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EURRECA: EURopean micronutrient RECommendations Aligned. Preparing the Way

A European Commission Network of Excellence

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EURopean micronutrient RECommendations Aligned

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I am more than pleased to present, as Guest Editor, the first publications of EURRECA, which is short for EURopean micronutrient RECommendations Aligned. EURRECA is a Network of Excellence funded by the European Commission and co-ordinated by ILSI Europe.

In the 1980s of last century, I was the project leader of EURONUT, a Concerted Action on Nutrition and Health, again supported by the European Commission. We also considered the topics studied and discussed in the two papers presented in this supplement. At that time we published a letter in The Lancet (18 November 1989, p. 1220) entitled *Recommended dietary allowances for Europe*. I want to cite a few sentences: "It would be idle to pretend that national differences can be rationalised. Whatever the final decision (for a single value or for a range) there are virtually no scientific reasons why the requirements of a German, Italian, or British, or other child or adult should be significantly different". Nearly 20 years later the EURRECA initiative is determined to provide the answers that were amongst others raised in the above-mentioned letter.

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How we will produce the evidence-based EURRECA toolkit to support nutrition and food policy

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Abstract *Background* There is considerable variation in the recommended micronutrient intakes used by countries within Europe, partly due to different methodologies and concepts used to determine requirements and different approaches used to express the recommendations. As populations become more mobile and multinational, and more traditional foods become available internationally, harmonised recommendations based on up to date science are needed. This was recognised by the European Commission's (EC) Directorate-General (DG) Research in their 2005 call for proposals for a Network of Excellence (NoE) on 'nutrient status and requirements of specific vulnerable population groups'. EURopean micronutrient RECommendations Aligned (EURRECA), which has 34 partners representing 17 European countries, started on its 5-year EC-funded programme in January 2007. The programme of work was developed over 2 years prior to submitting an application to the EC. The Network's first Integrating Meeting (IM) held in Lisbon in April 2007, and subsequent consultations, has allowed further refinement of the programme.
Aim This paper presents the rationale for the EURRECA Network's roadmap, which starts by establishing the *status quo* for devising micronutrient recommendations. The Network has the opportunity to identify previous barriers and then explore 'evidence-based' solutions that have not been available before to the traditional panels of experts. The network aims to produce the EURRECA 'toolkit' to help address and, in some cases, overcome these barriers so that it can be used by those developing recommendations.
Results The *status quo* has been largely determined by two recent initiatives; the Dietary Reference Intake (DRI) reports from the USA and Canada and suggestions for approaches to international harmonisation of nutrient-based dietary standards from the United Nations University (UNU). In Europe, the European Food Safety Authority (EFSA) has been asked by the EC's Directorate-General for Health and Consumer Protection to produce values for micronutrient recommendations. Therefore, EURRECA will draw on the uniqueness of its consortium to produce the sustainable EURRECA toolkit, which will help make such a task more effective and efficient. Part of this uniqueness is the involvement in EURRECA of small and medium-sized enterprises (SMEs), consumer organisations, nutrition societies and other stakeholders as well as many scientific experts. The EURRECA toolkit will contain harmonised best practice guidance for a more robust science base for setting micronutrient recommendations. Hence, in the future, the evidence base for deriving nutrient recommendations will have greater breadth and depth and will be more transparent.
Conclusions The EURRECA Network will contribute to the broader field of food and nutrition policy by encouraging and enabling the alignment of nutrient recommendations. It will do this through the development of a scientific toolkit by its partners and other stakeholders across Europe. This will facilitate and improve the formulation of micronutrient recommendations, based on transparently evaluated and quantified scientific evidence. The Network aims to be sustainable beyond its EC funding period.

Key words EURRECA – Network of Excellence – micronutrients – nutrient recommendations – nutrient requirements – food policy – nutrition policy – health – EURRECA toolkit – harmonisation

Introduction

This paper represents an overview of the EURopean micronutrient RECommendations Aligned (EURRECA) Network of Excellence (NoE) together with a summary of the most important issues discussed during its initial stages (for further details please see the project website [10]).

About micronutrient recommendations

How are they devised?

For growth, maintenance and to promote overall good health, the human body needs certain amounts of many different micronutrients. The minimum amount of a nutrient needed by an individual to avoid deficiency is traditionally referred to as the nutrient *requirement*, and is defined by the body's physiological needs. Nutrient deficiency can be defined by clinical, physiological and biochemical criteria and these may all give different values for *requirements*.

For an individual the *requirement* for any nutrient depends on a variety of factors such as age, gender, genotype, physical activity, health status and factors such as the efficiency with which an individual absorbs and metabolises micronutrients. Among older people, for example, vitamin B12 absorption can be relatively poor and some women of child bearing age have high requirements for iron due to greater blood losses. Additionally, the intake and status for one

nutrient can impact on the absorption and utilisation of another and thus influence dietary requirements, a phenomenon generally referred to as nutrient interaction.

The requirement for a certain nutrient can thus vary both within and between individuals. Traditionally, the nutrient *recommendation for a group of people* is derived statistically and is the amount judged necessary to avoid deficiency in *virtually all individuals* within that group. It is generally calculated as 2 SD above the estimated average requirement and is set using the best currently available information about both the average and the inter-individual variation in *requirements* within the group for that micronutrient. In many cases data on the average requirement, and in particular on the inter-individual variation of requirements, are limited and so judgements need to be made. As a result differences can arise according to who makes the judgements. As populations become more multi-national and more traditional foods become available internationally, harmonised recommendations based on the most up to date science are needed to compare populations on basis of their intake.

A more recent concept, which is finding favour for some micronutrients, is to define the requirement as the intake at which health and functioning is optimal. As well as the prevention of deficiency disorders, this takes into account amounts, which have been shown to reduce the risk of developing other chronic disorders and to promote optimal growth and bodily functions (as far as influenced by the nutrients concerned).

What are their uses?

Nutrient recommendations may be used to assess the adequacy of the diets of healthy populations and to plan diets for groups of people. Their use to assess the diets of individuals has traditionally been discouraged [3, 14] due to the inter-individual variability in requirements. One of the aims of EURRECA is to consider this issue through evaluating inter-individual variability and its determinants. Nutrient recommendations are important for population nutritional planning and have food policy applications such as the development of food-based dietary guidelines and food fortification and enrichment programmes. They are also used in nutrition labelling because the amount of micronutrient contained in a portion or in 100 g is expressed as a percentage of a nutrient recommendation. In this way, it is possible to assess the contribution the micronutrient in an individual food can make to the overall diet.

Why do recommendations need to be aligned?

Current diversity of micronutrient recommendations across Europe

There is considerable variation in the recommended micronutrient intakes used by countries within Europe since different concepts (e.g. definitions and standards), and sometimes different data, are used to produce them [5].

Table 1 shows examples of different concepts and ways of expressing recommendations used in Europe and North America, and those recommended more recently by the United Nations University (UNU) [28]. The most commonly given values are for average requirements of groups and for the average + 2 SD. The latter cover most of the population (97.5%, assuming the distribution of individual requirements is statistically normal) and are the most generally used recommendations. In France, 130% of the average requirement is used for population recommendations [1].

The process of defining nutrient recommendations involves judgemental elements such as the opinions of the selected experts on the quality of the available research papers, potential bias towards national research and the need to consider any local health issues. As a consequence, various expert committees across Europe and elsewhere have produced a variety of values. The European Commission's (EC) former Scientific Committee on Food (SCF) published a collation of European micronutrient Recommended Daily Allowances for adults (i.e. the average requirements + 2 SD) in 2003 [34]. In addition to European population reference intakes (PRI), recommendations at national levels continue to be developed. Although some groups of countries have harmonised their recommendations (the Nordic countries [30] and the German speaking countries—D-A-CH [13]), there are still wide disparities between many other countries (Table 2).

Within each set of recommendations, values are generally given for different population groups such as adult men, adult women, pregnant and lactating women, different age groups of infants and children, and the elderly. However, these groups are often classified differently, in particular the age bands for infants, children, adolescents and the elderly vary between countries. An expert group, supported by the European Branch of the International Life Sciences Institute (ILSI Europe), has highlighted the main methodological and technological issues for producing nutrient recommendations for children and adolescents, which will need to be resolved to achieve harmonisation [33].

Table 1 A selection of concepts and acronyms used for micronutrient recommendations across the world

Source	Mean	Mean + 2SD	Mean − 2SD	Definition used in absence of information on distribution of requirements	Upper limit of intake	General term to encompass all values
EC Scientific Committee on Food (1993,2000/01/02/03), [34]	Average requirement (AR)	Population reference intake (PRI)	Lowest threshold intake (LTI)	Acceptable ranges	Tolerable upper levels (UL)	
UK Department of Health (1991) [3]	Estimated average requirement (EAR)	Reference nutrient intake (RNI)	Lowest reference nutrient intake (LRNI)	Safe intake	Safe upper levels	Dietary reference values (DRV)
Nordic Council of Ministers (2004) [30]	Average requirement	Recommended intake (RI)			Upper limit of intake	
DACH (2000) [13]	Average requirement	Recommended nutrient intake (RNI)		Estimated value		Reference values
Health Council of the Netherlands (2000) [14]	Average requirement	Recommended dietary allowance (RDA)		Adequate intake (AI)	Tolerable upper intake level	Dietary reference intakes (DRI)
US Institute of Medicine (1997) [15]	Estimated average requirement (EAR)	RDA		AI	Tolerable upper intake level (UL)	DRI
United Nations University (2007) [28]	Average Nutrient requirement (ANR)				Upper nutrient level (UNL)	Nutrient intake values (NIV)

Table 2 Variation in recommended daily allowances for micronutrients for adults: between different countries and organisations in Europe as given by Scientific Committee on Food, 2003

	Folate (mcg)	Vit. B_{12} (mcg)	Vit. C (mg)	Vit. A (mcg RE[a])	Vit. D (mcg)	Calcium (mg)	Iron (mg)	Selenium (mcg)
EC Scientific Committee on Food, 1993	200	1.4	45	700/600	0–10	700	9/20	55
France, 2001	330/300	2.4	110	800/600	5	900	9/16	60/50
Germany, Austria, Switzerland, 2000	400	3.0	100	1000/800	5	1000	10/15	30–70
Italy, 1996	200	2	60	700/600	0–10	1000	10/18	55
Netherlands, 1989, 2000, 2003	300	2.8	70	1000/800	2.5–5	1000	9/15	50–150
Nordic countries, 1996	300	2.0	60	900/800	5	800	10/18	50/40
United Kingdom, 1991	200	1.5	40	700/600	-	700	8.7/14.8	75/60

When there are two values, the left-hand side value is for adult men and the right-hand side for adult women
[a]Retinol equivalents
Adapted from: Scientific Committee on Food 2003 [35]

Comprehensive collations of recommendations for vitamin A and vitamin D illustrate some disparities between European countries [5]. Although some recommendations, such as vitamin D, may need to differ between countries due to differences in sunlight exposure, the simple alignment of age bands across Europe would be a huge step forward for public health nutrition and would simplify evaluations and comparisons of dietary adequacy.

Need for harmonisation recognised by the EC

The need for the harmonisation of micronutrient recommendations across Europe was recognised by the EC in their call in 2005 for proposals on 'nutrient status and requirement of specific population groups' (see "Box") under the Food Quality and Safety Area of 'Epidemiology of food related diseases and allergy'.

Box. EC Call T5.4.2.1: Nutrient status and requirements of specific population groups (NoE)

The aim is to provide and collate data about the status and the requirements of selected nutrients, particularly micronutrients, for specific vulnerable population groups identified by the proposers (such as infants, children, adolescents, pregnant women, lactating women, post-menopausal women, elderly people, immigrants and/or low-income groups) in order to harmonise dietary recommendations Europe-wide. Existing epidemiological data from different population groups will be compared and harmonised, and new data will be provided—where necessary—in view of developing European dietary guidelines. As a result, consumer understanding will be improved and behavioural changes will be facilitated by communication to consumers, food chain operators, health professionals and policy makers. The participation of industry, new Member States and candidate countries is strongly encouraged, while the involvement of consumer organisations is essential.

Subsequently, funding was given for the EURRECA NoE from the beginning of 2007 until the end of 2011. The first Integrating Meeting (IM1), held in Lisbon in April 2007, reviewed the state of the art for micronutrient recommendations and defined in more detail how EURRECA can contribute significantly to improving the methods for aligning recommendations over the next 5 years, and beyond.

What can be learned from recent initiatives to produce recommendations and to consider related issues?

Dietary reference intakes for the USA and Canada

The earlier experience of the USA and Canada provides useful insights into the challenges and opportunities for EURRECA. These two countries worked together to produce several comprehensive technical reports, some of which covered a large number of micronutrients. The 'Dietary Reference Intakes' (DRI) were published in a series of volumes between 1997 and 2005 and contained reference values for each sex and for 12 different physiological and life stages [15–25]. Some of these volumes cover the recommended values for micronutrients and also some guidance on their use in planning and dietary assessment.

