it is essential that nutrient-dense foods be included in the diet. A low nutrient density could lead to excess energy being consumed to meet the need for essential nutrients. In the original development, the concept was applied to individual foods or meals on the understanding that no single food or meal will meet all the requirements for essential nutrients.

In developing the concept of nutrient density for use in FBDGs, the original nutrient density approach has been modified to include other factors. The concept is being used to express required nutrient intakes (e.g. protein), desirable nutrient intakes (e.g. folic acid) and population goals (e.g. fat and sodium) relative to energy intake. Obviously, FBDGs need to integrate these various ways to express the nutritional quality of the diet, but it is useful to spell out the distinction. The required nutrient intake is based on the value set in an RDI or RDA that includes the minimum required level, plus a safety margin. The desirable range of intake refers to an amount ranging from the RDI to a higher level that may be protective (e.g. vitamin C to promote iron absorption or folic acid to lower the risk of neural tube defects). Population goals refer to the range of desirable average intakes within a population that may lower the risk of noncommunicable diseases.

The reference to "high" or "low" nutrient density should be considered in the context of the nutrient and the intention of the FBDGs. For example, a high nutrient density for vitamin A activity or iron may be important in preventing deficiencies of these nutrients, whereas a relatively low density of fat or sodium and a high density of fibre may be desirable in lowering the risk of noncommunicable diseases.

Because of this more comprehensive approach, the concept is most appropriately used by health professionals or policy-makers in developing dietary goals or targets, which are the background for devising FBDGs. Additionally, care should be taken to apply these standards to the total diet rather than to individual foods or meals.

The RNI values used to derive these nutrient densities have been obtained from the latest international RDAs (*1–9*). The conditions for this model are that a diet that provides for the energy needs of family members will also satisfy the RNIs for all essential nutrients.

In Table A1.1 and the accompanying text, requirements for nutrients with relevant public health implications are expressed not in absolute terms but as nutrient density per 4.184 MJ (1000 $kcal_{th}$). This should not be interpreted as a physiological relationship between the specific nutrients and energy requirements but as a way of defining the

Table A1.1

Reference nutrient densities[a] for selected nutrients relevant to developing and evaluating dietary guidelines

Nutrient	Density per 4.184 MJ (1000 $kcal_{th}$)	Comments
Energy	See age-, sex- and activity-specific recommendation (*2*)	Energy density 2–5 years of age: 2.5–3.1 kJ (0.6–0.75 $kcal_{th}$)/ml for liquid foods; 6.3–8.4 kJ (1.5–2.0 $kcal_{th}$)/g for solid foods
Protein	20–25 g	8–10% of total energy if protein quality is high
	25–30 g	10–12% of total energy if animal protein intake is low
Total fats	16–39 g (maximum)	15–35% of energy; cholesterol <300 mg/day
Saturated fats	<11 g	Saturated up to 10% of total energy intake
Carbohydrates	140–190 g	55–75% of energy
Fibre	8–20 g	Total dietary fibre must be accounted for, not only "crude fibre"
Vitamin A (retinol)	350–500 retinol equivalents	1 retinol equivalent = 1 μg retinol or 6 μg β-carotene as provitamin A
β-Carotene		Functions as antioxidant; no RDA/RNI for β-carotene (see text)
Vitamin D	2.5–5.0 μg	Promotes bone health
Vitamin E	3.5–5.0 mg α-tocopherol equivalents	Inhibits lipoprotein oxidation
Vitamin K	20–40 μg	
Vitamin C (ascorbic acid)	25–30 mg	Functions as antioxidant; enhances iron absorption
Thiamine (vitamin B_1)	0.5–0.8 mg	
Riboflavin (vitamin B_2)	0.6–0.9 mg	
Nicotinic acid (niacin or equivalent)	6–10 mg	60 mg tryptophan equivalent to 1 mg niacin
Vitamin B_6	0.6–1.0 mg	
Vitamin B_{12} (cyanocobalamin)	0.5–1.0 μg	Reduces homocysteinaemia
Folate	150–200 μg	Intakes of 400 μg/day associated with reduced risk of neural tube birth defects; reduces hyperhomocysteinaemia
Iron	3.5, 5.5, 11 or 20 mg	For high, intermediate, low and very low bioavailability diets (see text)
Zinc	6 or 10 mg	For high and low bioavailability diets
Calcium	250–400 mg	Calcium-rich foods, especially for adolescents and lactating and pregnant women
Iodine	75 μg	100–200 μg/day in regions free of goitre; salt fortification usually required
Fluoride	0.5–1.0 mg (maximum)	If water has ≥1 mg/l requirement is met
Sodium (as NaCl)	<2.5 g	Total sodium as NaCl <6 g/day (population mean)

[a] These nutrient densities refer to total diet. If intake is sufficient to meet energy needs, the diet will also meet the needs of all members except possibly infants under 2 years of age and pregnant and lactating women).

Note: Infants under 1 year of age should be fed according to age: up to 4–6 months of age exclusively human milk; after this period breast milk should be complemented with appropriate foods to provide additional energy, protein and specific nutrients.

adequacy of a given diet to meet the needs for specific nutrients if sufficient energy is consumed. This approach permits the simplification of age and sex RNI figures since, if the figures are expressed per unit of energy, the values do not differ substantially among the various groups, except for calcium and possibly certain trace elements. In addition, for the purpose of establishing dietary guidelines for the general population, precise age- and sex-specific RNIs are not needed. The figures presented should be interpreted as a way to assess dietary quality.

The household is normally the basic unit for food consumption. Thus if the amount of food is adequate, individual members of the household can consume a diet with the recommended nutrient densities and meet their nutrient needs. The problem of intrafamily distribution needs to be considered, since women and children may not receive a proportional share of foods of higher nutrient density. This should be taken into account in establishing both general dietary guidelines and those specifically addressing the needs of vulnerable groups in the community.

If intake for adolescents or adults is less than 8.368 MJ (2000 $kcal_{th}$) per day, the diet will not secure vitamin and mineral needs, so sedentary lifestyles should be discouraged. Children below 2 years of age need a different diet and require specific dietary guidelines.

In using nutrient densities to establish dietary goals and guidelines, the quantitative and qualitative aspects of the food supply should be considered. The quantitative aspects include an estimation of the amount of nutrients and the relative proportion of a nutrient in the food source that will satisfy nutritional needs in practice. The qualitative aspects relate to the biological quality of the nutrients in the food source, and to the potential for interaction of nutrients that may enhance or inhibit the biological quality of a given source if both are ingested simultaneously.

Dietary goals for some nutrients, where there may be risks associated with high as well as low intakes, are specifically identified by indicating maximum intake. If the upper limit of safe intake is so high that in practice most diets fall well below it, no mention is made of an upper limit. Where the data in the various available reports provide justifiable differences in figures, densities are also expressed as ranges; in this case the selection of a value should be based on the user's assessment of the background information.

The recommended nutrient densities in Table A1.1 refer to the total diet available and not to individual foods.

4. Scientific areas relevant to the development of food-based dietary guidelines

Four broad areas of science have been utilized in taking this initial look at FBDGs: nutritional science (i.e. food components as nutrients and non-nutrients); food science and technology; educational, social and behavioural sciences; and agricultural and environmental sciences. This annex then looks at the areas, as related to foods and health, that are not clear, and areas where there may be some scientific uncertainties and limitations.

4.1 Nutritional science

4.1.1 *Energy intake, macronutrients and FBDGs*

The study of energy balance and metabolism, and of macronutrient and micronutrient physiology, is well established. Nutritional science has now also evolved to take account of non-nutrient components of foods having biological significance.

Macronutrients are broadly defined as those food components that are present in quantities of one gram or more in the daily diet, and which generally provide energy. They therefore include protein, fat, carbohydrates, most dietary fibres and alcohol. Although it does not provide energy, water is also considered a macronutrient.

Macronutrients may also have various physiological functions, other than the provision of energy, that make them more or less essential in their own right. They may also serve to identify foods of biological importance for reasons other than their macronutrient composition, i.e. macronutrients may be "marker nutrients". It is for these reasons that they are referred to in dietary guidelines.

Compounds related to a derivative of macronutrients may also need to be considered in developing dietary guidelines, e.g. "bioactive peptides" as well as protein; "resistant starch" and oligosaccharides as well as digestible starch, monosaccharides and disaccharides; and essential fatty acids of the $n-3$ ($\omega 3$) and $n-6$ ($\omega 6$) polyunsaturated (PUFA) type (*1*, *9–14*). To some extent, RNIs for amino acids and essential fatty acids, rather than protein or fat, may determine how FBDGs should develop (*1*, *9*).

Energy

Energy intake cannot be allowed to fall below limits that allow for basal energy expenditure, thermic response to food, physical activity and intermittent illness. There are also limits below which food intake ceases to serve as a vehicle for the adequate supply of essential nutrients and other compounds of biological importance. Evidence from prospective studies in developed as well as developing countries shows that those who eat most are those who live longer, provided they do not become obese and that they choose a diet with an emphasis on plant foods and, in some cases, fish (*15–18*).

It follows that dietary guidelines should not seek to restrict food intake but should encourage those food choices, such as the careful use of energy-dense, fatty foods, that enable energy balance to be achieved. Dietary guidelines that encourage energy balance cannot be constructed without reference to physical activity, and to some measure of energy stores, usually body fatness (a weight/height relationship such as body mass index) and its distribution, e.g. abdominal/hip ratio as recently recommended by a WHO Expert Committee (*19*). The corollary is to encourage physical activity so that enough food can be eaten to match the associated energy expenditure. In developing FBDGs, energy balance and food energy density are more important than setting an upper limit on energy intake (*20, 21*).

Under conditions of energy deficit or excess, certain important physiological adaptations come into play that allow individuals to preserve critical functions that depend on energy adequacy. This adapted state includes adjustments to basal energy expenditure, facultative thermogenesis or changes in the efficiency of physical work. On the other hand, if the changes in intake are beyond the adaptive range, the subject will accommodate to a new level of energy balance by changing body mass, or by slowing growth rate in the case of energy deficit. Individuals may also accommodate by reducing physical activity; this may not be apparent, since economically productive activities may continue at the expense of social activities.

Thus in adults, changed social or family behaviour may be the sole consequence of energy deficit. In small children, altered physical growth and mental development are the usual manifestations of energy deficit, while older children show lower physical activity rather than altered growth.

In the presence of excess energy intake, the adaptive range is extremely small (<5%) and the body energy reserve as adipose tissue increases rapidly. The metabolic and pathological consequences of obesity include hypertension, hyperlipidaemia and type II diabetes; in some studies, obesity has also been found to be an independent risk factor for atherosclerosis and myocardial infarction. The prevalence of obesity in urban developing societies is on the rise, and efforts should be made to prevent the related adverse consequences. Nutritional goals and guidelines should be set to prevent the social and pathological consequences of both energy deficit and excess.

Most recommendations concerning energy intake are based on the approach described in the 1985 report of a Joint FAO/WHO/UNU Expert Consultation (*2*), which defines energy needs based on energy expenditure. Estimating energy needs involves the summation of: (a) basal needs, derived from age- and sex-specific equations and actual or desirable body weight; (b) needs for growth in the case of children, based on usual energy content of tissue gain; and (c) needs for activity calculated as multiples of basal metabolic rate. Economically necessary activity and socially desirable activity should be considered, in addition to sedentary requirements. Pregnant and lactating women need additional energy to meet the requirement of tissue formation and milk secretion, respectively.

The digestibility of energy sources varies depending on the fibre content of the foods. Thus, following the recommendations of the Expert Consultation on formulating dietary guidelines for rural populations in developing countries where fibre intake is high, energy RNIs should be increased by 15%. For populations where fibre intake is moderate the correction is 5%.

For small children, energy density should be considered in developing dietary guidelines, since a low energy density may limit total energy intake. For liquid foods, energy density should be 2.5–3.1 kJ (0.6–0.75 $kcal_{th}$)/ml, whereas for solids it should be 6.3–8.4 kJ (1.5–2.0 $kcal_{th}$)/g. For older children and adults, the suggested energy density of the combined diet is 6.3–10.5 kJ (1.5–2.5 $kcal_{th}$)/g. For obese people, lower energy densities of less than 4.2 kJ (1 $kcal_{th}$)/g are desirable, since gastric repletion may help to maintain lower energy intakes.