Recommendations were based on comprehensive overviews of the science and expert judgement, since systematic, evidence-based reviews were not possible at the time due to lack of resource. Expertise was limited to the USA and Canada, and only selected experts could be invited to work on each nutrient. Although over 400 experts participated, non-invited experts might of course have had different insights and opinions.

Time constraints meant that there was limited opportunity to investigate more basic issues or to include the wider issues such as consumer and stakeholder involvement and suitability for end users until the very end of the process, when a guide for users was produced. New concepts that were possible to incorporate included novel statistical models, chronic disease endpoints and excess intakes. The

work was co-ordinated by a steering committee, who asked the experts to use the evidence base to produce comprehensive reviews, including new experimental data from human and animal studies.

The use of voluntary scientific expertise to undertake evidence-based reviews and further review by a steering committee had the effect of extending the time to complete the process to over 15 years. The process for developing the DRIs was not self-sustaining—they may not be reviewed again for a considerable time, depending on the science and funding.

Professor Johanna Dwyer, who was a member of the Food and Nutrition Board of the Institute of Medicine when the DRI concept was developed, and also served on several DRI committees, shared her experiences with the EURRECA Network at the IM and identified some future needs:

- Better ways to incorporate or produce systematic comprehensive evidence-based reviews and a process to follow up on research gaps and recommendations [26].
- Valid methods to estimate dietary intakes so that knowledge can be developed on how to act on apparently low intakes relative to recommendations. There is a particular need to evaluate consumption of bioactive ingredients other than traditional micronutrients.
- Data on good biomarkers for the intake of some nutrients, as well as markers for physiological and other health effects. Chronic disease endpoints were rarely available to the DRI committees and functional indicators were difficult to agree upon in a consistent manner.
- Less extrapolation and interpretation of data.
- Better scientific basis for recommendations in groups, which are particularly complex to define or study, for example healthy older people and breast fed infants.
- Clarification of the terminology and concepts used to derive recommendations. The DRI committees made judgements based on the experimental literature to Estimate Average Requirements (EAR). However, the definition of Recommended Dietary Allowance (RDA) as 2 SD above the EAR, whilst traditional in the USA, was to some extent arbitrary. The concept of Adequate Intake (AI) was unclear and its applications were limited.
- More involvement of risk managers in shaping and setting recommendations without compromising the important scientific independence and integrity of the process.
- A system which can revisit problems arising when the concepts/recommendations are applied to policy. The current 'sunset' system, where the committees have disbanded before any problems become apparent, has considerable disadvantages. A better system might help to overcome the dilemma when public health problems arise—do they indicate real deficiency or are they due to inappropriately set or applied DRIs?
- Better communication about the uses of the DRIs at the time they are being developed. Public and professional awareness is still quite low some years after publication of the North American recommendations.
- Practical tools to assist the users of the recommendations. The Canadian Dietetic Association produced a web-based course [4] and the Institute of Medicine, in partnership with Health Canada, has recently published a user-friendly version of the DRIs after consultation with the intended users such as dietitians, nutritionists and other health professionals [27, 31]. However, more needs to be done.
- More rapid adoption and use of the new DRIs. Health professionals have been slow to use them for assessment and planning, many journals still do not insist on using appropriate techniques and reviewers are often unaware of what the DRIs are and how to apply them.

All these identified needs can be considered as opportunities for the EURRECA Network to address. We hope to provide solutions for several of them as components of the EURRECA toolkit (see section on "comprehensive toolkit" below).

International harmonisation proposed by the UNU

The UNU, in collaboration with the Food and Agricultural Organisation (FAO), World Health Organisation (WHO) and the United Nations Children's Emergency Fund (UNICEF), has published an expert committee report on the international harmonisation of approaches for developing nutrient-based dietary standards [28]. The report recommends that the term nutrient intake values (NIV) should be used to encompass all nutrient-based data derived from primary data. NIVs are analogous to umbrella terms developed by other countries such as the DRIs of the United States, the DRI and DRV of the Netherlands and UK, respectively, and the reference values of Germany, Austria and Switzerland (see Table 1). The UNU report suggested that, globally, there should only be two values for recommendations, the average nutrient requirement and the upper nutrient level of intake. Other values would be derived from these and should be flexible. For example RDA, typically set at average nutrient requirement + 2 SD and covering the needs of 97.5% of the population, might in some cases be set at a level where it covered the needs, for example, 75, 80 or 90% of the population.

How will the comprehensive EURRECA toolkit complement the mandate of the EFSA?

The mandate of EFSA to set values for nutrient recommendations

Previously the EC's Scientific Committee for Food have provided Europe-wide micronutrient recommendations [34]. These PRIs have been used for the list of labelling values (EC Nutrition Labelling Directive, 90/496/EEC). In 2005 the EC's Directorate-General for Health and Consumer Protection asked EFSA to review existing PRIs for energy, macronutrients and dietary fibre as well as to advise on PRIs for micronutrients. Recommendations for carbohydrate, dietary fibre and water are expected in the first instance and work on micronutrients will be initiated in 2009. In addition, EFSA has been asked to provide guidance on the translation of nutrient recommendations into food-based dietary guidelines and held a colloquium on this topic in March 2006 [9].

In the light of this, the EURRECA Network has an excellent opportunity to develop tools, which should help EFSA when addressing its mandate, providing timescales are favourable. Further, EURRECA hopes that its comprehensive toolkit will be useful to any organisation charged with producing recommendations, thus extending the use of the toolkit globally. The toolkit will facilitate and improve the formulation of micronutrient recommendations, based on transparently evaluated and quantified scientific evidence.

The EURRECA goal is to produce a comprehensive toolkit for those developing recommendations

As EURRECA progresses, barriers which were apparent during previous attempts to set recommendations will be identified and tools, to help to address some of these barriers, will be developed for wide dissemination and exploitation throughout the EC funding period and beyond. The EURRECA toolkit will provide harmonised best practice guidance for a more robust science base for assessing nutrient requirements and hence for devising nutrient recommendations which can be used for evidence-based food/nutrition policies in their widest context (see section on "general framework and food and nutrition policy" below).

The EURRECA toolkit is expected to consist of a series of consensus criteria out of which 'gold standard' methods and, in some cases, decision trees will be developed. The early EURRECA activities will identify the most useful components of the toolkit and preferred formats. Later activities will develop and refine them.

Some examples of possible toolkit components are:

- Guiding principles on best methods to provide practically usable evidence for deriving nutrient requirements and recommendations;
- Consensus on indicators of micronutrient status and best methods for their measurement;
- Best practice guidelines for the involvement of consumers and other stakeholders to help scientists express and explain nutrient recommendations in a consumer friendly format.

What is the EURRECA Roadmap?

The EURRECA Roadmap will allow EURRECA to reach its overall goal. This is to create a sustainable collaborative network, which will produce an evidence-based toolkit to develop quality assured and aligned nutrient recommendations across Europe.

Most panels producing micronutrient recommendations have no opportunity to commission new research to answer the questions that arise during their deliberations. The essence of the EURRECA network is that the (desk) research activities can be channelled into addressing urgent questions at the appropriate time. This is why sequential phases of research activities are planned during the initial 5 years of EURRECA (the EURRECA Roadmap—see Fig. 1) and why the remits of each research activity are only determined once the outputs from the previous phase have been assessed at IMs. The fluid nature of the Roadmap means that the participants in EURRECA can be reactive to the results and conclusions, which are derived as the network progresses. EURRECA will investigate various aspects of the steps required to define micronutrient requirements and set recommendations, and recommend future research needs for developing new methods and approaches.

The initial phase of research activities (RA1) is focussing on quality assurance to ensure that nutrient requirements (the basis for recommendations) are only derived from best practice for assessing dietary intake and on the best markers of status, assessed by the most robust methodology. During the first IM, concepts of deficiency and sufficiency were discussed and a list of micronutrients most relevant to public health were drawn up and agreed for the initial focus of the Network (Table 3).

At its second IM, the EURRECA Network will agree the standards of excellence from RA1. It will also start to identify possible/probable barriers for assessing

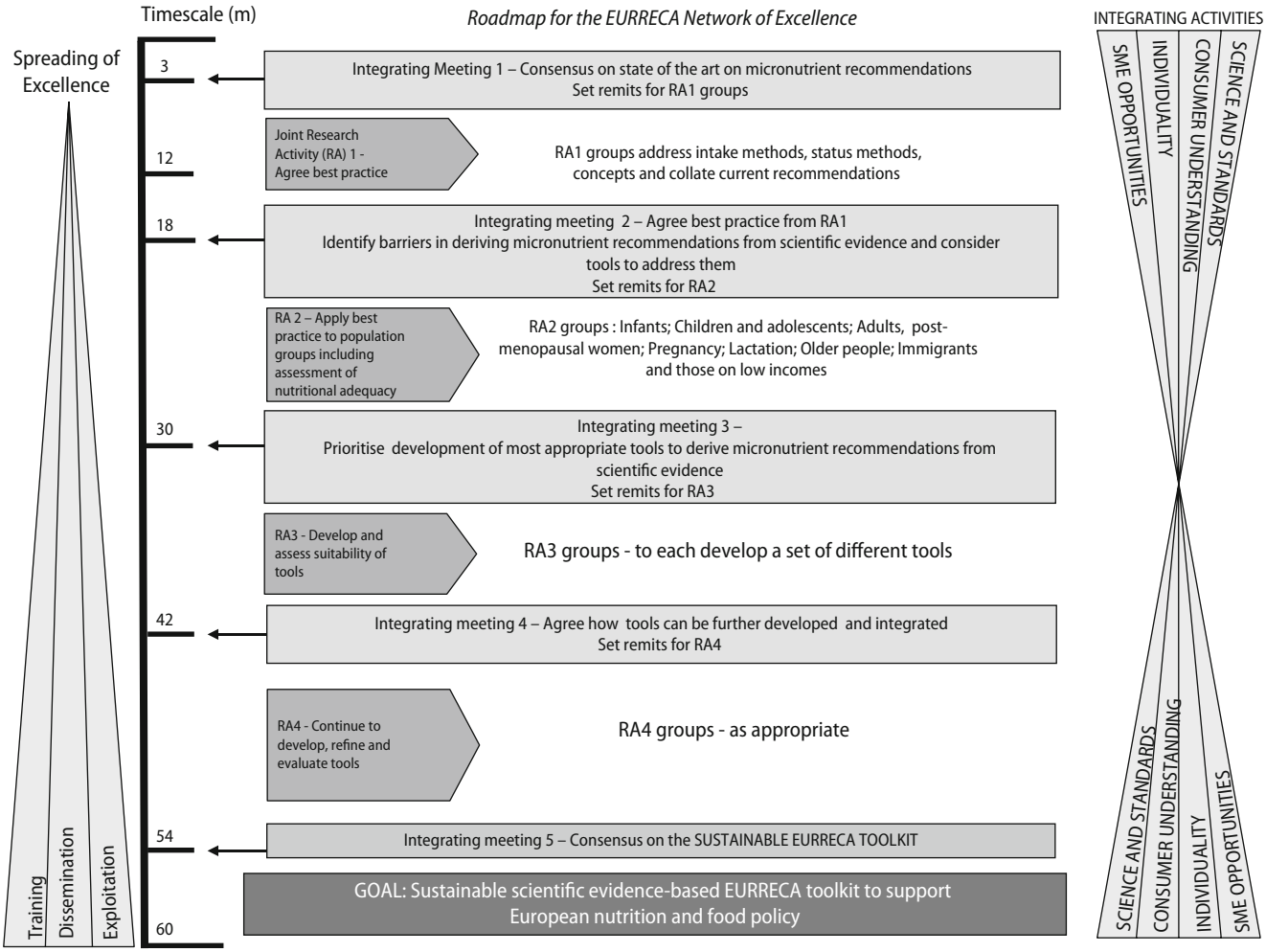

Fig. 1 The EURRECA Roadmap: overview of activities and the development of the EURRECA toolkit

requirements and devising recommendations and will therefore explore ideas for Toolkit components to address some of these.

The second phase of research activities (RA2, 18–30 months) will apply best practice developed in the first phase to various population groups in order to extract the more robust data from the literature and other available surveys. Each working group will assess which of the best markers of status and best intake methods are most suitable for their group and evaluate the extent to which compromises have to be made for practical reasons. Nutritional adequacy in the different groups will be assessed, if there is sufficient robust data available, and knowledge gaps will be identified. From this, it should be possible to compare the performance of common approaches to all population groups and nutrients and to identify where approaches should differ.

Table 3 Micronutrients agreed for the initial focus of the Network

Calcium	Riboflavin
Magnesium	Vitamin B12
Iron	Folate
Zinc	Vitamin D
Copper	n-3 fatty acids
Iodine	Phytochemicals (specific classes to be decided)
Selenium	

At the third Integrating Meeting (IM3), the components of the toolkit which are considered most useful and which are feasible and practical to produce will be agreed. Development work will begin in RA3, can be considered at the fourth IM (IM4) and then further developed during RA4.