Protein, peptides and amino acids

Protein requirements and ways of achieving them from foods have been well covered in previous reports (*2, 22, 23*). Increasingly, biologically active peptides such as those that affect growth, gut physiology and blood pressure control mechanisms (inhibitors of angiotensin-converting enzyme) and conditionally essential amino acids such as taurine, arginine and glutamine tend to be reflected in food choices. Thus, for example, milk proteins may yield biologically active peptides, while nuts are a good source of arginine (*10, 13, 14, 24*).

For protein, virtually all RNIs are based on the protein needed for nitrogen balance and growth. The 1985 FAO/WHO/UNU report (*2*) suggested the mean requirement plus 25% (equivalent to two standard deviations) as the RNI for age- and sex-specific groups. In general, recommendations for developing countries take into account a lower average protein quality and digestibility. The digestibility of a mixed diet is considered to be 80–85% and the amino acid score only 90%, and therefore the RNIs are higher. For example, in Latin America, the RNI of 0.75 g of reference protein per kg of body weight becomes 1.0 g per kg after adjusting for protein quality.

In circumstances where the mixed diet does not contain sufficient legumes and/or animal protein, corrections for amino acid score may also be needed. Correction for amino acid score was emphasized in the past since single sources of vegetable proteins may be limiting in one or more amino acids (lysine for most cereals, methionine for most legumes). Yet diets composed of cereal/legume mixes with some animal protein (10–20%) are sufficiently high in essential amino acids to meet RNIs. Thus, except under very restrictive diets, amino acid score is not usually a problem.

New approaches to defining amino acid needs, based on kinetic indices, may provide a different perspective on the amino acid needs of humans and may require additional adjustments. At present, these indices suggest that existing recommendations greatly underestimate the requirements for amino acids to sustain optimal rates of protein synthesis. The interpretation of "optimal" in this context is elusive at best, since the physiological consequences of higher or lower levels of protein synthesis have not been established.

In settings where environmental sanitation is inadequate and diarrhoeal disease is prevalent, an increase in protein intake by 10% is recommended. For children recovering from acute infection or malnutrition, protein intake should be increased to meet the demands imposed by rapid tissue synthesis. Depending on the degree of deficit, protein needs may be 2–3 times the normal amount. Even for children, protein needs during convalescence are elevated by 20–40%. Intake of protein, especially animal protein, has been linked with a lower prevalence of stunting in developing countries. Although this may not necessarily be linked to essential amino acid supply, since micronutrients such as zinc are also growth promoters, it is suggested that 10–25% of dietary protein should be of animal origin.

At present, no upper limit on protein intake has been set, yet animal and human data suggest that excessive protein intake has an adverse effect on kidney function. Glomerular filtration rates increase acutely in response to protein overload, but long-term hyperfiltration may lead to excessive loss of nephrons and thereby, with advancing age, reduced renal function. The latest American recommendation is to limit total protein intake to twice the RDA (*25*).

Table A1.2
Safe levels of protein intake for males and females at different ages, and supplementary levels for pregnant and lactating women

Age (years)	Males			Females		
	Reference protein	High biological value diet	Low biological value diet	Reference protein	High biological value diet	Low biological value diet
Infants children and adolescents (g/day)						
0.5	12.9	12.9		11.9	11.9	
1	14.1	21.2	23.5	13.3	20.0	22.2
2	15.5	23.3	25.8	15.0	22.6	25.0
3	16.9	25.4	28.2	16.5	24.8	27.5
4–6	19.7	29.6	32.8	18.6	28.0	31.0
7–9	23.0	28.0	31.5	22.9	27.9	31.4
10–12	36.8	44.9	50.4	38.4	46.8	52.2
13–15	51.6	54.8	60.7	46.9	49.4	55.4
16–19	58.3	61.3	68.6	45.3	47.7	53.3
Adults (g/kg of body weight per day)						
20–29	0.75	0.79	0.88	0.75	0.79	0.88
30–59	0.75	0.79	0.88	0.75	0.79	0.88
60+	0.75	0.79	0.88	0.75	0.79	0.88
Supplement for pregnant women (g/day)				+6.0	+6.3	+7.1
Supplement for lactating women (g/day)						
First 6 months				+16.0	+16.8	+18.8
Following 6 months				+12.0	+12.6	+14.1
Thereafter				+11.0	+11.6	+12.9

Source: World Health Organization (*2*).

RNIs for protein by age and sex according to the 1985 FAO/WHO/UNU report (*2*) are provided in Table A1.2 for two diets having different biological values. The protein densities recommended have been derived as protein–energy ratios to represent the protein quality of the mixed diet. For high-quality proteins, requirements can be met by providing 8–10% of total energy as protein. For predominantly mixed vegetable diets in developing countries, 10–12% is suggested, since protein needs should be corrected for lower digestibility and an increased incidence of diarrhoeal disease. Finally, in the case of the elderly where energy intake is low, protein should provide 12–14% of total energy.

Fat

In general, adults should derive at least 15% of their energy from dietary fats and oils, and women of childbearing age should consume at least 20%. Active individuals who are not obese may derive up to 35% of their energy from fat, as long as saturated fatty acids do not exceed 10% of energy intake. Sedentary individuals should limit their consumption of fat to not more than 30% of energy intake and also limit saturated fatty acids to less than 10% of energy intake, while ensuring that needs for all other specific nutrients are met (*9*). RDIs for adults include limiting cholesterol intake to 300 mg/day.

Infants fed breast milk or formula usually receive 50–60% of their total energy intake from fat. The use of vegetable oil in foods for infants and children is important in maintaining the energy density of liquid foods above 2.5 kJ (0.6 $kcal_{th}$)/ml. Infants should preferably receive breast milk; if they do not, the fatty acid composition of the infant formulas used should correspond to the range found in breast milk from omnivorous women. During the complementary feeding period — up to 2 years of age or beyond — the diet should provide 30–40% of energy from fat.

Recommendations for fat vary, depending *inter alia* on the prevalence of protein–energy malnutrition and diet-related noncommunicable diseases. For the former, promoting an increased consumption of fat is usually desirable, while for the latter decreasing it may be in order. The prevalence of these problems varies widely between countries and may coexist within countries. Urban slums and suburban affluence are not uncommon in many developing and newly industrialized countries, and dietary guidelines should address the problems of both. Thus, for low socioeconomic groups in some developing countries, reaching 20% of energy intake from fat is a difficult goal, while among some affluent populations in the same countries there may be a need to reduce fat intake to less than 30% of total energy.

Excessive (i.e. over 40%) intake of energy from fat among adults may be associated with an increased prevalence of obesity and associated disorders (*27*). It may also increase the risk of certain types of cancer (*9*, *26*, *27*). High fat intake reduces the nutrient density per unit of energy of the diet (with the exception of those nutrients occurring naturally in fats, such as vitamin E in vegetable fats) (*28*). Although it may be easier to reduce and modify the intake of visible fat (*29*), hidden fat from foods such as high-fat meat, cheese, baked products and some fried food also has to be considered, and included in the calculations.

The balance between different classes of fatty acid is important, particularly with respect to the risk of coronary heart disease (*9*, *30*). Saturated fatty acids with lauric (C12:0), myristic (C14:0) and palmitic (C16:0) acids elevate serum cholesterol and low-density lipoprotein (LDL) cholesterol. Polyunsaturated fatty acids (PUFA) lower serum cholesterol and LDL, while monounsaturated fatty acids

(MUFA) are less effective in lowering cholesterol or LDL levels. However, MUFA and saturated fatty acids raise high-density lipoprotein (HDL) cholesterol levels. MUFA are not as easily oxidized and their effects on lipoprotein metabolism are neutral (*31–33*). There is no reason to set an upper limit for MUFA within accepted total fat and energy intakes. Cholesterol intake can also increase total cholesterol and LDL cholesterol levels in the serum of susceptible individuals, but response is less than that induced by changes in the fatty acid composition of the diet (*33*). Compared with dietary MUFA, *trans* fatty acids increase serum LDL cholesterol, and may in fact lower HDL cholesterol (*9*, *34*, *35*).

Both $n-6$ and $n-3$ PUFA are essential fatty acids. The balance between $n-6$ and $n-3$ fatty acids is of importance in determining the biological effects of dietary PUFA. Some studies have shown that consumption of marine foods containing long-chain $n-3$ fatty acids such as eicosapentaenoic acid (EPA, 20:5, $n-3$) and docosahexaenoic acid (DHA, 22:6, $n-3$) is associated with lower cardiovascular mortality. Essential fatty acids are also important for normal fetal and infant growth as well as for brain development and visual maturation. *In vitro* experiments indicate a higher susceptibility for oxidative modification of PUFA-containing lipoproteins. High intake of $n-6$ PUFA may have adverse effects on eicosanoid production (*33*). In animal studies, consumption of $n-6$ PUFA has been found to promote the growth of certain forms of carcinogen-induced cancer (*27*), which may indicate that growing tumours require PUFA. There is, however, no compelling direct evidence of harmful health effects of PUFA in humans. There are sufficient antioxidants (e.g. vitamin E) in unrefined and properly processed high-PUFA oils to protect lipoproteins. The $n-3$ fatty acids may have specific beneficial effects on platelet function and insulin sensitivity.

Sources of $n-6$ fatty acids are abundant in most diets. Vegetable oils commonly used, such as corn, sunflower and safflower oils, are all good sources of $n-6$ fatty acids. The $n-3$ fatty acids are present in green leaf vegetables and in some vegetable oils; soya oil and low-erucic-acid rapeseed oil (canola oil) are good sources of $n-3$ fatty acids. The long-chain (>C18) essential fatty acids (arachidonic acid and DHA) are present mainly in animal foods, while marine foods are good sources of EPA and DHA. The RNIs for essential fatty acids of the $n-6$ family are 3–12% and for the $n-3$ family 0.5–1.0% of energy intake. The ratio of linoleic (18:2, $n-6$) to α-linolenic (18:3, $n-3$) acids should be between 5:1 and 10:1. No specific recommendations for long-chain essential fatty acids have been established, except for infants, but epidemiological information supports the incorporation of essential fatty acids and DHA from foods in the diet. Pregnant women should receive adequate essential fatty acids to meet the demands of fetal development.

Both the amounts and the types of fat consumed by population groups, along with other dietary and lifestyle factors, are considered of great importance in determining the prevalence of noncommunicable diseases throughout the world. Dietary guidelines should include a consideration of the type and amount of dietary fat, as this is of great importance in promoting health.

Recent evidence indicates that *trans* fatty acids, produced during the hydrogenation of PUFA, may behave more like saturated fatty acids than like MUFA in terms of their effect on cholesterol metabolism. Hydrogenated vegetable fats that are high in *trans* fatty acids (>10%) should not be promoted as having the same effects on health as fat sources containing predominatly PUFA in the *cis* configuration and which are low in saturated fatty acids. As consumers become more informed about *trans* fatty acids, and as more is known of their effect, it may be useful to consider the sum of saturated and *trans* fatty acids in evaluating the health effects of fats and oils. Where coronary heart disease is a concern, it may be appropriate to encourage the use of liquid oils and soft margarines rather than hard fats, which have a higher content of saturated and *trans* fatty acids.

Fats and oils also provide a vehicle for fat-soluble vitamins such as vitamin A and tocopherols, and an adequate intake of dietary fat is essential for the absorption of these vitamins. Red palm oil is an excellent source of carotenoids and tocopherols; it should therefore be considered an especially good source of low-priced oil for populations where vitamin A deficiency is prevalent. Tocopherols are important natural antioxidants and will help to prevent peroxidation of PUFA. The ratio of vitamin E to PUFA should normally exceed 6:10 000.

Carbohydrate

Carbohydrates are the main source of energy in the diet for most people. Most dietary carbohydrates come from vegetable foods and include sugars, oligosaccharides, starch and dietary fibre.

Grain products, tubers, roots and some fruits are rich in complex carbohydrates. They generally need cooking before they are fully digestible, especially by children. They are less soluble in water and will form gels when mixed with water, which limits the energy density of the final food product. These considerations are particularly relevant when establishing dietary guidelines for small children.

Sugars (monosaccharides and disaccharides) found in foods or added to the diet usually increase the acceptability of the diet. Sucrose is the most common sugar in most diets and, since it is readily soluble and easily digested, increases the palatability and energy density of the diet. When considering sugar intake in the context of dietary guidelines, it is important to consider all sources of sugars in the diet and the contribution of other nutrients from these foods.

Frequent consumption of sugar and other fermentable carbohydrates throughout the day increases the cariogenic risk potential of the diet, especially in the absence of reasonable oral hygiene practices (*36, 37*). On the other hand, reduction of sugar intake plays a minor role in caries prevention where fluoridation and hygienic measures have been taken.