Some of the components of the toolkit, such as those relating to consumer understanding and to the roles of SMEs will be produced by partners working on the integrating activities. They will be refined as EURRECA progresses and, in RA4, can be tested by

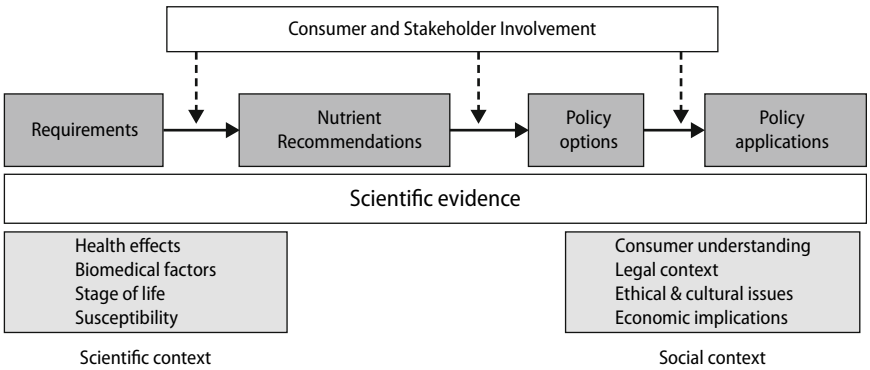

Fig. 2 A general food and health policy framework to show the broader context of the possible applications of EURRECA toolkit: from requirements to policy

the most appropriate EURRECA partners, sometimes in joint tasks between partners in research activities and those in integrating activities.

Finally, a consensual toolkit for the development, use and dissemination of recommendations for the various population groups can be discussed at IM5 and disseminated at the end of the EU funded part of the project. It will contain sustainable evidence-based scientific tools for use in the broad context of food and health policy.

What will be different about EURRECA?

The EURRECA toolkit will be developed within a general framework to show how it relates to food and nutrition policy

A general framework (Fig. 2) for establishing the wider context of nutrient requirements and recommendations, their adaptation into dietary guidelines and their dissemination, incorporating relevant aspects of science, policy and practice at each stage, has been developed. Stakeholder involvement is crucial at all stages.

For consumers there is a direct (but often unconscious) short-term feedback loop from intake to physiological and mental functioning as well as social well-being, affecting food consumption. For policy makers there is a much longer term feedback loop, based on the ultimate effects of dietary habits and nutrient intake on population health and associated costs. Development of nutrient recommendations is one essential element of nutrition policy, but for its application in policy, the framework should include food.

Thus, although evidence-based nutrient recommendations are central to the feed back loop for both consumers and policy makers, a logical framework should not be limited to scientific evidence on nutrient requirements. It should evolve in such a way that evidence on food (patterns) and health fits naturally into a transparent process of making evidence-based nutrition and food policy.

At present policy advice is partially evidence-based, but the process of translating the evidence into degrees of (un)certainty and the subsequent formulation of nutrition and food recommendations largely remains a matter of valuable eminence-based logical reasoning and agreement by the responsible committees. In future, this part of the process will gain further confidence and transparency through the development and use of tools that have been subjected to scientific scrutiny.

EURRECA will consider a greater breadth of recommendations

EURRECA will consider a wider range of population groups than is normal for panels setting nutrient recommendations, focusing on vulnerable groups. Initially low income and migrant groups as well as the more traditional population groups based on gender and age (infants, children, adolescents, pregnant and lactating women, the elderly) will be included. Further, as well as the traditional vitamins and minerals, other dietary components with demonstrable health benefits, such as n-3 fatty acids and phytochemicals, will also be included.

One of the early activities is the use of a standardised questionnaire, by partners working in the research activity looking at current recommendations for population groups and the integrating activity on consumer understanding and stakeholder interaction. The purpose of this is to:

- Collate all micronutrient recommendations currently existing from each European country and from those non-European countries where they are the most elaborated. Also to determine how these recommendations have been set [5].
- Discover how micronutrient recommendations have been applied in nutrition-related policy pro-

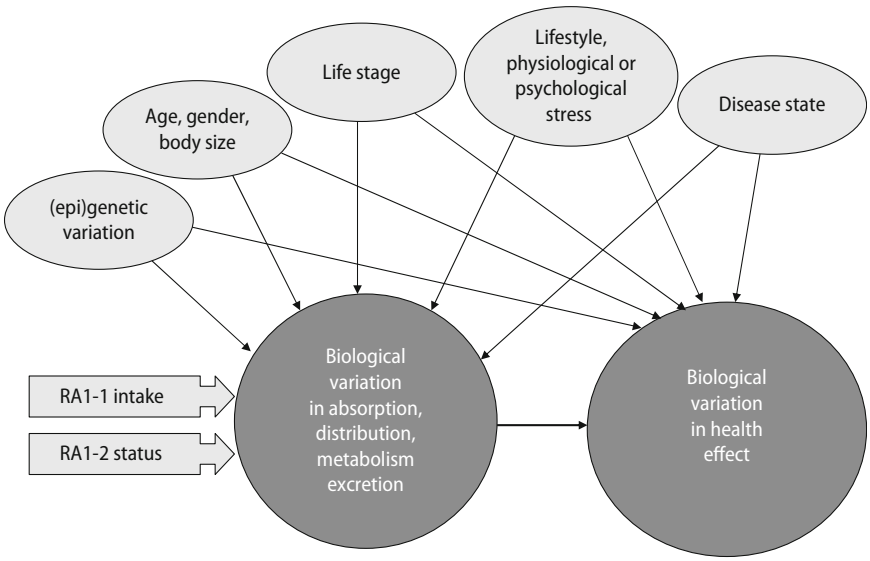

Fig. 3 Sources of biological variability of individual nutrient requirements

cess across Europe. Questionnaire respondents are asked to report on two further dimensions of this process: statements of options for action for identified problem nutrients, and policy applications.

EURRECA will consider a greater depth in recommendations; the nutrigenomic approach

Previous sets of recommendations have not usually attempted to go beyond those for population groups based on gender and age. However, EURRECA will investigate whether recommendations could, or should, be given according to a person's nutritional phenotype. Indeed one of the integrating activities ongoing for the full 5-year term is devoted to this objective.

Variation in metabolism between individuals is complex, and so has been difficult to study. However, in addition to clinical biochemistry, classical nutrition and biomedical sciences, recent technological developments (especially plasma and urine metabolic profiling and metabolomics) has the potential to be used for evaluating the relationship between micronutrient status and a wide range of metabolites (including macronutrients, micronutrients and other micro-components of the diet). This information would then be able to help give both an accurate description of the nutritional phenotype of an individual and a quantitative analysis of the food they consume.

First, the origins of variation in micronutrient requirements, and what makes some individuals more vulnerable to poor nutrition, will be explored and defined. The biological variation in absorption, distribution, metabolism and excretion leads to variations in the health benefits of a given intake of a nutrient (Fig. 3). These variations are due to a number of factors such as age, gender, body size, lifestyle, physiological or psychological stress and genetic variation, but our current knowledge about them is poor. To be able to better quantify how nutrition relates to health, EURRECA will collate information on relationships between biomarkers such as plasma concentrations of micronutrients and their health effects. EURRECA will then determine the quantitative extents to which genetic, epigenetic and dietary factors interact to determine the nutritional phenotype.

Eventually, EURRECA will be in a position to create a database of 'nutritional phenotype' characteristics (age, gender, body size, lifestyle, physiological or psychological stress linked to the above described metabolomic approach) and provide correlations between the two. Phenotype will be correlated with micronutrient status. The task will be achieved in the context of a large international effort of extensive nutritional phenotyping, linked to the European Nutrigenomics Organisation (http://www.NuGO.org) and others. The ultimate objective is to ascertain whether it is appropriate to provide personalised nutrient recommendations, based on capturing and quantifying the nutritional phenotype.

EURRECA will engage with players outside the scientific community so that recommendations are in suitable formats for the stakeholders and end-users

The involvement of many stakeholders and end-users will help EURRECA produce tools, which ensure that recommendations are in formats, which are in accordance with the needs of the users. The next

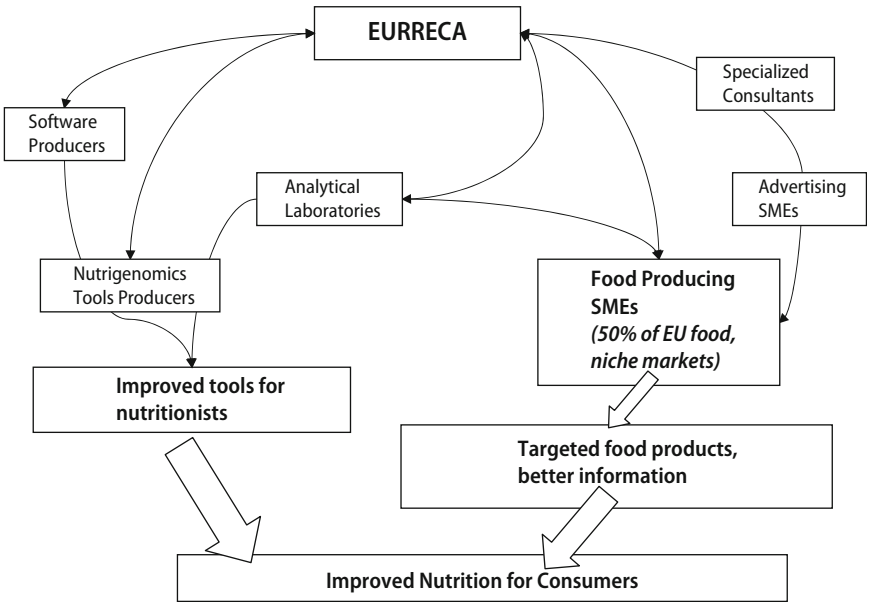

Fig. 4 The role of small and medium enterprises in EURRECA

section outlines why these players are important and how they are involved.

Stakeholders can be defined as those willing to invest resources and accept some responsibility for maintaining the viability of nutrient recommendations because of their own interest in the recommendations. Users include any organisation that uses or employs nutrient recommendations as a means to fulfil a task. Stakeholders may also be users of nutrient recommendations and vice versa.

These two groups include consumers, research scientists, nutrition societies, government sectors (health, food, agriculture, fisheries, consumer protection, education, transport, urban planning and housing, environment, labour, social policy, research), the European Union institutions, WHO, United Nations (UN) organisations and other international actors, non-governmental organisations (health professional organisations, consumers' organisations, non-profit charitable organisations, patients' associations, sport and outdoor recreation organizations, trade unions) and the private sector (primary producers, food manufacturers, food retailers, caterers, media and advertising, the leisure and well being industry).

Consumer groups

Consumer involvement, through their representative groups, is essential in the process of developing nutrient recommendations. In the past this has either been non-existent or not transparent. Since one of its ongoing integrating activities is focussed on consumer issues, EURRECA will provide a better understanding of consumer involvement in the process of nutrition policy making. It will also show how public opinion on nutritional matters is affected by exchanges between the various actors.

During the first 18 months there will be several studies, covering eight to ten countries representing a geographical spread across Europe, which will help to determine the most useful toolkit components. These include:

- A study to identify criteria for assessing the direct and indirect impact of the involvement of consumers and other stakeholders that represent consumer interests in nutrition policy making;
- An evaluation of current forms of consumer and other stakeholder involvement (e.g. consultative groups, advisory committees, surveys, focus groups, citizens' juries). The objective will be to assess the impact of different forms of consumer involvement on the quality of decision-making and of outcomes in specific policy formulations.
- A systematic review of consumer-related issues pertinent to intake methods, status methods, concepts, definitions, individuality, vulnerability and variability, for example the extent of consumer knowledge.

Small and medium-sized enterprises

Small and medium-sized enterprises (SMEs) will collaborate with the other EURRECA partners to realise their overall goal of identifying opportunities for exploitation in diverse fields. There is a challenge

for them to integrate with the scientific research leading to nutrient recommendations. Research has the potential to make a big impact on development, and hence marketing, as well as some impact on manufacturing and sales in many sectors. In turn, the availability of appropriate products can facilitate the achievement of nutritional goals by contributing tools for scientific work and by providing more nutritious foods for the European population (Fig 4).

SMEs will be able to develop and exploit new methods as they work alongside the research groups. At the same time, they will be able to help the scientific community by providing customised tools, such as assays for metabolic markers, kits for metabolomics studies, nutrient assessment methods and the development of dietary computer programmes.

SMEs already involved in EURRECA are software producers, analytical laboratories, biotechnology and food safety and nutrition consultancies. Small and medium-sized food producers are responsible for about 45% of the total food turnover within the European Community [2]. Thus, it is important to involve them into the Network to realise the great potential for utilising the results of EURRECA in the production of tools for food reformulation. This would enable them, or others, to manufacture food products with nutrient content and nutrient function claims which fall within the scope of the recent EC Regulation on Nutrition and Health Claims made on Foods [12].