Although some foods are relatively high in fat and sugars, there is no evidence that foods high in sugar contribute significant amounts of fat to the diet (*38*, *39*). Furthermore, total sugar intake is commonly inversely related to total fat intake (*39*). Moderate intakes of sugar are therefore compatible with a varied and nutritious diet. No specific limit for sugar consumption is proposed, since the putative relationship of sugar consumption to obesity is offset by the inverse relationship observed between sugar and fat intake.

The glycaemic effect of starchy foods, often measured as the glycaemic index, depends on rate of digestion (*40*, *41*). This is determined to some extent by the fibre content, but mainly by the availability of starch to digestion. Leavening and baking increase the glycaemic effect of starch in bread, but starch in pasta, pulses and legumes has a low and retarded glycaemic effect (*40*, *41*). The glycaemic effects of simple sugars are mainly comparable to (or less than) those of starch from cooked foods. In hypertriglyceridaemic people, long-term consumption of low-glycaemic index foods may reduce the risk of cardiovascular diseases by improving glucose tolerance, reducing insulin secretion and lowering blood lipids (*40*). A part of starch is resistant to digestion because of its crystalline or other properties. It acts like dietary fibre, passes unabsorbed into the colon, promotes bowel function, increases the production of short-chain fatty acids and may reduce the risk of cancer (*42*).

Only small amounts of carbohydrate are necessary in the human diet in order to prevent ketosis. Ten percent of energy or approximately 50 g per day are sufficient for this purpose. Yet, since carbohydrates represent, on a relative basis, over half of the energy intake for most populations, and since the relative contribution of fat and carbohydrate may affect the prevalence of chronic noncommunicable diseases, it is important to consider them when setting dietary guidelines.

Lactose is the sugar in milk and the main source of carbohydrate in small children. It is well digested by small children, but most older children and adults in tropical countries have a limited capacity to digest and absorb a large lactose load (50 g). Nevertheless, even with laboratory-determined lactose intolerance it is possible to tolerate a glass of milk, which provides 15 g of lactose in a fat- and protein-containing solution. This should, therefore, not be a reason to limit the consumption of milk or the use of milk in food distribution programmes in developing countries. Moreover, milk represents an excellent source of high-quality protein, calcium and riboflavin, and is well tolerated by most children, even those recovering from malnutrition. Children with prolonged diarrhoea may benefit from lactase-containing fermented milk products such as yoghurt (*43*, *44*).

Dietary fibre includes non-starch polysaccharides such as cellulose, hemicellulose, gums and pectins, with different solubility and viscosity characteristics (*45*). Fibre components have beneficial effects on glucose and cholesterol metabolism and on bowel function (*46*). A regular and varied intake of cereals, fruit and vegetables ensures the supply of both soluble and insoluble types of fibre.

Fibre consists primarily of the components of cell walls in vegetable foods that are indigestible, complex carbohydrates; it also includes gums, lignins and polyphenols. An important physiological function of dietary fibre is to provide bulk for laxation and stool formation. Although many food composition tables are based on acid- and alkali-insoluble vegetable food components (crude fibre), this in fact includes only cellulose and lignin. Other components of vegetable cell walls, such as hemicellulose, pectins and gums, have important properties that affect the intestinal microenvironment and may affect the prevalence of chronic disease.

Volatile fatty acids derived from colonic fermentation of fibre components may increase metabolizable energy and also serve as fuel for intestinal cell metabolism. Fibres reduce the energy density of the diet and may be beneficial in preventing obesity (*47*, *48*). On the other hand, fibres decrease the bioavailability of specific nutrients, especially minerals, thus affecting the biological quality of foods. Most recommendations specify intakes of 15–20 g/day for adults, i.e. 8–10 g per 4.2 MJ (1000 $kcal_{th}$) is recommended, while up to 20 g per 4.2 MJ can be consumed daily without untoward effects. If high-fibre diets (>40 g/day) are customary in a given population, protein and mineral RNIs should be adjusted accordingly.

Alcohol

Alcoholic beverages are inherent in the dietary patterns of many human cultures. In societies with subsistence agriculture, alcoholic beverages often provided significant essential nutrients (such as amino acids from fermented cactus for Mesoamericans, or thiamine in traditional beer in Africa). In general, however, alcoholic beverages are now better known for their adverse social and health effects rather than as part of a spectrum of fermented food beverages. Evidence on the acute effects of alcohol indicates that its adverse effects (impairment of cognitive function, decreased cardiac output and elevated blood levels of keto and lactic acids) can be partially reduced by taking it with food. The effects of alcohol on increased energy density and the displacement of more healthful nutrients require particular consideration when food-based dietary goals are being developed.

There is considerable interest in the possible effects of ethanol, or of associated compounds such as phenols, in alcoholic beverages on the prevalence of coronary heart disease. Even though plausible pathways exist by which cardioprotection may occur (increased blood level of HDL cholesterol, decreased platelet aggregation, antioxidation and stress reduction), potentially adverse pathways also exist (elevated blood pressure and myocardial damage). A recent review of alcohol, diet and mortality data from 22 countries (*49*) concluded that ethanol, particularly wine ethanol, is inversely related to coronary heart disease but not to longevity in populations. Light to moderate alcohol intake may improve longevity, but alcohol abuse sharply reduces it. Promoting the use of alcohol would appear to be unwise as a cardioprotective public health measure (*49*).

Much more research is required to determine both the protective effects of alcoholic beverages on coronary heart disease, and how protective such a mode of alcohol ingestion may be for more chronic alcohol-related health problems, such as hepatic cirrhosis, cardiomyopathy or Korsakoff psychosis. In some cultures where wine is regularly consumed with food, cirrhosis still remains a major health problem. Although individual differences in patterns of alcohol consumption could explain this relationship, many factors are still unknown.

4.1.2 *Water*

Fluid needs are met by a combination of foods and beverages. A dependable and chemically and microbiologically safe source of water is essential.

Obtaining a safe source of water has introduced new problems for those concerned with its recirculation, packaging and storage. At the same time, depending on the location, water may be an important source of such essential elements as iron, iodine, fluoride, calcium and copper (*50*). Assuming an intake of 1.5 litres a day, water can provide 10% of total intake for iodine, cadmium and copper, 15–20% for lead and chromium, and up to 32% for fluoride (*50–54*). In an aging population, thirst mechanisms may be compromised (*55*), so that special attention to water intake in the elderly may be worth including in FBDGs.

4.1.3 *Micronutrients*

Micronutrient deficiencies are now recognized as important in the etiology of communicable and noncommunicable diseases and classical deficiency disorders. The formulation of FBDGs in all cultures with varying health patterns therefore needs to take account of the fact that vitamin and mineral components of foods are essential for growth and development, for the utilization of macronutrients, for the maintenance of an adequate defence against infectious diseases, and for many other metabolic and physiological functions. Stress and physical trauma, such as that resulting from prolonged physical overactivity, also influence micronutrient demands.

Today more than 2000 million people are at risk from micronutrient deficiencies and more than 1000 million are actually ill or disabled as a result through, for example, nutritional anaemias, mental retardation, learning disabilities, low work capacity and blindness (*56–59*). More than 13 million people suffer night blindness or total blindness due to lack of vitamin A (*59*, *60*). Low folate status is one of the earliest indicators of vitamin deficiency, and represents a sensitive index of inadequate food supply in addition to its role in the prevention of birth defects (*61*). Risk of vitamin D deficiency in older adults, especially in those who receive little exposure to sunlight (*62*) and/or do not consume fortified foods, is common and is associated with increased prevalence of osteoporosis. Osteoporosis is also associated with insufficient absorbable calcium, potassium and vitamin C.

The proposed nutrient densities for the family diet depend on the consumption of adequate amounts of energy for adults and adolescents. If intake for adolescents or adults is under 8.4 MJ (2000 $kcal_{th}$) per day, it is unlikely that their vitamin and mineral needs will be met.

Interactions among micronutrients, as well as other food components, are of great importance. For example, a recommendation in dietary guidelines to increase the intake of one or more micronutrients may also affect other micronutrients as well, through effects on their absorption, availability or excretion. Some foods contain inhibitors of element absorption that reduce their availability, such as the restriction of calcium utilization by the presence of oxalates in dietary spinach or rhubarb. Other significant examples are the decreased availability of iron from foods rich in tannins or through excess of calcium, and the effects of dietary phytate from whole-grain cereals and pulses restricting the utilization of iron, zinc and possibly magnesium and calcium. On the other hand, absorption of non-haem iron is enhanced by increasing the vitamin C content of the diet — a factor that is likely to be important when plant sources of iron predominate over animal sources. Some examples are given in Table A1.3.

The role of vitamins

Vitamins were discovered early this century, and the evidence of their importance was slowly pieced together, initially from observational studies and then from balance studies that measured the levels at which signs and symptoms of deficiency of specific vitamins would appear. A classical example is thiamine deficiency resulting from diets largely consisting of polished rice. Thiamine deficiency has remained

Table A1.3
Promoters and antagonists of the uptake or utilization of inorganic elements from foods

Essential elements	Promoters	Factors reducing availability
Iron	Vitamin C; iron in the haem of animal tissues	Excessive consumption of vegetable sources of phytates,[a] oxalates (e.g. spinach), tannins (e.g. tea), polyphenols and calcium salts (>500 mg Ca)
Iodine		Brassicas consumed in excess; cassava inadequately dried or fermented
Calcium	Lactose-containing foods; unidentified factors in milk	Excessive dietary fibre rich in associated phytate;[a] plants rich in oxalates or uronic acids; fat malabsorption
Zinc	Unidentified factors in animal protein	Phytate-rich foods[a] (e.g. whole-grain cereal foods) if accompanied by high calcium
Magnesium		Phytate-rich foods[a] if dietary calcium high
Potentially toxic elements (pollutants)	Factors promoting retention or toxicity	
Cadmium	Low dietary calcium; low iron status; low copper status	
Lead	Low dietary calcium; low dietary phytate	
Fluoride	Low dietary calcium	

[a] Includes maize, brown rice, beans, whole wheat flour and sorghum.

a concern in countries such as Thailand, and in populations in developed countries who consume large amounts of alcohol. More recently, there has been an enormous amount of interest in vitamin A which, in addition to preventing xerophthalmia, is generally considered to reduce mortality by some 20–30% among young children in areas where vitamin A deficiency is endemic, possibly even among those with subclinical deficiency (*63*).

The scientific evidence supporting an important role for vitamins in promoting health and preventing noncommunicable diseases, independent of other nutritional constituents, is currently receiving considerable attention (*64*). Much of the evidence has been derived from epidemiological studies of food intake and from clinical trials of vitamin supplements, as well as from experimental animal studies. While all three of these research approaches have implicit limitations, the overall consistency, strength and biological plausibility of the results from the work to date are in many cases now sufficient for them to be translated into FBDGs.

In many parts of the world, efforts to ensure adequate vitamin status for the primary prevention of deficiency states still continue to be of paramount importance. Thus, recommendations can be offered to ensure that attention is focused on the consumption of appropriate (or fortified) foods that provide, for example: adequate vitamin A to promote growth, prevent night blindness and strengthen corneal structure and immune function in children; folic acid to help reduce the risk of neural-tube birth defects as well as anaemia and perinatal mortality in women of childbearing age; and vitamin D to promote bone health in children and adolescents and reduce the risk of osteoporotic fractures in the elderly, especially older women.

While currently emerging evidence remains sometimes equivocal in identifying specific vitamins as responsible for providing certain health benefits, the data are sufficiently strong now to encourage the view that all populations should ensure adequate consumption of foods rich in antioxidant nutrients (i.e. vitamins C and E and β-carotene) and certain B vitamins (i.e. vitamins B_6, B_{12} and folate) to reduce the risk of cardiovascular and cerebrovascular diseases, and foods rich in antioxidant nutrients, vitamin A and folate to reduce the risk of some forms of cancer. Experimental evidence supports a biological plausibility for these health-promoting effects of vitamins (*65*). The putative protective role of antioxidants against vascular disease appears to be based in part on their ability to inhibit the oxidative modification of LDL cholesterol, a critical early step in the atherogenic process (*66*). The action of vitamins B_6, B_{12} and folate may be beneficial against vascular disease, owing in part to their ability to modulate homocysteine metabolism (*67*).

Vitamins may serve as chemopreventive agents through their ability to prevent the formation of and/or increase the detoxification of carcinogens, as well as by regulating cell differentiation processes. As the qualitative and quantitative nature of the relationship between these vitamins and the prevention of vascular disease and cancer becomes further established, this information can be more precisely incorporated into FBDGs.

It is also important to recognize, as part of FBDGs, the impact of vitamins on specific physiological functions and performance, with potentially significant benefits for individual and public health. Examples are the role of antioxidant nutrients and vitamin B_6 in improving immune function in older adults, and of the B complex vitamins and vitamin C on improving physical performance in children.

Provocative but preliminary data regarding the relationship between generous intakes of certain vitamins and the reduction of some other diseases are continuing to evolve, but they are premature and/or insufficient to merit consideration for inclusion in FBDGs. Examples are the relationships between antioxidants and a reduced risk of degenerative eye diseases such as cataract and age-related macular degeneration, and between B vitamins (particularly vitamins B_6, B_{12} and folate) and a reduced risk of age-related cognitive impairment and dementia.

More important is the evidence that most, and perhaps all, of the benefits can be provided by eating a diversity of foods rich in these vitamins and related phytochemicals (*68*). Moreover, as noted above, the increased intake of a few vitamins from fruits and vegetables may provide a wide spectrum of benefits in respect of several physiological functions and many diseases. These intakes, while sometimes in excess of current recommended standards for dietary requirements, can none the less be met through appropriate food selection. However, groups at particular risk of inadequate intake of these vitamins include children, pregnant and lactating women and the elderly, because of their increased needs or low levels of energy intake.

The elderly represent a growing percentage of the world's population and are at risk of inadequate vitamin consumption owing to their reduced energy intake and increased requirement for selected micronutrients (*69*). Recent research has demonstrated that, to maintain their metabolic balance, elderly people must consume more vitamins B_6, B_{12}, D and folate than younger adults (*70*). The physiological and health consequences of these changes in nutrient requirements can be illustrated by the potential adverse effect in older adults of low vitamin B_6 status, such as impaired glucose tolerance, decreased immune responsiveness and altered cognitive function (*69*).

As noted, desirable ranges of vitamin intake for health promotion and the prevention of noncommunicable diseases may be similar to or above current dietary recommendations (*71, 72*). However, individual vitamin needs — and their relationship to individual predisposition to noncommunicable diseases — appear partly to depend on differences in genetic inheritance and on lifestyle factors. Increasing dietary intakes of one or more vitamins from a variety of sources to these desirable ranges does not appear to promote harmful imbalances affecting other nutritional or metabolic conditions in the body. More important still, vitamin-rich foods prepared in a way that maintains their vitamin content should be consumed regularly and frequently, as some vitamins remain a relatively short time in the body.

Food-based approaches, including fortification, to improve vitamin status are likely to prove widely applicable, sustainable and affordable in the long term for avoiding deficiency diseases, improving health and preventing both noncommunicable and many communicable diseases. None the less, further research efforts, including controlled clinical trials with food-based interventions, are still required to fully establish the efficacy of this approach. Foods making important contributions to daily intakes of selected vitamins are given in Table A1.4.

Vitamin A can be consumed as retinol in animal products or the body can manufacture it from plant carotenoids. The biological vitamin A activity of the diet should be computed in retinol equivalents. A dietary goal of 350 retinol equiralents per 4.2 MJ (1000 $kcal_{th}$) is sufficient to meet the needs of all family members. The presence of diarrhoeal disease, infection and intestinal parasites increases vitamin A needs. Vitamin A supplementation in deficient children has been shown to reduce the risk of death from diarrhoea and sometimes from other infections. Present RNIs do not provide for the increased needs of vitamin A in acute infections such as measles, where adequate intakes are required to reduce both complications and mortality. Vitamin A fortification of foods has contributed to lowering the prevalence of deficiency in some parts of the world (*73*). Low-fat diets and diets poor in animal products reduce vitamin A bioavailability by limiting absorption and utilization.

β-Carotene is a provitamin A compound, but also acts in an independent fashion in several cellular functions, for example as an antioxi-

Table A1.4

Foods making an important contribution to daily intakes of selected vitamins

Vitamin	Sources
Vitamin A (as retinol)	Meat, fortified dairy products, liver and other offal, egg yolk, fish liver oils
Vitamin A (as β-carotene)	Red/orange/yellow fruits and vegetables (papayas, pumpkin, carrots, etc.), dark green leaf vegetables (spinach, kangkong, *Ipomoea aquatica*, coriander, etc.)
Thiamine (vitamin B_1)	Whole-grain cereals (wheat germ), pork, lamb, fish, poultry, liver
Riboflavin (vitamin B_2)	Soya beans, nuts, milk, cheese, yoghurt, brewer's yeast, whole-grain cereals, eggs, green leaf vegetables, offal
Nicotinic acid (niacin, vitamin B_3)	Groundnuts, enriched breads and cereals, lean meats, poultry, fish, octopus, taro, bulgur, couscous
Vitamin B_6	Green leaf vegetables, avocados, bananas, dried beans, potatoes
Vitamin B_{12}	Lean meats, offal, fish, shellfish, dairy products, brewer's yeast
Folate	Dark green leaf vegetables, avocados, liver, brewer's yeast, amaranth, oranges, chick peas
Vitamin C (ascorbic acid)	Citrus fruits, tomatoes, peppers, green leaf vegetables, potatoes, papayas, lychees, daikon radishes
Vitamin D	Fatty fish, fortified dairy products, liver, egg yolk
Vitamin E	Vegetable oils, nuts, wheatgerm, whole-grain cereals, green vegetables, seeds, dried beans
Vitamin K	Broccoli, cabbage, vegetable oils, seaweeds, green leaf vegetables, yoghurt, egg yolk, liver, soya beans, potatoes, dairy products

dant trapping free radicals and quenching singlet oxygen. The bioavailability of carotenoids in many foods is less than that of vitamin A, 6 μg β-carotene being nutritionally equivalent to 1 μg retinol. A dietary intake of 2100–3000 μg β-carotene per 4.2 MJ (1000 $kcal_{th}$) as provitamin A appears to be a healthy goal for all family members. The absorption and utilization of β-carotene is enhanced by dietary fat, protein and vitamin E, and is depressed by the presence of peroxidized fat and other oxidizing agents in food. It is important to note that, because only a few carotenoids serve as provitamin A compounds and many other yellow/orange pigments are present in plants, the colour intensity of a fruit or vegetable is not a reliable indicator of provitamin A content. Biologically active carotenoids are found in abundance in carrots and dark green leaf vegetables. Additional knowledge is needed on the carotene content and retinol bioequivalence of plant foods throughout the world.

In a limited number of trials and several epidemiological studies, carotene-containing foods have been associated with a reduced risk of cancer of the colon, lung and stomach and of cardiovascular diseases.

Vitamin C (ascorbic acid) not only participates in intermediary and oxidative metabolism but also improves iron absorption. In addition, ascorbic acid has been shown to be necessary for a normal immune response. The proposed nutrient density of 25–30 mg per 4.2 MJ (1000 $kcal_{th}$) exceeds the true ascorbic acid needs of most individuals, but it underlines the fact that enhancement of iron absorption from plant foods is very desirable. The range in this case is derived from existing recommendations. Preventing or decreasing the prevalence of iron deficiency, a significant problem worldwide, is an important consideration in setting dietary guidelines.

Ascorbic acid in foods is affected by heat treatment during cooking and processing. The general recommendation to avoid overcooking vegetables and fruits is supported by the effect of heat on ascorbic acid, of which commonly about half is lost when cooking water is discarded.

Vitamin E represents a group of dietary tocopherols and tocotrienols that serve as antioxidants, trapping oxygen free radicals to prevent the oxidation of unsaturated fatty acids and other target molecules. Requirements of vitamin E are increased with increasing intakes of unsaturated fats. The biological vitamin E activity of the diet should be computed in mg α-tocopherol equivalents (mg α-TE). A dietary intake of 3.5–5.0 mg α-TE per 4.2 MJ (1000 $kcal_{th}$) appears to be a healthy goal for all family members. Frank vitamin E deficiency is usually limited to premature infants and patients with diseases characterized by fat malabsorption, but marginal intakes and subclinical deficiencies may be prevalent in many populations.

In a limited number of clinical trials and several epidemiological studies, vitamin E has been associated with a reduced risk of a number of chronic diseases, including coronary heart disease, cataract and some forms of cancer. Vegetable oils, including those from soya, safflower and corn, and seed oils, nuts, whole grains and wheatgerm represent the principal source of vitamin E. Absorption of vitamin E depends on concomitant digestion and absorption of dietary fat.

Folate at a nutrient density of 150–200 μg per 4.2 MJ (1000 $kcal_{th}$) is sufficient to prevent folate deficiency in all family members, including women of childbearing age. It is now well established that higher folate intake before and during pregnancy, either via the diet or by supplementation with 400 μg folate per day, is associated with a lower prevalence of congenital neural tube defects in the newborn. In addition, recent evidence on the role of folate in cysteine metabolism indicates that the folate density of the diet given above is also adequate to lower homocysteine plasma levels and decrease the risk of cardiovascular diseases. This folate level is higher than that recommended by FAO/WHO, but is consistent with the American RDA for pregnant women (*25*). It is also in line with the views expressed by the Scientific Committee for Food of the Commission of the European Communities (*74*). The Consultation felt that the new evidence was sufficiently compelling to use the higher value.

Folates found in animal and plant foods can be easily destroyed by cooking since they are labile to moderate heat. Boiling or heat processing milk destroys folates, leaving minimal amounts in the powdered milk product. Folate deficiency is prevalent in many developing countries, especially during pregnancy and lactation. The general recommendation to avoid overcooking food is supported by the effect of heat on folate.

The potential benefit of folate on the prevention of cancer of the lung and stomach remains speculative; any recommendation based on this effect should await further evidence.

Thiamine, riboflavin and nicotinic acid (niacin) deficiencies are now uncommon, except under conditions of extreme social deprivation or among people dependent on alcohol. The proposed minimum nutrient densities of 0.5, 0.6 and 6 mg per 4.2 MJ (1000 $kcal_{th}$) for thiamine, riboflavin and nicotinic acid, respectively, are sufficient for all family members. Grain products lose part of these vitamins during processing, dehulling and refining. Thiamine is particularly heat-sensitive in an alkaline environment; thus it is recommended not to use sodium bicarbonate in cooking water. Nicotinic acid can be absorbed from the diet or synthesized by the body from dietary tryptophan (60 mg tryptophan yields 1 mg niacin); this should be considered in defining the potential nicotinic acid content of a food. On the other hand, if the diet is limited in tryptophan, little or no nicotinic acid will be formed. Maize is treated with alkali and heat as part of traditional food processing to prepare tortillas in Central America and Mexico, thus making the nicotinic acid available; the tryptophan also becomes more absorbable. This may explain the low prevalence of pellagra in this region despite a predominantly maize diet low in nicotinic acid. Fortification of wheat flours or other staple foods has been successful in eradicating vitamin B complex deficiency in various parts of the world.

Vitamin B_6 comprises pyridoxine, pyridoxal and pyridoxamine. Vitamin B_6 is converted in the body to pyridoxal phosphate and pyridoxamine phosphate, which serve primarily as coenzymes in transamination and decarboxylation reactions. Because of its role in amino acid metabolism, the requirement for vitamin B_6 increases with an increasing intake of protein. A dietary goal of 0.6–1.0 mg vitamin B_6 per 4.2 MJ (1000 $kcal_{th}$) appears satisfactory to meet the needs of all family members. Vitamin B_6 deficiency is generally noted only among people deficient in several B-complex vitamins.

In addition to its essential role in the metabolic transformation of amino acids and the metabolism of lipids and nucleic acids, it has been suggested that vitamin B_6 modulates immune responsiveness and glucose homeostasis. The most nutrient-dense sources of vitamin B_6 include chicken, fish, kidney, liver, pork and eggs, although unmilled rice, soya beans, whole-wheat products and peanuts are also good sources. Substantial amounts of vitamin B_6 are lost through food processing. A wide variety of therapeutic drugs have been reported to interfere with the bioavailability and/or metabolism of vitamin B_6.

The role of minerals and trace elements

Minerals and trace elements of public health importance that have received attention include calcium, iron, iodine, zinc, sodium and fluoride but, depending on geographical, environmental and cultural factors, copper, selenium and probably others could also be included. Physiologically the trace element nutrients have an extremely wide range of functions, many of which are still under investigation. Foods making important contributions to daily intakes of essential inorganic elements can be seen in Table A1.5.