During the first 18 months there will be several activities, which will help to determine the most useful toolkit components and the preferred formats:

- SMEs experiences and training needs related to nutrient recommendations will be assessed through a survey. Key food, catering, food supplement and food marketing/health claim consulting SMEs will be identified. Their attitudes to nutrition and the use of dietary guidelines will be assessed in a sample of selected EU countries through interviews, with the cooperation national trade organizations. SMEs that market products to vulnerable population groups will be specifically sampled.
- The framework for supporting the development of food products or menus informed by the results of the network will be developed, tested and promoted through the NoE website, through national organisations and through the survey described above.
- A survey of leading laboratories in the EU will be conducted, taking into account work at standardisation organisations to identify relevant protocols. Protocols used for the analysis of vitamins, minerals, phytonutrients, essential fatty acids and amino acids will be collated and reviewed to identify gaps, advantages and deficiencies. A program for SMEs leading to standardisation will be promoted through a website, which will include posting of a list of available protocols and laboratories.
- Key computer programs used for dietary assessment in Europe and North America will be identified, collated and reviewed. Their use will be assessed within partners of NoE, through the software producers, and through a limited user survey. A list of specifications that brings together the survey information, gaps in current programs and results of research within the NoE will be produced.

National and International Nutrition Societies

The involvement of nutrition societies across Europe, both through the Federation of European Nutrition Societies (FENS) and national societies, is an important aspect of EURRECA [32]. The societies have varying influence on the development of nutrient recommendations and food-based dietary guidelines, either through individual members or as a society. Some, such as the German, Austrian, Swiss and Italian nutrition societies, are responsible themselves for developing recommendations. In some countries such as the UK and Netherlands, government departments and advisory boards rather than the nutrition societies have been responsible for reviewing recommendations, relying on the expertise of panel members.

Other nutrition societies, such as the Polish Society of Nutritional Sciences, can use the EURRECA outcomes for dissemination and education as well as reference points in discussion with policy makers. For example, outcomes can be used for developing guidelines for food donation programmes for the unemployed and other vulnerable groups such as older people.

One group, represented within EURRECA, is the UNU Food and Nutrition Programme's Standing Committee on Nutrition (SCN), a working group on capacity development set up in collaboration with the International Union of Nutritional Sciences (IUNS). The UNU/SCN Network for Capacity Development in Nutrition for Central and Eastern Europe (NCDN-CEE) was established in 2006 to support CEE countries in developing research and training in public nutrition [37]. This network will be involved in EURRECA dissemination and, based on their specific needs, will develop a customised EURRECA nutrition and epidemiology course.

Conclusions

Through the integrating activity on science and standards, all this experience will be harnessed during the initial phases of the project to identify common problems. These will be addressed by the develop-

ment of appropriate components in the EURRECA toolkit. In this way, the stakeholders and end users can contribute fully to the process, while leaving the evaluation and interpretation of evidence as a secured scientific process.

Spreading of excellence

The EURRECA Network and all individual partners involved are committed to ensuring that the expertise and experience generated through and by the Network will be handed on, shared and utilised to the benefit of all policy, professional, consumer and industry stakeholders. The Spreading of Excellence (SoE) will contribute to the on-going sustainability of the Network and its area of work.

SoE will be achieved through specific Training, Dissemination and Exploitation programmes of work involving all partners and will increasingly engage a wider range of external interested parties.

Training will initially focus on meeting the needs of Network members, by identifying clear gaps and needs, sharing internal expertise and delivering a wide range of training opportunities on agreed priority areas. Training will be opened up to external parties at appropriate points. A EURRECA Training Programme will be developed as a recognised and accessible resource for all working in the field of micronutrients and nutrient recommendations.

Dissemination activities will focus on both internal and external communication utilising internal and external websites, newsletters, dissemination databases, checklists for stakeholder groups and consumer engagement activities.

The exploitation potential of EURRECA's outcomes will be explored in policy development (by policy-makers, professional organisations and consumer groups) and in products and services (by food producers, manufacturers, marketers, retailers and health professionals). Work groups, seminars, web-based discussion groups and newsletters will facilitate this work.

Within the SoE programme of work, particular attention will be paid to:

- Including and involving all appropriate EU Framework Projects (completed, on-going and future) and Networks to maximise information exchange and to share resources.
- Aligning programmes of work with those of EFSA and ETP Food for Life.
- The inclusion and involvement of contacts and organisations across the whole EU Community, particularly Central and Eastern Europe and Accession countries.
- Embracing the full spectrum of potential SME interest (computer software and laboratory assays to food producers).
- Involving professionals, organisations and other channels of communication that address ethnic, religious and minority sectors of the EU population.

SoE activity will align with the integrating activities to deliver synergy and cost-effectiveness, using material generated (backgrounders, scientific papers and consensus statements) as the collateral to drive the timing and precise nature of the work programmes delivered.

Sustainability

Partners in a NoE are committed long-term, beyond the 5 years of EU funding. This includes a commitment to strategic planning for the future by aligning, synchronising and co-ordinating their activities. Sharing activities, such as tasks and responsibilities related to infrastructure access and use, human resources management, as well as knowledge and intellectual property management, will be mutually beneficial to partners.

After 5 years, EURRECA aims to become a sustainable entity so that the research, which relates to recommendations can continue in a structured format so that policy makers will be able to draw on it at any time. This ongoing process will also mean that non-scientific partners within EURRECA will be able to develop and exploit new methods as they work alongside the research groups over and beyond the 5 years and, at the same time, help the scientific community.

Meeting EC expectations

As a NoE, EURRECA is expected to provide Europe with world leadership in the field of micronutrient research, human nutrient requirements and translation into recommendations. In particular, European research on nutrient recommendations will become harmonised and structured through:

- the integration of a critical mass of resources and expertise;
- the provision of a supportive platform for the collaboration of research entities;
- the development of joint approaches for methodologies and training schemes;
- the development of joint strategy and operational approaches as exemplified by EURRECA Codes of Practice.

- The creation of a visible and autonomous entity which is appreciated by the entire research community and is a self-sustainable structure beyond the EC funding period.

EURRECA will strengthen and spread the science and technology (S&T) excellence in the area of nutrient recommendations by considering all relevant stakeholders and establishing strong links to related European projects, such as Early Nutrition Programming Project (EARNEST) [36], European Food Consumption Validation (EFCOVAL) [7], European Food Information Resource Network (EUROFIR) [8], Health Lifestyle in Europe by Nutrition in Adolescents (HELENA) [29] and the European Nutrigenomics Organisation (NuGO) [11] and other national projects. It should be able to act as a 'starting block' for innovation and new technologies in existing food and other companies, and possibly in new 'spin off' companies.

As well as supporting science-based harmonised nutrient recommendations, the work of the Network should also support other science-driven regulation and nutrition policy in the EU such as nutrition and health claims. In addition, it will be able to contribute to the EC's White Paper 'A Strategy for Europe on Nutrition, Overweight and Obesity related health issues' [6] and the EU's research strategy against malnutrition and nutrition-related disorders.

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Conflict of interest none

References

1. Agencie Francaise de Securite de Sanitaire des Aliments (AFFSA) (2001) Apport nutritionnels conseilles pour la population Francaise. Lavoisier Tec et Doc, Paris
2. Confederation of the Food Industries of the EU (CIAA) (2007) 2006 Data and Trends Report of the EU Food and Drink Industry Brussels
3. Department of Health (1991) Dietary reference values for food energy and nutrients for the United Kingdom. Report of the panel on dietary reference values of the Committee on Medical Aspects of Food Policy. HMSO, London
4. Dietitians of Canada (2001) Dietary reference values—learn about these important nutrition reference values online. Canadian Dietetic Association, Toronto
5. Doets EL, de Wit LS, Dhonukshe-Rutten RAM, Cavelaars AEJM, van 't Veer P, de Groot LCPGM (2008) Current micronutrient recommendations in Europe with special focus on vitamin A and vitamin D. Eur J Nutr 47(Suppl 1): 17–40
6. European Commission (2007) A strategy for Europe on nutrition, overweight and obesity related issues Brussels
7. European Food Consumption Validation (EFCOVAL). http://www.efcoval.org
8. European Food Information Resource Network. http://www.eurofir.net
9. European Food Safety Authority (2007) Development of food-based dietary guidelines, EFSA Scientific Colloquium 5 Summary Report. EFSA, Parma
10. European Micronutrient Recommendations Aligned (EURRECA). http://www.eurreca.org
11. European Nutrigenomics Organisation (NuGO). http://www.nugo.org
12. European Parliament and Council (2007) Regulation (EC) No. 1924/2006 of the European Parliament and of the Council of 20 December 2006 on nutrition and health claims made on foods. Official Journal of the European Union OJ L 404, 30 December 2006. Corrigendum OJ L 12 18 January 2007, pp 3–18
13. German Nutrition Society, Austrian Nutrition Society, Swiss Society for Nutrition Research (2000) Reference values for nutrient intake (D-A-CH). Frankfurt am Main
14. Health Council of the Netherlands (2001) Dietary reference intakes: energy, proteins, fats, and digestible carbohydrates. Health Council of the Netherlands, The Hague
15. Institute of Medicine (1997) Dietary reference intakes for calcium, phosphorus, magnesium, vitamin D, and fluoride. National Academy Press, Washington
16. Institute of Medicine (2000) Dietary reference intakes for thiamin, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, pantothenic acid, biotin and choline. National Academy Press, Washington
17. Institute of Medicine (2000) Dietary reference intakes for vitamin C, selenium, and carotenoids. National Academy Press, Washington
18. Institute of Medicine (2000) Applications in dietary assessment. The National Academies Press, Washington
19. Institute of Medicine (2001) Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc. National Academy Press, Washington
20. Institute of Medicine (2001) Proposed definition of dietary fiber. The National Academies Press, Washington
21. Institute of Medicine (2002) Dietary reference intakes for energy, protein, carbohydrate and fat. National Academy Press, Washington
22. Institute of Medicine (2003) Applications dietary planning. The National Academies Press, Washington
23. Institute of Medicine (2003) Guiding principles nutrition labeling and fortification. The National Academies Press, Washington
24. Institute of Medicine (2004) Dietary reference intakes for water, potassium, sodium, chloride, and sulfate. The National Academies Press, Washington
25. Institute of Medicine (2005) Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein and amino acids (Macronutrients). The National Academies Press, Washington
26. Institute of Medicine (2006) Dietary recommendations research synthesis: workshop summary. The National Academies Press, Washington

27. Institute of Medicine (2006) Dietary reference intakes—the essential guide to nutrient requirements. The National Academies Press, Washington
28. King JC, Garza C (2007) International harmonization of approaches for developing nutrient-based dietary standards. Food Nutr Bull 28(suppl):S3–S153
29. Moreno LA, Gonzalez-Gross M, Kersting M, Molnar D, de Henauw S, Beghin L, Sjostrom M, Hagstromer M, Manios Y, Gilbert CC, Ortega FB, Dallongeville J, Arcella D, Warnberg J, Hallberg M, Fredriksson H, Meas L, Widhalm K, Kafatos AG, Marcos A, on behalf of the HELENA Study Group (2008) Assessing, understanding and modifying nutritional status, eating habits and physical activity in European adolescents. The HELENA Study. Public Health Nutr 11:288–299
30. Nordic Council of Ministries (2004) Nordic nutrition recommendations, 2004, Copenhagen
31. Otten JJ, Hellwig JP, Meyers LD (2006) Dietary reference intakes: the essential reference for dietary planning and assessment. National Academy Press, Washington
32. Pavlovic M, Prentice A, Thorsdottir I, Wolfram G, Branca F (2007) Challenges in harmonizing energy and nutrient recommendations in Europe. Ann Nutr Metab 51:108–114
33. Prentice A, Branca F, Decsi T, Fleischer Michaelsen K, Fletcher R, Guesry P, Manz F, Vidailhet M, Pannemans D, Samartin S (2004) Energy and nutrient dietary reference values for children in Europe: methodological approaches and current recommendations. Br J Nutr 92:S83–S146
34. Scientific Committee on Food (1993) Opinion of the Scientific Committee on Food on nutrient and energy intakes for the European Community. http://ec.europa.eu/food/fs/sc/scf/out89.pdf
35. Scientific Committee on Food (2003) Opinion of the Scientific Committee on Food on the revision of reference values for nutrition labelling. SCF/CS/NUT/GEN/18
36. The Early Nutrition Programming Project (EARNEST). http://www.metabolic-programming.org
37. UNU/SCN Network for Capacity Development in Nutrition for Central and Eastern Europe (NCDN-CEE). http://www.srbnutrition.info/?page=Network

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Current micronutrient recommendations in Europe: towards understanding their differences and similarities

Abstract *Background* Nowadays most countries in Europe have established their own nutrient recommendations to assess the adequacy of dietary intakes and to plan desirable dietary intakes. As yet there is no standard approach for deriving nutrient recommen-

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dations, they may vary from country to country. This results in different national recommendations causing confusion for policymakers, health professionals, industry, and consumers within Europe. EURRECA (EURopean micronutrient RECommendations Aligned) is a network of excellence funded by the European Commission (EC), and established to identify and address the problem of differences between countries in micronutrient recommendations. The objective of this paper is to give an overview of the available micronutrient recommendations in Europe, and to provide information on their origin, concepts and definitions. Furthermore this paper aims to illustrate the diversity in European recommendations on vitamin A and vitamin D, and to explore differences and commonalities in approaches that could possibly explain variations observed.