Susceptibility to the effects of heavy metal pollutants is influenced by dietary mineral balance as well as by protein status and the physical form in which pollutants enter the diet. Thus cadmium and lead absorption are potentiated by lower dietary calcium and iron (*50, 51*). In contrast, foods high in phytic acid content are potent inhibitors of lead (*51*, *75*) and iron absorption.

Table A1.5

Foods making an important contribution to daily intakes of essential inorganic elements

Element	Sources
Iron	Meat (ruminant, pig, pigeon), liver, blood, green vegetables, cereals, pulses, teff
Iodine	Seafood, milk, cheese, cereals, (all contents influenced greatly by regional iodine content of soil), iodized salt, some kinds of rock salt
Calcium	Milk, cheese, legumes, pulses, green leaf vegetables
Phosphorus	Milk, cheese, cereals, meat
Potassium	Root vegetables, green leaf vegetables, bananas/plantains
Zinc	Red meats, cheese, milk, pulses, legumes
Magnesium	Green leaf vegetables, cereals
Copper	Liver, green leaf vegetables
Selenium	Cereals (reflect selenium content of soil), fish, meat, eggs
Chromium	Red meats, whole cereal products, pulses, spices
Molybdenum	Legumes, pulses
Fluorine	Tea (content influenced strongly by fluoride in groundwater or irrigation water)
Boron	Vegetables

Recognized geochemical variables have a profound influence on the content of some elements such as iodine, selenium, molybdenum and manganese in foods. The parent soil and agricultural conditions in various ecological zones can influence, sometimes more than tenfold, the content of these elements and of fluoride in staple crops. FAO has reported extensively on the ways in which such regional factors influence mineral element supply (*52*, *76*, *77*). They will have a profound influence on the significance of iodine deficiency as a cause of delayed development in infants and children. Losses of elements during food processing should be taken into account; for example, some forms of selenium and of iodine in foods can be lost during heat treatment. Sodium, potassium and magnesium are all lost to a greater or lesser extent during boiling.

Calcium is an essential component of the mineral matrix of bone, and a regulator of nervous system and muscle membrane function and clotting mechanisms. Virtually all (99%) of the calcium in the body is deposited in bone. Mineral deposition in bone reaches a peak by 25 years of age. In women after the menopause, calcium loss from bone exceeds deposition, leading to progressive demineralization. Osteoporosis with advancing age increases the risk of fractures. Most recommendations are based on needs for calcium balance and retention in bone rather than on acquired peak bone mineral density; the present RNIs may therefore need re-examination.

The relatively high calcium requirements needed to confer protection on infants against depletion before weaning, and to promote satisfactory bone density during adolescence, are now recognized internationally (*78*). The debate continues about the wisdom of further increases in calcium intake by other age groups, in an attempt to reduce the high incidence of osteoporosis and bone fracture in some geographical areas compared to others (*79*, *80*). Genetic variables, differences in physical activity, nutrient and dietary interactions, and ethnic factors influencing the relationships between calcium intake and skeletal density are inadequately understood.

Evidence from noninvasive measurements of bone density indicate that a range of dietary variables influences the beneficial effects of calcium-rich foods on bone density. These include vitamin C, fruits and vegetables, potassium and fibre (*81*). Whether these act directly or indirectly is not known. Calcium loss is promoted by even mild degrees of dietary acidosis (*82*) or by excessive intake of protein, particularly animal protein (*83*).

Sequelae to the overenthusiastic use of calcium supplements, which are often disregarded, include reduced iron and zinc absorption from diets rich in vegetable sources of phytic acid, the effects of which are potentiated by high dietary calcium.

Metabolic synergism involving calcium, magnesium and potassium influences the physiological and functional effectiveness of all three elements in the maintenance of healthy nervous tissue and skeletal integrity (*84*). Dietary balance should be maintained between these elements even though their contents in staple foods differ markedly.

In tropical developing countries, increased activity levels and exposure to the sun may protect against osteoporosis, so the RNIs are usually set lower. In addition, recent evidence indicates that bone mineral density in China is adequate despite a chronically lower calcium intake, suggesting that some populations may have a more efficient absorption of calcium and therefore have adequate bone mineralization with lower levels of intake (*85*).

The calcium RNIs in the USA are higher than those accepted internationally, and extend the increased needs of adolescents to young adults up to 24 years of age, the point at which peak bone mass is reached. Newly acquired results on bone density favour calcium intakes beyond the needs for calcium balance and retention for growth. Recent evidence that bone mineral mass can be influenced by calcium intake from prepuberty through to early adulthood has resulted in an increase in the RNIs proposed for this age group.

A nutrient density of 250–400 mg calcium per 4.2 MJ (1000 $kcal_{th}$) is proposed in the light of differing views on this subject. The higher level is suggested for industrialized countries; and will meet the needs of all family members except pregnant and lactating women. This goal is virtually impossible to meet unless dairy products are consumed in sufficient amounts. Sea foods, sardines with bone, legumes and calcium hydroxide-treated maize products are important potential sources of calcium where dairy products are not consumed.

Iron is a constituent of haem and cytochromes, and is a cofactor for redox and other key enzymic reactions. Relatively minor reductions in iron status associated, for example, with haemoglobin concentrations within the range 100–120 g/litre, are now recognized as delaying the development of cognitive function (*86*) and inducing behavioural changes in children (*58*). Available iron should be sufficient to reduce the currently high prevalence of iron deficiency, as manifested in more than 2000 million people worldwide by clinical anaemia, behavioural changes and other covert signs of deficiency (*58*). Voluntary work performance is adversely affected in adults (*87*). The absorption of heavy metal pollutants, such as cadmium and lead, is enhanced by even a modest fall in iron status (*50, 51*). Absorbed iron needs are defined by replacement of obligatory losses and requirements for growth. Milk is a relatively poor source of iron; infants weaned onto unfortified cow's milk are at high risk of iron deficiency. Women, because of iron loss during menstruation, are at higher risk of deficiency. Pregnancy also imposes additional needs (30–60 mg/day) that can be difficult to meet by regular mixed diets. Owing to the variable (1–30%) absorption of iron from a mixed diet, RNIs are best based on iron bioavailability within the diet.

Animal foods and ascorbate are important enhancers of non-haem iron absorption, while phytates, polyphenols, tannins and fibre lower it. Thus, recent RNIs (*88*) are defined in terms of very low (<5%), low (5–10%), intermediate (11–18%) and high (>19%) bioavailability. The corresponding densities suggested for the mixed diet at the family level are 20, 11, 5.5 and 3.5 mg per 4.2 MJ (1000 $kcal_{th}$). Low bioavailability diets are cereal-based and have low ascorbate content. Intermediate absorption is found in diets based on plant foods with some animal protein and ascorbic acid. Similarly, high-bioavailability diets show an intermediate level of absorption if consumed with coffee or tea, which contain polyphenols and tannins, respectively. High bioavailability is found in diets based predominantly on animal protein together with fruits rich in ascorbic acid. It is evident that higher-income groups of the population will have lower needs and a higher intake with greater bioavailability than lower-income groups. Fortification of staple foods such as wheat or maize flour, sugar, salt or soya sauce has been successfully implemented in various countries to help prevent iron deficiency.

Iodine is vital for cell differentiation and thyroid hormone synthesis. Iodine deficiency disorders, manifesting as goitre, cretinism and learning defects in children exposed to deficiency during fetal development, are widespread and have important public health consequences in all regions of the world (*56*). Deficiency in early life can affect brain development even in the presence of normal thyroid function. A low iodine content in the water is considered a valuable indicator of the iodine content of foods in a given ecological setting. A low level of iodine in foodstuffs is a key determinant in the prevalence of iodine-deficiency goitre. A density of 75 μg per 4.2 MJ (1000 $kcal_{th}$) is suggested. Consumption of seafood is desirable, although iodine fortification of salt is in practice the most effective way of eradicating the deficit.

Zinc has gained greater significance in human nutrition since it was demonstrated to be crucial for linear growth (particularly in males) and normal immune function. Susceptibility to zinc deficiency is high during maximum rates of protein synthesis. Thus, the substitution of sources of highly available zinc such as milk, meat and fish by vegetable sources of protein rich in phytic acid is frequently the cause of deficiency during rehabilitation after infection or any nutritional insult that has restricted growth.

Zinc absorption in the mixed diet can vary from 10% to 30% and is dependent on interactions with other nutrients such as phytates and fibre. The zinc nutrient densities suggested for high (20%) and low (10%) bioavailability are 6mg and 10mg per 4.2MJ (1000kcal$_{th}$), respectively. Recent studies indicate that faltering in the growth of young children after weaning can sometimes be prevented by zinc supplements. Although the concentration is low, zinc in breast milk (but not cow's milk) is well absorbed. Animal proteins other than milk are excellent sources of bioavailable zinc, thus supporting the suggestion that 10–25% of dietary protein should be of animal origin.

Selenium status affects the efficiency with which iodine is incorporated into the thyroid hormone triiodothyronine (*89*) and its deficiency leads to reduced rates of tissue growth and other related symptoms.

Recently, concurrent deficiencies of selenium and vitamin E have been shown to increase susceptibility to several viral infections including enteritis and cardiomyopathy (*90–92*). Studies indicate that selenium has at least two major physiological roles. It is involved, like vitamins E and C, in processes protecting body tissues against the damaging effects of highly reactive oxygen-rich compounds generated after tissue injury or infection, and also in the synthesis of triiodothyronine. Indications are that selenium intakes exceeding about 10μg per 4.2MJ (1000kcal$_{th}$) afford protection against these effects. Concurrent exposure to some viral infections is now believed to potentiate expression of the effects of selenium deficiency, as for example in the cardiomyopathy of infants and young children with Keshan disease associated with selenium deficiency in China.

Fluorine, absorbed as fluoride, is needed to strengthen hydroxyapatite crystals in dental enamel and dentine. It also affects bone growth and remodelling, and is considered an essential element. Water is an important contributor to fluoride intake in many areas of the world, while in other areas foods of marine origin and tea represent the main sources. Fluoridation of water supplies where the natural content is low is the most practical way of assuring sufficient intake. The suggested dietary goal for fluoride is 0.7mg per 4.2MJ (1000kcal$_{th}$).

Fortification of salt has also been proposed (and is carried out in Switzerland). Excess fluoride intake (>2.5 mg/day) causes mottling of the dental enamel; extremely high intakes (>8 mg/day) cause deformation of the skeleton.

Sodium is an essential component of extracellular fluid, serving as the primary regulator of osmotic pressure in the extracellular space. It also determines transmembrane bioelectric potentials, and changes in membrane permeability trigger depolarization and conduction of electric signals. Sodium is also required for regulation of osmolarity and acid–base balance. Excess sodium is excreted through the kidneys. Sodium deficiency resulting from low dietary intakes is rare; it can occur with heavy and persistent sweating or when the body is unable to retain sodium due to trauma, chronic diarrhoea or kidney disease.

High sodium intake, as measured by increased urinary sodium excretion, is associated with an elevated incidence of cerebrovascular stroke in some populations (*93*). A specific genetic susceptibility to sodium is likely to be a determining factor in the causation of essential hypertension in human populations. There are data indicating that a high sodium intake in elderly people may be associated with elevated blood pressure (*94*). Some people with hypertension benefit from sodium restriction.

It is important to note the interaction between sodium, potassium and calcium with regard to blood pressure. Adequate calcium : sodium and potassium : sodium ratios help to maintain optimal blood pressure.

Dietary guidance on using salt and sodium in moderation should depend on the extent of hypertension as a public health problem and its causes. "Moderation" has been defined differently for different populations, usually depending on the level of sodium currently being consumed. The customary sodium content of natural foods is sufficient to meet requirements, and no lower limit for intake has therefore been established except for infants. An upper limit of 6 g sodium per day or 2.5 g per 4.2 MJ (1000 $kcal_{th}$) is commonly suggested as a population mean target value.

4.1.4 *Non-nutrient food components of biological significance*

Several compounds of interest have traditionally been investigated as "antinutrients," including phytates, antitrypsin and other enzyme inhibitors, tannins, phenolic compounds and lecithins. When diets are marginal for nutritional adequacy, these antinutritional effects may be of significance. By contrast, in diets that are nutritionally adequate, the physiological activities associated with other compounds, such as flavonoids and salicylates, may provide some of the health benefits now known to be associated with plant foods.