Methods A questionnaire was developed to get information on the process of establishing micronutrient recommendations. These questionnaires were sent to key informants in the field of micronutrient recommendations to cover all European countries/regions. Also the latest reports on nutrient recommendations in Europe were collected. Standardisation procedures were defined to enable comparison of the recommendations. Recommendations for vitamin A and vitamin D were compared per sex at the ages 3, 9 months and 5, 10, 15, 25, 50 and 70 years. Information extracted from the questionnaires and reports was compared focusing on: (1) The concept of recommendation (recommended daily allowance (RDA), adequate intake (AI) or acceptable range), (2) The year of publication of the report (proxy for available evidence), (3) Population groups defined, (4) Other methodological issues such as selected criteria of adequacy, the type of evidence used, and assumptions made.

Results Twenty-two countries, the World Health Organization (WHO)/the Food and Agriculture Organization of the United Nations (FAO) and the EC have their own reports on nutrient recommendations. Thirteen countries based their micronutrient recommendations on those from other countries or organisations. Five countries, WHO/FAO and the EC defined their own recommendations. The DACH-countries (Germany, Austria and Switzerland) as well as the Nordic countries (Norway, Sweden, Finland, Denmark and Iceland) cooperated in setting recommendations. Greece and Portugal use the EC and the WHO/FAO recommendations, respectively and Slovenia adopted the recommendations from the DACH-countries. Rather than by concepts, definitions, and defined population groups, variability appears to emerge from differences in criteria for adequacy, assumptions made and type of evidence used to establish micronutrient recommendations.

Discussion The large variation in current micronutrient recommendations for population groups as illustrated for vitamin A and vitamin D strengthens the need for guidance on setting evidence based, up-to-date European recommendations. Differences in endpoints, type of evidence used to set recommendations, experts' opinions and assumptions are all likely to contribute to the identified variation. So far, background information was not sufficient transparent to disentangle the relative contribution of these different aspects.

Conclusion EURRECA has an excellent opportunity to develop tools to improve transparency on the approaches used in setting micronutrient recommendations, including the selection of criteria for adequacy, weighing of evidence, and interpretation of data.

Key words micronutrients – recommendations – nutrient requirements – EURRECA

Background

Most likely, the first true dietary recommendations were proposed by Dr. Edward Smith in 1862 in response to a request from the British Privy Council. The council wanted to determine the least cost for which enough food could be purchased to prevent starvation and associated diseases among the population that was unemployed as the result of the economic depression of the time. Since then, many other nutrient recommendations have been proposed that were used for the planning of food supplies and ration scales during times of war and food shortages, focussing merely on the prevention of deficiencies [23]. Due to the continuously increasing knowledge on the physiological role of nutrients, and the health consequences of micronutrient deficient diets, the concept of dietary and nutrient recommendations still receives much attention [37]. Nowadays most countries in Europe have established their own nutrient recommendations to assess the adequacy of dietary intakes and to plan desirable dietary intakes both at the individual and population level [1, 4–8, 11–16, 18, 19, 22, 24–31, 34, 36, 39, 41–45, 50, 53]. These recommendations serve as a basis for national or regional nutrition policies, nutritional education programs, food regulations and action programs.

Table 1 Paradigm of nutrition science: classical and extensions of the twenty-first century

+	Classical	Twenty-first century
Scientific domain	• Essential nutrients (±50) • Biological effects • Adequate intake via food	• Essential nutrients and bio-active food components • Biological effects • Adequate intake via food, supplements and "functional foods" • Avoid toxic levels
Basis for nutrient recommendation (criteria for adequacy)	• Prevention of deficiency diseases	• Prevention of deficiency diseases • Prevention of chronical diseases (optimal health)
Variables taken into account for recommendation (assumptions)	• Age, sex, physical activity, body weight • Made up for groups	• Age, sex, physical activity, body weight • Ethnicity • Heredity • Genetic predisposition for disease • Made up for groups and individuals • Food patterns • Lifestyle and environment
Scientific Base (type of evidence)	• Clinical "depletion-repletion" model	• Epidemiology: Meta-analyses and RCT provide best funded evidence

Based on IOM [35] and van Staveren [46]

In 1993, the European Commission (EC) defined population reference intakes (PRIs) to be used for food labelling in Europe [6].

The approach to establish nutrient recommendations has changed over the course of time. The classical paradigm focused on an adequate intake of nutrients via food to prevent deficiencies based on clinical trials. In 1994, the Food and Nutrition Board of the Institute of Medicine (IOM) introduced dietary reference intakes (DRIs) for the United States of America and Canada including many aspects of the conceptual framework from the report published in the United Kingdom [36]. These DRIs represented a paradigm shift in the way nutrient recommendations were established and used by practitioners, educators, and researchers. Besides the prevention of deficiencies, DRIs were intended to help individuals optimize their health, prevent disease, and avoid consuming too much of a nutrient. Furthermore the IOM paradigm placed greater emphasis on the distribution of nutrient requirements within a population, rather than on a single value and they quantified the relationship between a nutrient and the risk of disease based on scientific evidence [35].

In Table 1 the classical paradigm and the new paradigm as presented by the IOM are shown.

The DRIs included four nutrient-based reference values: estimated average requirement (EAR), the recommended dietary allowance (RDA), the adequate intake (AI) and the tolerable upper intake level (UL). The EAR is defined as the average daily nutrient intake level that is estimated to meet the requirements of half of the healthy individuals in a particular life-stage and gender group. The RDA represents the average daily dietary nutrient intake level that is sufficient to meet the nutrient requirements of nearly all (97–98%) healthy individuals in a particular life-stage and gender group. When an RDA cannot be determined, an AI is estimated which is the recommended average daily intake level based on observed or experimentally determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate. The UL is outside the scope of this paper [35].

Pavlovic et al. [37], King et al. [21] and Prentice et al. [38] compared a selection of European nutrient recommendations to provide an overview of existing differences in terminologies and reference values. The countries/organisations included were: the Nordic countries (Norway, Sweden, Denmark, Finland and Iceland), the DACH-countries (Germany, Austria and Switzerland), the United Kingdom, the Netherlands, Italy, World Health Organization (WHO)/Food and Agricultural Organization of the United Nations (FAO), and EC. From these comparisons, it appeared that often nutrient recommendations have been established involving small and select committees of experts. As yet there is no standard approach for deriving nutrient recommendations, they vary from country to country. This occurs even for well-defined population groups that are assumed to have the same physiological requirements. Given the lack of standardized methodologies, some nations/organisations provide, for example, one single recommendation for all adults grouped together, while others provide recommendations separately for males and females [21].

Besides such differences in methodologies, national recommendations are reviewed at different times so they may not always be based on the same most up-to-date scientific information. Furthermore, cultural and regional factors may affect the weighing

of evidence and the decision process. This results in different national recommendations causing confusion for policy-makers, health professionals, industry, and consumers within Europe.

Harmonisation will improve the objectivity and transparency of values that are derived by various national, regional and international groups. Where harmonisation is not possible, transparency is needed on the approaches to establish recommendations. This will improve understanding and explanation of potential differences between recommendations and simplifies their application in policy making.

EURRECA Network of Excellence (www.eurreca.org)

EURRECA (EURopean micronutrient RECommendations Aligned) is a network of excellence funded by the EC and established to identify and address the problem of differences between countries in micronutrient recommendations. It is originally made up of 34 partners based in 17 countries, drawn not only from nutrition science but also from industry, consumer groups, national nutrition societies and health professions. Based on previous experiences of the University of the United Nations (UNU) [20] and the International Life Sciences Institute (ILSI) in the WHO South-East Asia Region [17], EURRECA works towards a general framework including harmonized approaches, methods and key terms to be used for the development of micronutrient recommendations. This general framework will supply a basis for the use of micronutrient recommendations across countries/regions for establishing public and clinical health objectives, food and nutrition policies, and for addressing trade and regulatory issues [21].

Further details on the network can be found in the article by Ashwell et al. [2].

Aims and objectives

One of the research activities within EURRECA (Research Activity 1.4: Current Recommendations for population groups) aims to collate, compare and critically evaluate existing micronutrient recommendations for all population groups set by European countries/organisations. The objective of this paper is to give an overview of the availability of nutrient recommendations in Europe and to provide information on the origin, concepts and definitions used, and population groups defined. Furthermore this paper shows the diversity in European recommendations on vitamin A and vitamin D, and aims to explore differences and commonalities in approaches that could possibly explain variations observed. These two nutrients were selected because vitamin D already had some attention in earlier stages of the EURRECA network and vitamin A was selected because much work on this nutrient was already done by the authors. In the near future other nutrients will be studied and more in depth comparisons will be made. The results of these explorations will be used to identify gaps and opportunities on which subsequent activities within EURRECA can build.

Methods

Data collation

To obtain a comprehensive overview of currently used concepts and methods in European countries, a questionnaire was developed by the Division of Human Nutrition of Wageningen University and Research Centre (WUR) in the Netherlands in cooperation with the Food, Consumer Behaviour and Health Research Centre of the University of Surrey in the United Kingdom. Questions addressed three stages of the process of micronutrient policy development. The first stage concerned the approach for setting micronutrient recommendations, while the other two investigated the process from micronutrient recommendations to nutrition policies and options and applications for public health policy. Only the first stage will be reported in this overview.

The questionnaire included open-ended questions on the process of setting up recommendations and close-ended questions on the people involved in the process and the type of evidence used. Each of the 11 questions addressed the nutrients considered to be most relevant to public health: vitamins A, D, E, C, thiamin (B1), riboflavin (B2), niacin (B3), pyridoxine (B6), cobalamin (B12), folic acid (B11), sodium, potassium, calcium, magnesium, iron, zinc, copper, phosphorus, selenium, and iodine.

Questionnaires were distributed among seven EURRECA partners, (University of Oslo (Norway), National Institute of Public Health (Czech Republic), Institute for Medical Research (Serbia), Warsaw Agricultural University (Poland), University College Cork (Ireland), WHO Regional Office for Europe, and WUR, in August 2007. Subsequently, these partners sent the questionnaires to key informants in the field of micronutrient recommendations to cover all European countries/regions. Key-informants were asked to fill out the questionnaire, if necessary with help of others, and return it in September 2007 also providing the latest report(s) on nutrient recommendations. After the deadline had expired, the key-informants of the missing countries were followed up to increase response rate.

Table 2 List of European countries with published micronutrient recommendations and their recommendation report's origin

Country/organisation	Source		Origin				Remark
	Year	Ref no.	Own	Shared	Adopted	No info. provided	
Albania	2005	[4]			×		Adopted from literature, especially from the Linus Pauling Institute (http://lpi.oregonstate.edu/)
Austria	2000	[13]		×			Shared document with Germany and Switzerland
Belgium[a]	2006	[16]	×		×		Based on WHO [48], EC (1990) [no ref. provided], European countries that are geographically and culturally related to Belgium, e.g. UK [36], Netherlands [33] and France [25]
Federation of Bosnia and Herzegovina[b]	2000	[5]			×		Adopted from unknown source(s)
Republika of Srpska[b]	2005	[39]	×		×		Based on WHO [40, 48–51], WHO/FAO [9] and IOM [10]
Bulgaria	2005	[27]	×		×		Based on IOM [10] and WHO [2]
Croatia	2004	[7]	×		×		Aligned with EU legislation
Czech Republic	Not published				×		Adopted from Nutrition Society [no ref. provided] and EC [6]
Denmark	2004	[34]		×			Shared document with Finland, Iceland, Norway, Sweden
Estonia	2006	[45]	×		×		Based on Nordic Council of Ministers [34]
Finland	2004	[34]	×	×			Shared document (Denmark, Iceland, Norway, Sweden) is translated into own country specific document
	2005	[31]					
France	2001	[25]	×				
Germany	2000	[13]		×			Shared document with Austria and Switzerland
Greece	1993	[6]			×		Adopted from EC [6]
Hungary	2005	[1]	×		×		Based on EC [6] and IOM [10]
Iceland	2004	[34]	×	×			Shared document (Denmark, Finland, Norway, Sweden) is translated into own country specific document; Own recommendations for vitamin D and calcium
	2006	[43]					
Ireland	1999	[12]	×		×		Adopted from EC [6] and UK [36]; Own recommendations for folate, iron, calcium, vitamin C
Italy	1996	[42]	×		×		Based on NRC [32] and EC [6]
Latvia	2001	[22]	×				
Lithuania	1999	[24]	×				
Netherlands	1992	[11]	×				
	2000	[14]					
	2003	[15]					
Norway	2004	[34]	×	×			Shared document (Denmark, Finland, Sweden, Iceland) is translated into own country specific document
	2005	[8]					
Poland	1996	[53]	×		×		Based on NRC [10], UK [36] and EC [6]
Portugal	2004	[50]			×		Adopted from WHO/FAO (2004) [50]
Romania	1990	[18]				×	
Russian Federation[a]	1991	[29]				×	Valid from 1991, publication year 1992
Serbia	1994	[41]	×		×		Adopted from unknown source(s)
Slovakia	1997	[19]	×		×		Adopted from unknown source(s)
Slovenia	2004	[26]			×		Adopted from Austria, Germany, Switzerland (2004) [13]
Spain[a]	2007	[30]	×		×		Adopted from unknown sources. Published as a book chapter
Sweden	2004	[34]	×	×			Shared document (Denmark, Finland, Iceland, Norway) is translated into own country specific document
	2005	[44]					
Switzerland	2000	[13]		×			Shared document with Austria and Germany; Own recommendations for Iodine
The former YR Macedonia	2001	[28]	×		×		Based on recommendations of Former Republics of Yugoslavia (based on WHO) and UK [no ref. provided]
United Kingdom	1991	[36]	×				
EC[a]	1993	[6]	×				
WHO/FAO[a]	2004	[50]	×				