Most food salicylates (in microgram amounts) come from fruit (*95*), and their presence may explain, in part, some of the relationships between fruit intake and noncommunicable diseases. Although acetylsalicylic acid (aspirin) is not always biologically equivalent to salicylate, aspirin studies provide some insight into how food salicylate might be important in the prevention of cardiovascular diseases and gastrointestinal cancers (*96*). There is a problem, however, for those who are salicylate- or aspirin-sensitive, although this is dose-related and less likely when salicylate is ingested as part of the food supply (*97*).

Non-provitamin A carotenoids. There are over 500 plant carotenoids, and many of these compounds appear to have significant biological activity in humans. Lycopene is one of the main precursors of carotenoids in plants (*98*). It has no vitamin A activity but is a particularly powerful trapper of singlet oxygen (*99*). Lycopene is one of the main colourants of tomatoes and watermelons. It exemplifies how a non-nutrient, by its colour, may help to identify foods in FBDGs that have biological properties beyond those usually sought from foods. Several carotenoids that lack provitamin A activity are readily absorbed from the diet and distributed to tissues. For example, lutein and zeaxanthin are selectively concentrated in the retina, and their dietary intake may be correlated with a reduced risk of age-related macular degeneration. In any case, increasing the consumption of foods rich in certain carotenoids, in particular dark green leaf vegetables, appears to lower the risk of developing advanced or exudative age-related macular degeneration, the most visually disabling form of macular degeneration among older people (*100*). Some carotenoids also possess potent antioxidant activity, which may be why they are associated with reduced risk of some forms of cancer. However, a recent report concluded that, though average flavonoid intake may partly contribute to differences in coronary heart disease mortality across populations, it does not seem to be an important determinant of cancer mortality (*101*).

Polyphenols. Plant-derived polyphenols comprise a wide variety of chemical compounds, including the bioflavonoids. Many bioflavonoids possess antioxidant activity and have been shown to reduce oxidative stress by quenching free radicals and/or binding to minerals, such as iron, that catalyse free radical reactions. A limited number of experimental and epidemiological studies have associated an increased intake of bioflavonoids with a reduced risk of cardiovascular diseases and cancer (*102–104*).

Phytoestrogens. These fall into three families of compound — flavonoids, coumestans and lignans — that are found in a wide range of plant foods and, following ingestion, in animal-derived foods (e.g. milk from cows feeding on certain types of clover). They have been shown in human studies to moderate the expression of the menopause (*105*) and are likely to have wide-ranging biological effects on bone, cardiovascular diseases and the risk of certain cancers (e.g. breast and prostate), although they are generally weakly estrogenic or even anti-estrogenic. Some, like genistein, may be immunomodulatory and anti-angiogenic, with potential importance in metastatic cancer and diabetic retinopathy (*106*).

Consequently, in terms of FBDGs, these non-nutrient food components will become increasingly important as more is discovered about them, and constitute an important rationale for FBDGs.

4.1.5 *Dietary guidelines for vulnerable groups*

For the purpose of dietary guidelines, the family should be considered the unit of consumption. This approach assumes that all members of the family consume the same mixed diet except for children under 2 years of age, elderly people with difficulties in eating enough, and those who are ill and have special requirements.

In most countries, there are some particularly vulnerable age and sex groups, some of which are dealt with below, and other groups that are vulnerable because of geographical or socioeconomic conditions. The latter include those at risk of specific deficiency diseases, such as rickets, beriberi and scurvy, for which specific guidelines may be necessary.

The "menu" and content of specific dietary guidelines will depend on the circumstances of a country. Only some general principles are illustrated below. For these groups, examples are given of guidelines appropriate for some commonly occurring deficiencies or imbalances. The content of these guidelines, however, should be specifically tailored to the particular nutritional and dietary situation in the country concerned.

In most of the groups listed below, there are certain health, food and nutritional beliefs whose nutritional impact may be beneficial, neutral or harmful. Those that are beneficial should be encouraged, while those that are harmful should as far as possible be identified and circumvented through culturally acceptable alternative dietary or health practices.

Infants and young children

The general guidelines are designed to cover children over 2 years of age. Infants and children up to 2 years of age are an especially vulnerable group in almost every country, and care is needed to ensure that they achieve their full potential for growth and development. This development should be monitored and promoted, preferably on an individual basis.

Nutritional requirements are normally fully covered by breast milk (if the mother is in good health and well nourished) for the first 4–6 months of life. During this period, exclusive breast feeding is recommended. Introduction of any other liquid or solid feeding at too early a phase has been shown, in a wide variety of socioeconomic conditions, to reduce breast milk production and increase the risk of infection. Several measures to promote breast feeding are already widely used (*107*, *108*).

After 4–6 months, breast milk alone usually cannot provide all the nutritional requirements, and thus complementary foods are needed. These should be introduced according to a country-specific infant feeding guidelines. These should indicate, at least in a broad way, the quantity, quality and timing of foods to be introduced, together with the proper hygienic care, in culturally acceptable and socioeconomically feasible ways. They should therefore be developed in partnership with the communities concerned. The guidelines should be made available at all levels of the health system, including agricultural extension, community development and education services. WHO recommends that children should continue to be breast fed for up to 2 years or more, while receiving nutritionally adequate and safe complementary foods (*109*).

Major nutritional deficiencies such as protein–energy malnutrition, iron deficiency anaemia, vitamin A deficiency, often become manifest during the second year of life, but may begin to develop even during early infancy owing to, for example, intrauterine growth retardation, low birth weight, prematurity or inadequate lactation. Laying a good nutritional foundation during the second 6 months of life is often the key to subsequent growth and nutrition. Frequent feeding (4–6 times daily) during this period is very important, as are adequate amounts of food and an adequate nutrient density of the complementary foods. Where possible, a relatively thick porridge with some unsaturated oil or fat added is recommended.

Adequate feeding during mixed feeding and after weaning needs to be accompanied by appropriate public health measures to minimize infection. This can best be done through primary health care programmes and community-based feeding, as well as through optimal nutrition and food distribution within the family.

Pregnancy

Dietary intakes, especially in low-income populations deficient in food, commonly do not increase much or at all during pregnancy, and can thus be less than is recommended for increasing maternal fat stores to support lactation. It is usually important to recommend a moderately higher dietary energy intake (approximately 10%) during the last 6 months of pregnancy, and body weight should be monitored throughout pregnancy. Energy intake should be increased in the presence of excessive thinness, low body mass index, or little or no weight gain (<1 kg/month). It is not necessary, however, if weight gain is consistently over 1 kg per month.

Iron deficiency anaemia is very common (>50% in developing and about 17% in industrialized countries) and is often associated with folate deficiency, particularly where malaria occurs. The consumption of foods relatively rich in iron, vitamin C and folate and some foods of animal origin, as well as vitamin A in areas deficient in vitamin A, should be particularly encouraged. The consumption with meals of inhibitors of iron absorption, such as tea and coffee, should be avoided.

Calcium intake can be increased through the daily consumption of moderate amounts of dairy products, small whole fish and soft bones (such as chicken bones). Tubers usually provide more calcium than cereals. Excessive calcium intake inhibits iron absorption.

Fruits and vegetables and good protein sources should, where possible, be increased in the daily diet. Salt and energy intakes should be restricted in the case of oedema.

Lactation

Lactating women are at some risk of nutritional depletion, particularly in low-income populations deficient in food, where energy and other nutrient intakes may not increase sufficiently to cover their increased requirements.

Intakes of energy and protein should be increased by about 20% based on the existing dietary pattern, preferably with additional protein. Body weight should be monitored regularly. Those women losing weight steadily should be encouraged to eat more and, if necessary, provided with supplements, but not those who are overweight or gaining weight normally. The consumption of fruits and vegetables should also be increased.

The elderly

Most nutrient recommendations currently in use do not specify the particular needs of older people.

With advancing age, and particularly beyond the age of 70, among the most important changes affecting appetite, strength and energy needs are a decline in lean body mass and body mass index. It is therefore important to maintain adequate nutrient density in the diet of the elderly to compensate for these changes. Thus, if nutrient sufficiency is to be maintained, the nutrient densities given in Table A1.1 may need to be increased to compensate for lower appetites, body mass indexes and total energy intakes by the elderly. As with other age groups, the importance of continued physical activity — to stimulate appetite and maintain muscle mass and strength — should be a priority.

In countries where restricting fat intake is important, the detrimental effects of reducing the intakes of fat and energy by those already at risk of losing weight and lean body mass should be considered. Restricting energy intake in the elderly is not good nutritional practice.

Consideration should also be given to vitamin D intake for those among the elderly who are not active and receive little exposure to the sun, and to vitamin B_{12} to compensate for lower efficiency in absorbing food-bound vitamin B_{12}. Folate and pyridoxine intakes may also pose problems in the elderly. Among the minerals, intakes of calcium and zinc may be low with the problem compounded by reduced absorption.

4.1.6 *Nutritional quality of dietary patterns*

Given the variety of foods that can be combined to provide a healthy diet, it is difficult to define the ranges of intakes for specific foods that can be combined to provide a nutritionally adequate diet. Although a large set of food combinations that are compatible with nutritional adequacy could be defined, these can hardly be extrapolated to different ecological settings. Another approach to defining nutritional adequacy of diets, based on a scientific understanding of the biochemical and physiological basis of human nutritional requirements in health and disease, has evolved over the past two centuries. This has permitted the definition of essential nutrients and the establishment of RNIs.

FBDGs, as an instrument and expression of food and nutrition policy, can be based directly on diet and disease relationships of particular relevance to the individual country. In this way, priorities in establishing dietary guidelines can address the relevant public health concerns, whether they are related to dietary insufficiency or excess. In this scenario, meeting the nutritional needs of the population takes its place as one of the components of food and nutrition policy goals, along with the priorities embodied in the FBDGs for improved health and nutrition for a given population.

Three possible approaches are useful in assessing nutritional quality in the development and evaluation of FBDGs.

Food patterns

Adherence to a reference food pattern with an apparently favourable relationship to health is one way of evaluating the nutritional quality of an envisaged dietary guidelines approach. This is most likely to be a traditional food pattern of people with longevity, low morbidity and low perinatal and infant mortality rates (such as in Scandinavia, Japan and the Mediterranean region) whether the diet was established by tradition or by acculturation. In most of these populations, other factors such as health care, the educational system, safe water and socioeconomic development play important roles in relation to favourable health indicators.

Tracking health indices in populations in relationship to their intake patterns has, so far, been the most readily available evidence on which to base FBDGs. There have been a number of key studies in this area.

- The Zutphen (Netherlands) study by Kromhout et al. (*15*, *16*) showed that the 20% of men who consumed most plant-derived foods (using dietary fibre as a marker) lived longest and had the lowest morbidity. Even one or two meals of fish a week may be of preventive value in relation to coronary heart disease.
- Studies of American female nurses and male health workers by Willett and co-workers (*110–114*) showed that certain food sources of micronutrients (and possibly supplements) may reduce the risk of cardiovascular diseases, while taking alcohol may increase the risk of breast cancer in women. The complete data set clearly provides an opportunity to look at overall health/food patterns in prospective fashion, but this analysis awaits final compilation.
- Singapore's food and cancer studies by Lee (*115*) demonstrated that deviations from traditional Chinese and south-east Asian food patterns (e.g. those based around soya products) are associated with higher rates of certain cancers such as breast cancer.
- The Ireland–Boston cardiovascular disease study of men by Kushi et al. (*116*) showed that plant food intake is linearly and inversely

related to increasing coronary mortality over 20 years, whereas fat–cholesterol indices (Keys and Hegsted scores) had a more J-shaped relationship. This suggests that food scores may be more useful than nutrient scores in the development of dietary guidelines.

- Data from the study on women in western Sweden by Lapidus et al. (*117*) showed that, when body weight was controlled for, higher intakes of energy and food were predictive of lower mortality rates from coronary heart disease. This is helpful in developing dietary guidelines for women that are not based on life-long dietary restriction.
- In the American NHANES study (*118*), a food diversity score, based on food groups, predicted for mortality and allowed sex differences in this prediction to be recognized.

Food variety indices

While the value of increased food variety in either ensuring essential nutrient adequacy or decreasing the risk of food toxicity has been understood for some time (*119*), food variety as a predictor of health outcome is relatively recent (*118*, *120*). Nevertheless, enough evidence is available to justify this technique's inclusion in the development of FBDGs in order to reduce morbidity and mortality, while further scientific studies on how it operates are awaited.

In deriving indices of food variety, decisions are required about the numerator (categorization of food) and denominator (the time over which variety is achieved).

Nutrient requirements and RNIs

These have been the subject of technical reports by both FAO and WHO, which are currently being updated. Many countries have established their own recommended nutrient intakes.

4.2 Food science and technology

Food science and technology are creating a new framework for FBDGs, principally in the areas of food physicochemistry, methods of food storage and preservation, changes in food preparation, and opportunities for the use of formula foods where energy intake is low or the usual foods cannot be eaten.

Physicochemistry

Factors such as the viscosity and particle size of foods that otherwise have the same chemistry can influence digestion and absorption and the colonic microenvironment (*121–123*).

Preservation
Reduced use of salt and curing, and increased canning, dehydration, freezing and irradiation, are a result of innovations in food technology. New packaging techniques are also reducing food wastage and prolonging the shelf-life of fruits and vegetables. At the same time, new microbiological problems, such as listeriosis, may arise where the full impact of newer storage technologies is not appreciated. Some of these have implications for particular groups such as pregnant women, who could be at risk of aborting if they eat soft cheeses that may contain *Listeria*. Such factors may create the need for specific FBDGs for such special groups.

Preparation
FBDGs can encourage or discourage the use of certain food preparation techniques, such as boiling because of nutrient loss, frying with fat, microwaving for flavour retention, and cooking with herbs and spices rather than with salt, soya sauce or monosodium glutamate.

Formula foods
Where energy needs are low or the usual foods cannot be eaten, nutrient (and non-nutrient) needs may be met by formula foods, and guidelines for their use may be required.

Functional foods
New types of food are emerging — referred to as functional or "designer" foods (*124*) — that do not resemble or are surrogates for traditional foods, or that address some newly understood biological or health need. Some basic food commodities, such as cereals and fruits, are being used more as nutrient delivery systems than as basic commodities. The ability to distinguish between traditional foods and such new foods is difficult, and consumers may be unaware of differences in nutrient content or bioavailability and how these differences influence the adoption of FBDGs (*125*).

4.3 Behavioural and social sciences and education

Both the practicality of FBDGs and the consequences of following them require analysis through the behavioural and social sciences. For example, urging a reduction in the traditional use of salt may lead to an unintended reduction in the use of certain foods, e.g. potatoes or salted fish. Likewise, if FBDGs imply a lower energy intake, they may further exacerbate the current epidemic of eating disorders among young women in developed countries. An understanding of motivation and behaviour can anticipate such situations and help to avoid unintended consequences.

Several research studies in nutrition education have attempted to document the difficulties that the general public even if well educated, has when interpreting dietary guidelines presented in terms of nutrients (*126*, *127*). For example, "cholesterol" is often equated with blood lipids, "saturated fat" as a food full of fat, and "polyunsaturated fat" as a food lacking in fat (*128*). More complicated nutrient-based statements, such as those that mention specific fatty acids, may be dismissed altogether owing to unfamiliarity with the technical subject. It is recommended, therefore, that dietary guideline advice be presented in food-based terminology whenever possible. Nutrients should be mentioned only in an instructional context, whereby the public has had an opportunity to learn new words rather than relying on its own vocabulary to interpret the meaning.

Cognitive science has produced several findings relevant to the formation of dietary guidelines. First, it has been shown that people have the ability to code information in at least two ways, verbally or visually. Verbal coding includes words or text that are heard or seen. Visual coding refers to pictures or graphics that have been seen or observed. When both coding systems are used, the information is much more easily retained (*129–131*). In addition, the amount of information presented at one time will also influence its retention. Humans have an information-processing capacity of some seven concepts, or not more than between five and nine concepts in their working memory at one time. Thus, if people are expected to recognize information as a set and use it all together (*132*), any information presented as a list or set should never exceed nine concepts. In addition, such information should be illustrated to maximize effectiveness.

4.4 Agricultural and environmental sciences

Consideration of the agricultural and environmental sciences is important in developing and implementing dietary guidelines. It is activities in these fields that largely determine whether the food supply can support and sustain adherence to the guidelines. Dietary advice is appropriate only if it can be put into practice. For dietary guidelines to be followed, the range of foods available to the target population should be nutritionally adequate, of good quality and able to support the recommendations in the guidelines. Most importantly, the recommended foods should be accessible to and affordable by the target population.

This does not mean that dietary guidelines should be based solely on currently available food supplies. In fact, they can be useful in assessing the adequacy of food supplies and, especially where supplies are obviously inadequate, in assisting producers and planners to improve the quantity, quality and variety of available foods. For example, the inadequacy of food supplies in some low-income countries does not preclude dietary guidelines from recommending adequate intakes. On the contrary, the need to assure the availability of nutritionally adequate food supplies should be a driving force behind food, agricultural and trade policies in those countries.

Stressing that dietary guidelines should be feasible does imply, however, that any changes in the food supply that might be required to implement the guidelines are not only possible but probable. In a country with an efficient system of food production, processing, marketing and trade, changes in consumer demand for food products will alter their availability and price. To the extent that dietary guidelines can alter food demand and consumption patterns, supplies can also be altered. The greatly increased supply of low-fat foods in many countries, in response to increased consumer demand for these products, is a good example. Nevertheless if the guidelines attempt to promote unrealistic, unattainable or undesirable (from the consumer's point of view) dietary intakes, they will not be followed. For example, promoting higher intakes of olive oil in countries where it is unavailable, prohibitively expensive or simply undesirable to consumers is not an effective strategy for reducing the intake of saturated fats, particularly in the short to medium term.

In all cases, the role of the environmental and agricultural sciences in developing and implementing FBDGs needs to be recognized. This includes a range of issues related to land and water use and to the production and processing of crops, livestock and fishery and forestry products (*133*). Both pure and applied research can be important, either in expanding the production of particular foods or in modifying their nutrient content and that of non-nutrient components to satisfy dietary guidelines. The concept of sustainable agricultural development is particularly important and needs to underpin efforts to meet the food needs of present and future generations.

5. Conclusion and suggested research priorities

Because many factors in the relationships between food constituents, disease and health are still not understood, there remain many scientific concerns and areas of potential interest in those relationships. Much of the current research isolates and attributes the observed effects to a specific nutrient or non-nutrient component. It is well recognized, however, that the effect may be due to, or modified by, as yet unidentified food components. Research in this area will bring together work by food scientists, epidemiologists, biochemists and nutritional scientists.

Among the issues that have been identified are the following.

- The physicochemical properties of foods and how they are processed, refined, prepared and stored affect their biological activity (*134*). This is important in diabetes, as the glycaemic index of a specific food is altered by such factors as particle size and viscosity (*135*). There may be a further effect on the microflora of the large gut, and even on nutrient uptake, as less digested food proceeds into the large bowel. To cite one example, cereal as an extruded product has different nutritional effects from the base from which it is made, e.g. rice, wheat or wholemeal flour, even though the extruded product and base are chemically identical. Peanuts eaten as such differ in protein bioavailability and fat content from peanut paste (*137*). Differences in the granularity of protein clots produced in the young stomach are believed to be related to differences in the availability of zinc, copper, iron and calcium.
- Food patterns and food preparation can also be important. For example, levels of vitamin A vary depending on whether foods are steamed, fried or boiled (*138*). Food science will explore such relationships in greater detail as foods become the reference targets of guidelines. A dietetic component here is the consumer's ability to associate nutrient content (e.g. vitamins, fats or sugars) with various food or food patterns.
- A possible future area of concern, based on experimental animal evidence, is the increasing refinement of the food supply which, in extreme cases, may lead to a risk of reduced availability of micronutrients such as copper, iron, selenium and zinc. Geochemical and agricultural variables can influence the content of iodine, selenium, fluoride and molybdenum in staple foods.
- In the development of dietary guidelines, consideration should be given to new foods that become available to populations in a particular cultural context, such as white bread or extruded snacks replacing traditional foods or instant noodles being introduced into Asian societies.
- The increasing impact of "designer" or "functional" foods (*124*) is an extreme example. These foods may lead to difficulties in food choice, in that they will not deliver what consumers expect based on existing knowledge. Also relevant are issues such as appropriate

labelling, food legislation and nutrition education. In formulating such foods, non-nutrient components and even nutrients may not be included, an example being the absence of various components such as long-chain fatty acids and immunological factors in breast-milk substitutes. Some foods, such as breakfast cereals, may become merely vehicles for added nutrients.

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Annex 2
Examples of foods in current sets of dietary guidelines and food guides

The following examples illustrate how foods and food groups have been incorporated into dietary guidelines in selected countries. They also indicate the types of food guides that have been developed as visual aids and teaching tools to help implement the guidelines. The inclusion of these guidelines does not mean they are being endorsed or promoted as "recommended" dietary guidelines or food guides, especially since some of the scientific assumptions underlying some statements have been overtaken by more recent research and knowledge.

1. Foods included in dietary guidelines

A number of countries and organizations have developed dietary guidelines. While the Consultation did not review them, examples of foods that feature in the current sets of dietary guidelines are provided in Table A2.1 (*1*) In addition to guidelines that name specific foods, some countries have issued guidelines expressed in other ways, without naming foods (not shown in the table). The latter category predominates.

The foods that appear in these guidelines are usually large groups such as vegetables, fruits, cereals and meat, but in some cases they are more specific, e.g. citrus fruits, bread, fatty fish and rice. A few guidelines specify processing or lack of processing (e.g. whole-grain, smoked, full-cream, salt-cured or fresh).

2. Selected food groups used in food guides for nutrition education of the general public (Table A2.2)

Example 7 (Fiji) is used throughout the South Pacific and in a number of African and other countries. It may have originated in the United Kingdom during the Second World War. This three-food-group system has one group of foods said to provide energy, another providing protein and a third consisting of fruits and vegetables (in some sets termed "health" or "selective" foods).

Example 5 is a four-food-group system proposed by Abrahamsson & Gebre-Medhin (*2*) for developing countries, especially for feeding children. It gives pride of place to the country's staple, which not only provides energy but also protein and other nutrients. For good nutrition, it needs to be supplemented with foods from three groups: vegetables and fruits (for vitamins A, B and C), protein-rich food

Table A2.1
Food groups included in current dietary guidelines

Country	Year	Recommendations
Australia	1992	Eat plenty of breads and cereals (preferably whole-grain), vegetables (including legumes) and fruits
		Eat only a moderate amount of sugars and foods containing added sugars
		Eat foods containing calcium
		Eat foods containing iron
Denmark	1983	Eat more bread and corn products, potatoes, vegetables and fruit
		Eat less butter, margarine, fat, sugar and meat fat, and fewer fatty meat products and full-cream dairy products
France	1981	For sufficient fibre eat wholemeal breads, vegetables, cereals, dry legumes and dried fruits
Germany	1985	Eat sweets seldom
		Eat fresh foods (fruits, juices, vegetables, milk)
Hungary	1988	Reduce sugary snacks
		Drink half a litre of low-fat milk per day
		Eat fresh fruits, vegetables and salads more often
		Always have whole-grain bread on the table; choose potatoes over rice
		Quench thirst with water
Japan	1985	Eat 30 (different) foodstuffs a day; take staple food (i.e. rice), main dish and side dish together
New Zealand	1982 & 1991	Eat a variety of foods from each of the four major food groups each day
Republic of Korea	1980	Drink milk every day
Singapore	1989	Reduce intake of salt-cured, preserved and smoked foods
		Increase intake of fruit and vegetables and whole-grain cereal products, thereby increasing vitamins A and C and fibre
United Kingdom	1990	Eat plenty of food rich in starch and fibre (examples given)
		Look after the vitamins and minerals in your food (milk, cheese, butter and margarine, eggs, green vegetables, carrots, liver, meat, fish, beans, bread, breakfast cereals, citrus fruits, fatty fish, dried fruit)
United States	1995	Choose a diet with plenty of vegetables, fruits and grain products
	1989	Eat five or more servings of vegetables and fruits each day (especially green and yellow vegetables and citrus fruits). Also increase intake of starches and complex carbohydrates such as breads, cereals and legumes; an increase in added sugars is not recommended

(especially for young children) and extra energy (most conveniently as some form of oil).

Example 4 (Caribbean) had more groups — formerly six and now seven. The current food guide strongly emphasizes fruits and vegetables and includes, but de-emphasizes, fats and sugar.

Industrialized countries usually have three-, four- or five-food-group systems. The foods that differ most between country systems are the following (numbers in parentheses refer to the examples listed in Table A2.2).