Based on questionnaire primarily and recommendation report (when available) secondarily. Montenegro is excluded from the list because no questionnaire nor recommendation report was available for the author

[a]Based on recommendation report only

[b]Entities of Bosnia and Herzegovina

The former YR Macedonia = The former Yugoslav Republic of Macedonia; *EC* European Commission, *WHO/FAO* World Health Organization/Food and Agricultural Organization

Own country specific recommendations developed

Shared recommendations set by one collaborative committee representing different countries

Adopted recommendations borrowed from other nation/organization

Table 3 Description of currently available recommendations across Europe*

Source			Type/concept used	Equivalent to DRI/RDA/AI/ Acceptable range	Description	Micronutrients
Country	Year	Ref no.				
Albania	2005	[4]	RDA[Q]	Insufficient info provided	Recommended Dietary Allowance, which is based on the biological needs for the normal individual of 23 to 55 years	All
Belgium	2006	[16]	Recommended Dietary Allowance	DRI	General term for the set of recommendations	All
			Recommended daily amount of absorption	RDA	AR + 2SD, covering at least 97.5% of the population	All, except for vitamin D, sodium, potassium, iodine, copper
			Acceptable daily amount of absorption	AI/Acceptable range	Recommended daily absorption amount of adequate intake is the lowest level of intake, estimated, and covers practically the entire population: the adequate intake. This figure will be higher then the RDA in most cases	Vitamin D, sodium, potassium, iodine, copper
Bulgaria	2005	[27]	DRI	DRI	General term for the set of recommendations	All
			RDA	RDA	Recommended Dietary Allowance is the AR + 2SD	All, except for calcium, sodium, potassium
			AI	AI	Adequate Intake is the estimation of the lowest intake level that seems sufficient for almost all people in a group	Calcium, sodium, potassium
DACH countries	2000	[13]	Reference value for nutrient intake	DRI	General term for the set of recommendations	All
			Recommended Nutrient Intake (RNI)	RDA	AR + 2SD. These amounts should cover the needs of nearly 98% of the population and protect against deficiency related damage to health	All, except for vitamin E, sodium, potassium, copper, selenium
			Estimated value for adequate intake	AI/Acceptable range	Estimated values for Adequate Intake, using data that, though supported by experiment and mostly derived from intakes of healthy, well nourished groups, have not been adequately validated	Vitamin E, sodium, potassium, copper, selenium
Estonia	2006	[45]	Recommended Intake (RI)	Insufficient info provided	Average daily intake over time, for use in planning diets for groups	All
France	2001	[25]	ANC	DRI	General term for the set of recommendations	All
			PRI	RDA	Recommended Dietary Intake is the AR + 2SD	All, except for vitamin D, vitamin E, folate, riboflavin, thiamin, selenium, iodine
			AI	AI	The adequate intakes have been set on the basis of the observed deficiency thresholds, from the state of the reserves and sometimes from the quantities usually consumed with no apparent impact on health	Vitamin D, vitamin E, folate, riboflavin, thiamin, selenium, iodine
Hungary	2005	[1]	safe intake	na	Recommendation for 100% of the population, based on EAR	All, except for sodium
			maximum intake	na	No information provided	Sodium
Ireland	1999	[12]	Recommended Dietary Allowance (RDA)	DRI	General term for the set of recommendations	All
			Recommended Daily Allowance (RDA)	RDA	AR + 2SD	All
Italy	1996	[42]	RDA (LARN)	RDA	Recommended Daily Intake is the AR + 2SD. This procedure guarantees the coverage of the basic nutritional needs of over 97% of the population	All, except for vitamin E, sodium, magnesium
			Acceptable intake range[Q]	Acceptable range	no information provided	Vitamin E, sodium, magnesium
Latvia	2001	[22]	Recommended average Daily Intake	insufficient info provided	no information provided	All

Table 3 Continued*

Source			Type/concept used	Equivalent to DRI/RDA/AI/ Acceptable range	Description	Micronutrients
Country	Year	Ref no.				
Lithuania	1999	[24]	RDA	RDA	AR + 2SD^{Q}	All
Netherlands	1992	[11]	RDA (ADH)	DRI	General term for the set of recommendations	All
	2000	[14]				
	2003	[15]	RDA	RDA	Recommended Amount is the EAR + 2SD	Vitamin B6, vitamin B12, folate, thiamin, riboflavin, niacin
			AI	AI	Adequate Intake is an estimation of the lowest intake level that seems sufficient for almost all people in a group; defined in case the EAR is not known	All, except for magnesium, zinc, copper, phosphorus, selenium
			Adequate area of Intake	Acceptable range	Adequate Intake is an estimation of the lowest intake level that seems sufficient for almost all people in a group; defined in case the EAR is not known	Magnesium, zinc, copper, phosphorus, selenium
Nordic countries	2004	[34]	Recommended Intake (RI)	RDA	The amount of a nutrient that according to present knowledge can meet the known requirement and the maintain good nutritional status among practically all healthy individuals	All
Poland	1996	[53]	Safe intake level (s.l.)	RDA	Safe intake level is the amount of nutrient which is adequate to meet nutritional needs of 97.5% of all individual in a group: mean for group + 2SD: used for assessment	All, except for copper, sodium, potassium
			Recommended intake (r.i.)	na	Recommended intake is the amount of nutrient which is adequate to meet nutritional needs of 100% of all individual in a group and is dedicated to planning diets for groups	All, except for copper, sodium, potassium
			Recommended safe level (r.s.l)	Acceptable range	Range based on observations that individual consumption within this limits appears satisfactory and neither deficiency nor signs of excess are seen, used when there is no data to establish recommendation as one number	Copper
			Minimal intake (m.i.)	AI/Acceptable range	ranges and values considering the necessity of reducing salt consumption	Sodium, potassium
Romania	1990	[18]	Recommended amounts	DRI	General term for the set of recommendations	All
			RDA^{Q}	insufficient info provided	Physiological needs / Recommended amounts	All
Russian Federation	1991	[29]	Recommended level of intake	Insufficient info provided	Criterion for assessment of nutritional adequacy	All, except for copper
			Safe level of intake	AI	Where a recommended level of intake is not possible to establish	Copper
Serbia	1994	[41]	Recommended dietary allowance (DP)	RDA^{pc}	DP = daily needs	All
Slovakia	1997	[19]	RDA (OVD)	Insufficient info provided	Recommended Dietary Allowance for population groups, intended for production, consumption and as the ground for diets and food based dietary guidelines	All
Spain	2007	[30]	no information provided	Insufficient info provided	no information provided	No information provided
The former YR Macedonia	2001	[28]	Recommended Daily Allowance (RDA)	Insufficient info provided	insufficient info provided	All (ranges for copper, selenium, sodium, potassium)

Table 3 Continued*

Source			Type/concept used	Equivalent to DRI/RDA/AI/ Acceptable range	Description	Micronutrients
Country	Year	Ref no.				
United Kingdom	1991	[36]	Dietary reference Value (DRV)	DRI	General term for the set of recommendations	All
			Recommended Nutrient Intake (RNI)	RDA	EAR + 2SD	All, except for copper, iodine, potassium, selenium, sodium
			Safe intake	AI/acceptable range	A level or range of intakes at which there is no risk on deficiency and below a level where there is a risk of undesirable effects	Copper, iodine, potassium, selenium, sodium
EC	1993	[6]	PRI	RDA	Population Reference Intake is the AR + 2SD, covering at least 97.5% of the population	All, except for vitamin D, sodium, magnesium
			Acceptable range	Acceptable range	Acceptable Range of Intake is there where data are inadequate for making recommendations, and based on observations that individual consumptions within these limits appears satisfactory in that neither deficiency nor signs of excess are seen	Vitamin D, sodium, magnesium
WHO/FAO	2004	[50]	Recommended Nutrient Intake (RNI)	RDA	Recommended Nutrient Intake is EAR + 2SD, which meets the nutrient requirements of almost all (97.5%) apparently healthy individuals in an age- and sex-specific population	All, except for vitamin E, vitamin A
			Recommended safe intake level	AI	level of intake that prevents clinical signs of deficiency and allows normal growth, but is doe not protect vitamin A status during prolonged periods of infection or other deceases	Vitamin A
			Acceptable intake	AI	Best estimate of requirement, because data was not strong enough to formulate recommendations	Vitamin E

*Based on recommendation report. Croatia, Federation of Bosnia and Herzegovina and Republika of Srpska (entities of Bosnia and Herzegovina) and Montenegro are excluded from the table because no recommendation report was available for the author and information could not be extracted from the questionnaire. The Czech Republic was excluded due to lack of published source

DACH countries = Austria, Germany, Switzerland; Nordic countries = Denmark, Finland, Iceland, Norway, Sweden; The former YR Macedonia = The former Yugoslav Republic of Macedonia, *EC* European Commission, *WHO/FAO* World Health Organization/Food and Agricultural Organization

Footnotes in local language were not taken into account

^{Q} based on questionnaire only

^{pc} personal communication

DRI Dietary Reference Intake = General term for the set of recommendations [35]

RDA Recommended Dietary Allowance = (Estimated) Average Requirement + 2 standard deviation [(E)AR + 2SD] = Daily dietary intake level of a nutrient considered sufficient to meet the requirements of 97–98% of healthy individuals in each life-stage and gender group [35]

AI Adequate Intake = The derived intake by a defined population group that appears to sustain health, used when there are insufficient primary data to establish a statistical distribution of individual requirements [35]

na not applicable = a concept derived from the RDA

All vitamins A, D, E, C, B1, B2, B3, B6, B12, folic acid, sodium, potassium, calcium, magnesium, iron, zinc, copper, phosphorus, selenium, iodine (if applicable)

Data extraction

Both the completed questionnaires and the recommendation reports were used to extract micronutrient recommendations, information on their origin, the approach used for estimating them, definitions and concepts, scientific evidence used, and population groups considered. Any unclear information given in the returned documents was re-checked with the key-informants to be sure that correct information was extracted.