- Milk has its own group in Australia (1), Canada (3), Denmark (6), Finland (8), Germany (9), New Zealand (12), the United Kingdom (14), and the USA (15), but not in the Netherlands (11) or Sweden (13). In the Netherlands, milk is grouped with other animal foods; in Sweden, it is grouped with cereal foods and potatoes as the basal diet in the bottom layer of the pyramid.
- Potatoes appear as a special food group in Finland (8). In some countries (2, 3, 12) they are grouped with green vegetables. In other countries (6, 11, 13, 14) they are grouped with cereals.
- Fats and oils do not appear in Canada (3). In some countries, they appear as a small separate group to be eaten sparingly (1, 6, 8, 9, 11). In other countries (8, 12, 14) they are combined with sugar in a small ("eat sparingly") group.
- Legumes appear with the meat group in some countries (1, 3, 14, 15), usually described as "dry legumes". In other countries, they may be grouped with green vegetables.

Food groups are also being used to represent advice on vegetarian diets, therapeutic diets for diabetes mellitus, for lowering plasma LDL cholesterol and for describing an idealized Mediterranean diet.

It is much easier to illustrate unpackaged, single foods. Some countries have made suggestions as to where mixed dishes fit into their food-group systems, for example by providing a comprehensive reserve list.

Note that the food guides in Table A2.2 do not express all the dietary guidelines of the corresponding country. "Eat less or little fat" can be conveyed by having a fats and oils group and showing it to be very small (1, 11). In the USA, food pyramid fats are shown as small white circles against a black background. It remains to be seen how efficiently this pictorial symbolism can convey the message. It has proved very difficult to convey in visual form such statements as "balance energy intake against expenditure; avoid overweight/obesity" and "if you drink alcohol, do so in moderation".

In the food guides, the individual foods which are generally available and which educators wish to emphasize are mentioned in the text or shown in visual material. Preferred forms of the food, such as low-fat

Table A2.2

A selection of food guides for nutrition education of the general public

1. Australia	Australian Nutrition Foundation
Eat most	Fruit and vegetables (including canned and frozen)
Eat most	Cereal foods
Eat moderately	Lean meat, eggs, fish, chicken (no skin), nuts
Eat moderately	Milk, yoghurt, cheese
Eat in small amounts	Fats (butter, oil, margarine)
Eat least	Sugar
2. Australia	Target on healthy eating (South Australia and Victoria)
Large area	Cereal foods
Large area	Fruit and vegetables
Intermediate area	Meat, fish, poultry, legumes, nuts, eggs
Intermediate area	Milk, cheese, yoghurt
Minimal area	Butter and margarine
3. Canada	Rainbow (1992)
Outer largest quadrant	Grain products (5–12 servings per day)
Next, second largest quadrant	Fruit and vegetables (including canned and frozen) (5–10 servings per day)
Next, second smallest quadrant	Milk products
Innermost quadrant	Meat (lean), poultry, fish, dried legumes, eggs, tofu, peanut butter (2–3 servings per day), other foods and beverages
4. Caribbean	New circle
Semicircle (180°)	Fruit and vegetables: 1.75 to 2.5 lb
Next largest sector	Ground provisions (bananas, breadfruit, yam, potatoes): 12–18 oz
Next largest sector	Cereals: 6–9 oz
Next largest sector (20°)	Food from animals: 4–6 oz
Next largest sector	Legumes and nuts: 2–3 oz
Equal smallest sector (5°)	Fats and oils: 1–1.5 oz
Equal smallest sector (5°)	Sugar 1.5 oz

5. Food square for developing countries

Staple food	Protein supplement (milk powder, meat, beans or fish)
Vitamin and mineral supplement (mixed fruit and vegetables)	Energy supplement (oil)

6. Denmark	Kostcirklen
170°	Bread, grains, potatoes
55°	Meat, fish, eggs
50°	Vegetables
40°	Fruit
35°	Milk, cheese
10°	Fats
7. Fiji	Three food groups of equal size
Energy	Cereals, root crops, coconut, sugar, oil, butter
Health	Vegetables, fruits, seaweed
Body-building	Meat, fish, chicken, eggs, milk, cheese, legumes, groundnuts
8. Finland	Food circle (1987)
Largest sector	Fruit and vegetables
Intermediate sector	Cereal foods

Table A2.2
Continued

Intermediate sector	Milk, cheese, yoghurt
Somewhat smaller	Meat, poultry, fish, eggs, nuts
Smaller sector	Potatoes
Smallest sector	Fats and oils
9. Germany	Seven food groups
Largest area	Cereals, potatoes
Next largest	Vegetables, legumes, nuts
Next	Fruits
Next	Drinks
Next	Milk and other dairy products
Next	Meat, sausages, fish, eggs
Smallest	Fats and oils
10. Iran (Islamic Republic of)	Four groups of equal size shown in posters, and a miscellaneous group
Milk group	Milk, yoghurt, cheese, ice cream
Meat group	Beef, lamb, offal, poultry, fish, chicken, eggs, legumes
Cereal group	Bread, rice, macaroni, corn, wheat, barley, fruit and vegetables
Miscellaneous	Nuts, fats and oils, sweets, spices, beverages
11. Netherlands	Maaltijdschijf
1/3 circle	Bread, cereal products, potatoes
1/3 circle	Fruit and vegetables
1/6 circle	Meat, fish, poultry, milk, eggs, cheese
1/6 circle	A little fat
12. New Zealand	National Heart Foundation
Eat most	Fruit and vegetables (fresh)
Eat most	Cereal foods
Eat moderately	Lean meat, poultry, fish, dried beans, nuts, eggs
Eat moderately	Milk, cheese, yoghurt
Eat least	Salt, sugar, butter, margarine, oil
13. Sweden	Matpyramid
Base	Bread and other cereals, potatoes, milk, cheese, table fat
Middle	Vegetables, fruit, fruit juice, dry legumes
Apex	Meat, fish
14. United Kingdom	Food plate (1994)
Large sector	Fruit and vegetables (including canned and frozen)
Large sector	Bread, other cereals, potatoes (choose high-fibre)
Intermediate sector	Meat, fish, dry legumes, nuts, eggs
Intermediate sector	Milk, yoghurt, cheese
Smallest sector	Fatty and sugary foods
15. United States	New pyramid (1992)
Base	Bread and other cereals, potatoes, milk, cheese, table fat
Second level	Vegetable group (3–5 servings)
Second level (a smaller area)	Fruit group (2–4 servings)
Third level	Milk, yoghurt, cheese (2–3 servings)
Third level	Meat, poultry, fish, dry beans, eggs, nuts (2–3 servings)
Apex	Fats and sweets: use sparingly

Table A2.3
Examples of visual presentation of food guides related to dietary guidelines

1. A mixture of brief text with illustrations of major individual foods, with a spreadsheet for each food group (e.g. "Eat well . . . live well" by the Guild of Food Writers and Coronary Prevention Group, United Kingdom, 1991).
2. Several food groups, with examples illustrated in each. Each group within the same sized rectangle (e.g. Australian posters of the late 1970s with five groups; South Pacific Commission posters with three groups; British Second World War material).
3. Several food groups represented by rectangles, cubes or squares of different sizes (e.g. Are you overweight? Australia 1985).
4. Steps or piles of blocks of different heights (e.g. New Zealand). Each block the same size. Like building blocks, these can convey servings — cereal 5 blocks (= servings), vegetables 4, fruits 3, dairy products 2 and meat or alternative 1 block or serving.
5. Food circle, with food groups each the same sectoral size (e.g. the Swedish food circle has seven sectors of equal size).
6. Food circle with sectors of different area, typically largest for cereals and vegetable/fruit groups, smallest for fat (e.g. Netherlands Gezonde voeding met de maaltijdschiff, 1982; Finland has six sectors of different areas; Caribbean has six (old) or seven (new)).
7. Circle with sectors of different areas for food groups (narrow for fats) but also an outer band for more processed products in each sector (group), with more fat, salt or sugar, so less recommended than the central area (inner circle) of unprocessed foods (e.g. South Australia "Target on healthy eating").
8. The health food plate, which is a food circle with sectors of different sizes, each illustrating major foods of the group. The circle is seen as if tilted so is drawn as an ellipse. It looks like a plate with a knife on one side and a fork on the other (Food Guide, United Kingdom, 1994).
9. Triangle (sometimes called a pyramid but drawn as two-dimensional shape). Food groups that should be eaten least are at the top; staple foods that should be eaten most are across the broad base of the triangle (e.g. Sweden 1977; US Department of Agriculture's new food guide "pyramid" 1993; K. Baghurst (Australia) 1,2,3,4,5 + nutrition plan). Pennington (1981) first suggested that the triangle or pyramid should be upside down, with the food group you should eat least of at the apex and below the other groups.
10. Pyramid showing different groups on two faces (e.g. Australian Nutrition Foundation, early 1980s; New Zealand National Heart Foundation).
11. Quarter rainbow, with four quadrants, the innermost having the smallest area (so eat least) (e.g. Canada's Food Guide, 1992).
12. Traffic light: be careful with foods in red group; eat foods in orange group in moderation; eat as much as you like of foods in the green group (used especially for obesity and diabetic diets, e.g. Health Education Council, United Kingdom, 1981).

Other symbols used less often
Star
Arrows (e.g. Italy)
Groups of foods, shown without borders
Table with plates of different sizes (under trial by US Department of Agriculture)
Supermarket trolley with columns of different sizes (under trial by US Department of Agriculture)

meat, fatty fish and whole-grain cereals, can be described in the accompanying text.

3. Visual presentation food guides

The main forms in which dietary guidelines have been visually expressed as food groups are listed in Table A2.3.

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Annex 3
Sample interview protocol[1]

Part I: General nutrition/health: overall reaction to guidelines

1.1 Do you consider yourself healthy now?
- What does it mean to you to be healthy?
- What do you do to keep yourself healthy?
- Does what you eat have anything to do with being healthy? In what ways?
- Probe for: excess/deficiency; preventive/therapeutic; short long-term effects.

Part II: Responses to individual guidelines

2.1 How do you define variety?

2.2 How do you know if there is variety in your diet?

2.3 Are there any negative consequences if you don't?
- If yes, what are they?

Now I want to ask for your reaction to four different terms related to weight.

3.1 First, what is meant by desirable weight?
- How is that different from ideal weight?
- What about reasonable weight?
- And finally, what about healthy weight?
- Which term do you find most meaningful? Why?

3.2 If people do not maintain their desirable/ideal/reasonable/healthy weight, what might happen in terms of their health?

NOTE: For 3.2, 3.3 and 4.3, use the term the respondent identified above as the most meaningful.

3.3 How do you know what you should weigh?

4.1 What does the statement "Avoid too much fat, saturated fat, and cholesterol" mean to you?

4.2 Are there any differences in your mind between fat, saturated fat and cholesterol?
- If yes, what are the differences?
- In what ways are they the same?

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[1] Adapted from: Achterberg CL et al. Evaluation of "Nutrition and your health: dietary guidelines for Americans." Part II: a men's sample. 1991 (unpublished document).

4.3 How much fat (dietary) is too much?
- What about saturated fat?
- What about cholesterol?

If respondent has no answer, ask for an opinion, or what he/she thinks.

NOTE: For questions 4.4–4.6, separate the questions if the respondent made a distinction between the three. If not, leave them together.

4.4 How would you know if you were consuming too much fat/saturated fat/cholesterol?

4.5 How would you decrease the amount of fat/saturated fat/cholesterol in your diet?

4.6 What could happen to a person's health if too much fat/saturated fat/cholesterol were not avoided?

Now we will talk about guidance concerning starch and fibre. Let's begin with fibre.

5.1 What do you consider fibre to be?
- What are some foods that contain fibre?

5.2 What do you consider an adequate amount of fibre?
- How would you know if you were getting an adequate amount?

5.3 Are there any health benefits to eating an adequate amount of fibre? If yes, what are they?
- Are there negative consequencies if a person does not consume an adequate amount of fibre? If yes, what are they?

5.4 What do you consider starch to be?
- What are some foods that contain starch?

5.5 What do you consider an adequate amount of starch?
- How would you know if you were getting an adequate amount?

5.6 Are there any health benefits to eating an adequate amount of starch? If yes, what are they?
- Are there negative consequences if a person does not consume an adequate amount of starch? If yes, what are they?

5.7 Why do you think these two items were paired together in one recommendation?

6.1 When I say the word "sugar", what comes to mind?
- If you were reading a food label, how would you identify sugar?

6.2 How do you know if you are eating too much?
- How much is too much?

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