Comparison of recommendations for vitamin A and vitamin D

As micronutrient recommendations usually consist of values, ranges, multiple values applying to one population group, (for example values for different activity levels), or additional amounts for sub groups (for example pregnant females), standardisation procedures were defined to enable comparison of the recommendations. In case of multiple recommendations

Table 4 Characteristics of population groups as observed in Dietary Reference Intake documents of different European countries*

Source			Age					Other characteristics
Country	Year	Ref no.	Age span	Age groups 0–12 months	Age groups 1–18 years	Age groups adults (years)	Upper age group (years)	
Albania[a]	2005	[4]	All ages	0–6, 7–12	1–3, 4–8, 9–13, 14–18 (m/f)	≥19 (m/f)	≥19	P and L: age ≤ 18years, ≥19years
Belgium[b]	2006	[16]	All ages	0–12	1–3, 4–6, 7–10, 11–14, 15–18 (m/f)	19–59 (m/f), ≥60 (m/f)	≥60	P, L
Bulgaria[c]	2000	[27]	All ages	0–5, 6–12	1–2, 3–6, 7–9, 10–13 (m/f), 14–18 (m/f)	19–29 (m/f), 30–59 (m/f), 60–75 (m/f), ≥76 (m/f)	≥76	P and L: age ≤ 18 years, ≥19 years
DACH countries[d]	2000	[13]	All ages	0–3, 4–12	1–3, 4–6, 7–9, 10–12, 13–14 (m/f), 15–18 (m/f)	19–24 (m/f), 25–50 (m/f), 51–64 (m/f), ≥65 (m/f)	≥65	P: ≥4 months, L
Estonia	2006	[45]	≥6 months	6–12	1, 2–5, 6–9, 10–13 (m/f), 14–17 (m/f)	18–30 (m/f), 31–60 (m/f), 61–74 (m/f), ≥75 (m/f)	≥75	P, L
France[e]	2001	[25]	All ages	0–12	1–3, 4–6, 7–9, 10–12, 13–15 (m/f), 16–19 (m/f)	20–74 (m/f), ≥75	≥75	P, L
Hungary	2005	[1]	All ages	0–6, 7–24	2–3, 4–6, 7–10, 11–14 (m/f), 15–18 (m/f)	19–30 (m/f), 31–60 (m/f), ≥61	≥61	P, L
Ireland	1999	[12]	All ages	0–3, 4–6, 7–9, 10–12	1–3, 4–6, 7–10, 11–14 (m/f), 15–17 (m/f)	18–64 (m/f), ≥65 (m/f)	≥65	P: second half, L: first 6 months
Italy[f]	1996	[42]	≥6 months	6–12	1–3, 4–6, 7–10, 11–14, 15–17 (m/f)	18–29 (m/f), 30–59 (m), 30–49 (f), ≥60 (m), ≥50 (f)	≥60 (m), ≥50 (f)	P, L
Latvia[g]	2001	[22]	All ages	0–6, 7–12	1–3, 4–6, 7–10, 11–14, 15–18	≥19	≥19	P, L
Lithuania	1999	[24]	≤64 years	0–3, 4–6, 7–9, 10–12	1–3, 4–6, 7–10, 11–14 (m/f), 15–18 (m/f)	19–34 (m/f), 35–49 (m/f), 50–64 (m/f)	50–64	P and L: 4 PA levels and 2 body weights. PA: 4 levels (m/f) and 2 body weights (m), 2 body weights (f)
Netherlands[h]	1992 2000 2003	[11] [14] [15]	All ages	0–5, 6–12	1–3 (m/f), 4–6 (m/f), 7–9 (m/f), 10–12 (m/f), 13–15 (m/f), 16–18 (m/f)	19–21 (m/f), 22–49 (m/f), 50–64 (m/f), ≥65 (m/f)	≥65	P, L
Nordic countries[i]	2004	[34]	All ages	0–5, 6–12	1, 2–5, 6–9, 10–13 (m/f), 14–17 (m/f)	18–30 (m/f), 31–60 (m/f), 61–74 (m/f), ≥75 (m/f)	≥75	P, L
Poland	1996	[53]	All ages	0–5, 6–12	1–3, 4–6, 7–9, 10–12 (m/f), 13–15 (m/f), 16–18 (m/f)	19–25 (m/f), 26–59 (m/f), ≥60 (m/f)	≥60	P, L, PA: 3 levels (ages 19–59 years)
Romania	1990	[18]	All ages	0–12	1–3, 4–6, 7–9, 10–12, 13–15 (m/f)	16–19 (m/f), 20–45 (m/f), 46–62 (m), 46–60 (f), ≥63 (m), ≥61 (f)	≥63 (m), ≥61 (f)	PA: 3 levels (ages 20–60 years)
Russian Federation[j]	1991	[29]	All ages	0–3, 4–6, 7–12	1–3, 4–6, 7–10, 11–13 (m/f), 14–17 (m/f)	18–29 (m/f), 30–39 (m/f), 40–59 (m/f), 60–74 (m/f), ≥75 (m/f)	≥75	P, L: age <7 m, ≥7 m, PA: 5 levels (m), 4 levels (f) (ages 18–59y)
Serbia[k]	1994	[41]	1–14 years	not set	1, 2, 3–4, 5–6, 7–9, 10–11 (m/f), 12–14 (m/f)	not set	12–14	daily needs group, pre-school-and-school institution group

Table 4 Continued*

Source			Age					Other characteristics
Country	Year	Ref no.	Age span	Age groups 0–12 months	Age groups 1–18 years	Age groups adults (years)	Upper age group (years)	
Slovakia	1997	[19]	All ages	0–6, 7–12	1–3, 4–6, 7–10, 11–14 (m/f), 15–18 (m/f)	19–34 (m/f), 35–59 (m), 60–74 (m), 35–54 (f), 55–74 (f), ≥75 (m/f)	≥75	P, L, PA: 4 levels (ages 19–59 years (m) and 19–54 years (f)), 2 levels (ages 15–18 years)
Spain[l]	2007	[30]	All ages	0–5, 6–12	1–3, 4–5, 6–9, 10–12 (m/f), 13–15 (m/f)	16–19 (m/f), 20–39 (m/f), 40–49 (m/f), 50–59 (m/f), ≥60 (m/f)	≥60	P: second half, L
The former YR Macedonia	2001	[28]	All ages	0–3, 4–6, 7–9, 10–12	1–3, 4–6, 7–10, 11–14 (m/f), 11–14 (m/f), 15–18 (m/f)	19–24 (m/f), 25–50 (m/f), 51–64 (m/f), ≥65 (m/f)	≥65	P, L, preschool-in-kindergarten and school institution group
United Kingdom[m]	1991	[36]	All ages	0–3, 4–6, 7–9, 10–12	1–3, 4–6, 7–10, 11–14 (m/f), 15–18 (m/f)	19–50 (m/f), ≥51 (m/f)	≥51	P, L: >4 months, <4 months
EC[n]	1993	[6]	≥6 months	6–12	1–3, 4–6, 7–10, 11–14 (m/f), 15–17 (m/f)	≥18 (m/f)	≥18	P, L
WHO/FAO[o]	2004	[50]	All ages	0–6, 7–12	1–3, 4–6, 7–9, 10–18 (m/f)	19–50 (m/f), 51–65 (m/f), ≥66	≥66	P, L

*Based on recommendation report. Croatia, Federation of Bosnia and Herzegovina and Republika of Srpska (entities of Bosnia and Herzegovina) and Montenegro are excluded from the table because no recommendation report was available for the author and information could not be extracted from the questionnaire. The Czech Republic was excluded due to lack of published source.
Nordic countries = Denmark, Finland, Iceland, Norway, Sweden; The former YR Macedonia = The former Yugoslav Republic of Macedonia; EC = European Commission; *WHO/FAO* World Health Organization/Food and Agricultural Organization
m male, *f* female,
m/f Recommendations defined for males and for females separately; these recommendations do not have to differ between males and females,
P pregnancy,
L lactation,
PA physical activity,
[Q]based on questionnaire only
[a]Vit D, E, B12, folate, sodium, potassium, calcium, magnesium, iron, copper, phosphorus, selenium, iodine: no separate recommendation for male and female. Vit C: separate recommendations for male and female for all age groups. Vit D, E, B6, B12, folate, riboflavin, thiamin, niacin, iron (P), sodium, potassium, selenium, copper, iodine: no separate age groups for P and L. Magnesium: ≤18, 19–30 age, ≥31 years for P and L. Vit D: 19–50, ≥71 years. Vit B6, B12, calcium: 19–50, ≥51 years (vit B6 (19–50 years), vit B12, calcium: no separate recommendations for male and female). Sodium: 19–50, 51–70, ≥71 years and no separate recommendations for male and female. Magnesium: 19–30, ≥31 years and for 14–18 years no separate recommendations for male and female
[b]Minerals: 0–5, 6–11 months. Trace elements: 0–3, 4–5, 6–11 months. Iron (11–14, 15–18 and 19–59 years): separate recommendation for menstruating/non-menstruating women. Natrium (0–5, 6–11 months): based on weight
[c]Vit C: separate recommendation for smokers. Footnotes in local language were not taken into account
[d]Vit D, C, B12, folic acid, phosphorus, copper, selenium and Vit B6 (10–12,13–14 years): no separate recommendation for male/female. Vit E, Iodine (1–3, 4–6, 7–9 years): separate recommendation for male/female. Iron: separate recommendation for menstruating/non-menstruating women. Vit C: separate recommendation for non-smokers/smokers. Calcium, phosphorus, magnesium: separate recommendation for P and L for <19 and ≥19 years
[e]Minerals: 1–3, 4–6, 7–9, 10–12, 13–19 (m/f), 20–65 (m/f), 66–74 (m), 56–74 (f), ≥75 years. Vit C: separate recommendation for smokers above ten cigarettes/day and for pregnant women in the third trimester
[f]Iron: separate recommendation for menstruating/non-menstruating women. Calcium (≥50 years): separate recommendation for post-menopausal women with/without oestrogen therapy
[g]Minerals (≥19 years): separate recommendation for males and females
[h]Calcium, vit D, thiamin, riboflavin, niacin: 4–8, 9–13, 14–18, 19–50, 51–70, >70 years. Vit B6: 4–8, 9–13, 14–18, 19–50, ≥51 years. Vit B12, folate: age groups: 4–8, 9–13, 14–18, ≥19 years. Iron, zinc: for pregnancy separate recommendation for first/second/third trimester. Copper: pregnancy third trimester. Riboflavin, thiamin: separate recommendation for male and female. Calcium, phosphorus, zinc, Vit B6 (0–5 months): separate recommendation for breast-feeding/bottle feeding. Vit D: separate recommendation for no exposure to sunlight/light coloured skin/remain outdoor for at least 15 min a day with at least hands and face uncovered. Vit D: separate recommendation for 51–60 and 61–70 years. Vit A: recommendation per gram PUFA. Zinc (>3 months): separate recommendation

for one population group, the mean of all given values was used. In case of a range, the mid value was used. In cases where recommendations were not given in the most common unit, values were converted into that unit. Standardized recommendations for vitamin A and vitamin D were compared per sex at the ages 3, 9 months and 5, 10, 15, 25, 50 and 70 years. These ages were selected because they indicate points of time in the different population groups as defined by countries. More population groups were defined for children and adolescents and therefore more ages between 0 and 18 years were selected. Also comparisons of recommendations for pregnant and lactating females were made. To depict the diversity between recommendations for vitamin A and vitamin D, boxplots were constructed in SPSS version 12.0.

In exploring commonalities and differences between micronutrient recommendations, background information extracted from the questionnaires and recommendation reports was compared focusing on the following items that could help to explain the commonalities and differences found:

1. The concept of recommendation (RDA, AI),
2. The year of publication of the recommendations (proxy for available evidence),
3. Population groups for which recommendations were defined,
4. Other methodological issues from the paradigm used to establish recommendations as selected criteria of adequacy or health endpoints (e.g. preventing deficiencies, plasma concentration), the type of evidence used (e.g. review of randomized controlled trials (RCT), experts' opinion), and assumptions made (e.g. physical activity, weight, sunlight).

Information on the first three items was extracted from the recommendation reports and information on the last item came mainly from the questionnaires.

Results

Data collation

Of the total 35 questionnaires sent out, 32 have been completed. No reaction after follow up was received from Montenegro and the Russian Federation. No reaction from Iceland was received due to a delay in sending the questionnaire.

From 31 European countries, WHO/FAO, and the EC the latest versions of reports on nutrient recommendations were collected, including varying amounts of background documentation. At the time of publication of this paper, reports from Republika Srpska (entity of Bosnia and Herzegovina) and Croatia had just become available and could therefore

[i]Vit D: separate recommendation for infants >4 weeks and elderly people with little or no sun exposure. Folate (31–60 years): separate recommendation for women in reproductive age/not in reproductive age. Iron: recommendation according to meal composition, and separate recommendation for post-menopausal women. Zinc: separate recommendation for vegetarians. Calcium, phosphorus (18–20 years): separate recommendation
[j]Copper: 0–5 months, 7–10, 11–17, ≥18 years
[k]Minerals: no separate recommendation for male and female
[l]Folic acid: recommendation for first and second half of pregnancy
[m]Vit D (≥51 years): separate recommendation for ≤65/>65 years. Thiamin: recommendations for last trimester of pregnancy only
[n]Thiamin, niacin, vit B6: recommendation according to body weight, energy or protein intake. Thiamin: recommendation for >10 weeks of pregnancy. Iron (≥18 years): separate recommendations to cover of 96 and 90% of the population and postmenopausal women
[o]Minerals: recommendation for first, second, third trimester of pregnancy, and 0–3, 3–6, 7–12 months of lactation. Iodine: <5, 6–12, 13–18 years (m/f). Zinc: separate recommendation for three levels of bioavailability. Zinc (0–12 months): separate recommendation for breast feeding/bottle feeding. Iron: separate recommendation for four levels of bioavailability. Iron: separate recommendation for premenarche/post menarche. Calcium: separate recommendation for breast feeding/cow milk-feeding. Magnesium: separate recommendation for breastfeeding/formula feeding. Vit B6 (51–65 years, m): separate recommendation for 19–50/>50 years. Vit D (51–65 years, m): separate recommendation for 19–50/51–65 years

Table 5 Overview of micronutrient recommendations on vitamin A (μg) for selected population groups in Europe*: males

Source			Population group							
Ref no.	Year	Country	3 months	9 months	5 years	10 years	15 years	25 years	50 years	70 years
[4]	2005	Albania	400	500	400	600	900	900	900	900
[16]	2006	Belgium	350	350	400	500	700	700	700	700
[27]	2005	Bulgaria	375	400	450	600	800	800	800	800
[13]	2004	DACH countries	500	600	700	900	1,100	1,000	1,000	1,000
[45]	2006	Estonia		300	350	600	900	900	900	900
[25]	2001	France	350	350	450	550	700	800	800	800
[1]	2005	Hungary	420	400	500	700	1,000	1,000	1,000	1,000
[12]	1999	Ireland	350	350	400	500	700	700	700	700
[42]	1996	Italy		350	400	500	700	700	700	700
[22]	2001	Latvia	375	375	500	700	1,000	1,000	1,000	1,000
[24]	1999	Lithuania	420	400	500	700	1000	800	800	800
[11]	1992	Netherlands	450	400	500	1,000	1,000	1,000	1,000	1,000
[34]	2004	Nordic countries		300	350	600	900	900	900	900
[53]	1996	Poland	450	450	500	600	700	700	700	700
[18]	1990	Romania	450	450	600	900	1,050	1087.5	1087.5	1,050
[29]	1991	Russian Federation	400	400	500	700	1,000	1,000	1,000	1,000
[41]	1994	Serbia			500	1000				
[19]	1997	Slovakia	400	400	500	700	1,000	950	950	850
[30]	2007	Spain	450	450	300	1,000	1,000	1,000	1,000	1,000
[28]	2001	The former YR Macedonia	375	375	400	700	1,000	1,000	1,000	1,000
[36]	1991	United Kingdom	350	350	400	500	700	700	700	700
[6]	1993	EC		350	400	500	700	700	700	700
[50]	2004	WHO/FAO	375	400	450	600	600	600	600	600

*DACH countries = Austria, Germany, Switzerland; Nordic countries = Denmark, Finland, Iceland, Norway, Sweden; The former YR Macedonia = The former Yugoslav Republic of Macedonia

EC European Commission, *WHO/FAO* World Health Organization/Food and Agricultural Organization

Croatia, Federation of Bosnia and Herzegovina and Republika of Srpska (entities of Bosnia and Herzegovina) and Montenegro are excluded from the table because no recommendation report was available for the author. The Czech Republic was excluded due to lack of published source

not be included in this paper. Reports from Federation of Bosnia and Herzegovina (entity of Bosnia and Herzegovina) and Montenegro were not received after follow up. No national report on nutrient recommendations has been published for the Czech Republic, but among others they use the EC recommendations (J. Ruprich, Personal communication, January 2008).

Available nutrient recommendations in Europe

Current publications on nutrient recommendations in Europe are listed in Table 2. Most of the reports (22 out of 33) were published from the year 2000. The oldest report dates from 1990 (Romania) and the most recent one is published in 2007 (Spain).

Table 2 also shows that 22 countries and WHO/FAO and the EC have their own reports on nutrient recommendations (own, own + adopted and own + shared). Thirteen countries based their recommendations on those from other countries or organisations (own + adopted). Five countries (France, Latvia, Lithuania, the Netherlands and the United Kingdom), WHO/FAO and the EC defined their own recommendations (own). The DACH-countries as well as the Nordic countries cooperated in setting recommendations, indicated by 'shared' in Table 2. Greece and Portugal use the EC and the WHO/FAO recommendations respectively and Slovenia adopted the recommendations of the DACH-countries. The publication from which Albania and Federation of Bosnia and Herzegovina adopted their recommendations was not clear. The origin of recommendations was unknown for 2 countries (Romania and the Russian Federation).

Concepts and definitions used to define micronutrient recommendations

Different terms have been used for the total set of nutrient recommendations (DRIs, DRVs RDAs etc.). Within these sets, different terms have been used to express the levels of requirement and the certainty with which they have been set. Though terminology differed substantially between countries (e.g. recommended nutrient intake, recommended daily amount of absorption, recommended intake, population ref-

Table 6 Overview of micronutrient recommendations on vitamin A (μg) for selected population groups in Europe*: females

Source			Population group									
Ref no.	Year	Country	3 months	9 months	5 years	10 years	15 years	25 years	50 years	70 years	Pregnancy	Lactation
[4]	2005	Albania	400	500	400	600	700	700	700	700	760	1250
[16]	2006	Belgium	350	350	400	500	800	600	600	600	700	950
[27]	2005	Bulgaria	375	400	450	600	700	700	700	700	775	1150
[13]	2004	DACH countries	500	600	700	900	900	800	800	800	1,100	1500
[45]	2006	Estonia		300	350	600	700	700	700	700	800	1,100
[25]	2001	France	350	350	450	550	600	600	600	600	700	950
[1]	2005	Hungary	420	400	500	700	800	800	800	800	1,000	1,200
[12]	1999	Ireland	350	350	400	500	600	600	600	600	700	950
[42]	1996	Italy		350	400	500	600	600	600	600	700	950
[22]	2001	Latvia	375	375	500	700	1,000	1,000	1,000	1,000	1,100	1,300
[24]	1999	Lithuania	420	400	500	700	800	800	800	800	1,000	1,200
[11]	1992	Netherlands	450	400	500	800	800	800	800	800	1,000	1,250
[34]	2004	Nordic countries		300	350	600	700	700	700	700	800	1,100
[53]	1996	Poland	450	450	500	600	600	600	600	600	950	950
[18]	1990	Romania	450	450	600	900	1,050	950	950	900	900	900
[29]	1991	Russian Federation	400	400	500	700	800	900	900	800	1,100	1,300
[41]	1994	Serbia			500	800						
[19]	1997	Slovakia	400	400	500	700	900	850	850	800	1,100	1,200
[30]	2007	Spain	450	450	300	800	800	800	800	800	800	1,300
[28]	2001	The former YR Macedonia	375	375	400	700	800	800	800	800	1,000	1,200
[36]	1991	United Kingdom	350	350	400	500	600	600	600	600	700	950
[6]	1993	EC		350	400	500	600	600	600	600	700	950
[50]	2004	WHO/FAO	375	400	450	600	600	500	500	600	800	850

*DACH countries = Austria, Germany, Switzerland; Nordic countries = Denmark, Finland, Iceland, Norway, Sweden; The former YR Macedonia = The former Yugoslav Republic of Macedonia;
EC European Commission, *WHO/FAO* World Health Organization/Food and Agricultural Organization
Croatia, Federation of Bosnia and Herzegovina and Republika of Srpska (entities of Bosnia and Herzegovina) and Montenegro are excluded from the table because no recommendation report was available for the author. The Czech Republic was excluded due to lack of published source

erence intake, acceptable range, recommended daily allowance, acceptable intake range, recommended average daily intake, safe intake level, minimal intake, recommended safe level), all these concepts could be considered as equivalent to three basic concepts: RDA, AI (as defined by IOM [35]) and the acceptable range which is defined as a range of intakes high enough to avoid deficiency and low enough to avoid undesirable toxic effects [6]. Only the Hungarian publication included a deviating term, safe intake, which is defined as the recommended level of intake that is sufficient for 100% of the healthy population (Table 3). For Albania, Estonia, Latvia, Romania, Slovakia, Spain, and The former Yugoslav Republic of Macedonia, the concept of the recommendation (RDA or AI) was not clear from the reports and questionnaires. For most nutrients an RDA was defined, but for sodium, potassium, selenium, copper, vitamin D, vitamin E, and magnesium, an AI was often given instead. Besides a term considered equivalent to the RDA, the Polish recommendations also included the term recommended intake, representing the intake that meets the nutritional needs of 100% individuals in a healthy population.

Population groups

Age span

Table 4 lists the population groups encountered in the collated reports on nutrient recommendations. Deviations from generally defined population groups per country are given in foot notes. Table 4 shows that except for a few countries, most recommendations cover all ages. Exceptions include Estonia, Italy, and the EC, which do not give recommendations for infants under 6 months, and Serbia provides values only for children ages 1–14 years. Lithuania covers people up to the age of 65 years.

Children and adolescents

The first year of life is split up in two to four age categories. For the age span of 1–18 years, the grouping of ages differs substantially: the number of age categories varies between four and six and different age cut-off points are used. All publications, except for the Netherlands, start to separate recommendations for males and females between the age of

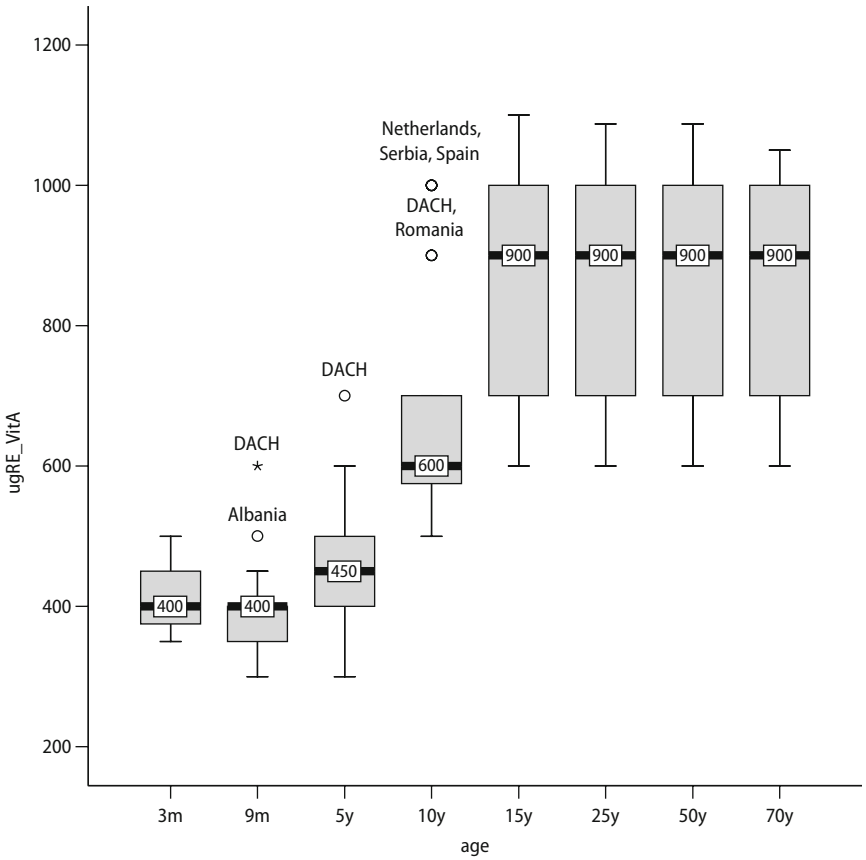

Fig. 1 Diversity of vitamin A recommendations for males in Europe expressed in μg retinol equivalents (RE) for selected ages. *x*-axis age = 3, 9 months and 5, 10, 15, 25, 50 and 70 years. *y*-axis μg RE vitamin A. *DACH = Austria, Germany and Switzerland. The *boxes* indicate the interquartile range (IQR = x_{75}–x_{25}) in which the median (x_{50}) of all vitamin A recommendations is indicated by a *horizontal line*. *Vertical lines* connected to the *upper* and *lower side* of the *box* indicate values less than 1.5 IQR below the first quartile or above the third quartile. Values not included in this range are considered as an outlier and are indicated by *open dots* (more than three times IQR above x_{75} or below x_{25}) and stars (more than 1.5 times the IQR above x_{75} or below x_{25})

10–15 years. The report from the Netherlands provides gender-specific separate recommendations from the age of 1 year, although the actual recommendations for men and females do not differ for all age groups and nutrients.

Adults

The number of age categories defined for adults varies from one to five but most reports include recommendations for four age categories. Discrepancies also emerge for the higher age levels. Most often the highest age group is ≥60, ≥65, or ≥75 years of age. The United Kingdom recommendations, however, have ≥51 years as an upper age group, the Italian recommendations defined ≥51 years for females and ≥60 years for males, both the Albanian and the Latvian recommendations defined the upper age group as ≥19 years and the European recommendations as ≥18 years. All countries, except Latvia, give recommendations separately for males and females, although Latvia does separate recommendations on minerals for the two sexes.

Other criteria considered in setting micronutrient recommendations

All countries except Romania provide separate micronutrient recommendations for pregnant and lactating females. The Albanian and the Bulgarian recommendations for both pregnant and lactating females are further split up in ≤18 years and ≥19 years. The United Kingdom and the Russian Federation split up the group of lactating females according to the period of lactation (≤4 months and >4 months for the United Kingdom and <7 months ≥7 months for the Russian Federation).

Some countries distinguish physical activity levels (PAL) per age group. Lithuania provides micronutrient recommendations for four PAL and two different body weights per age category and sex. The Russian Federation splits up the recommendations for adults in five PAL for males (1.4, 1.6, 1.9, 2.2, and 2.5). and four levels for females (1.4, 1.6, 1.9, and 2.2). Poland, Romania and Slovakia distinguish three PAL: low, moderate and high. In addition Slovakia also gives recommendations for students with and without physical workload. For specific nutrients other sub-

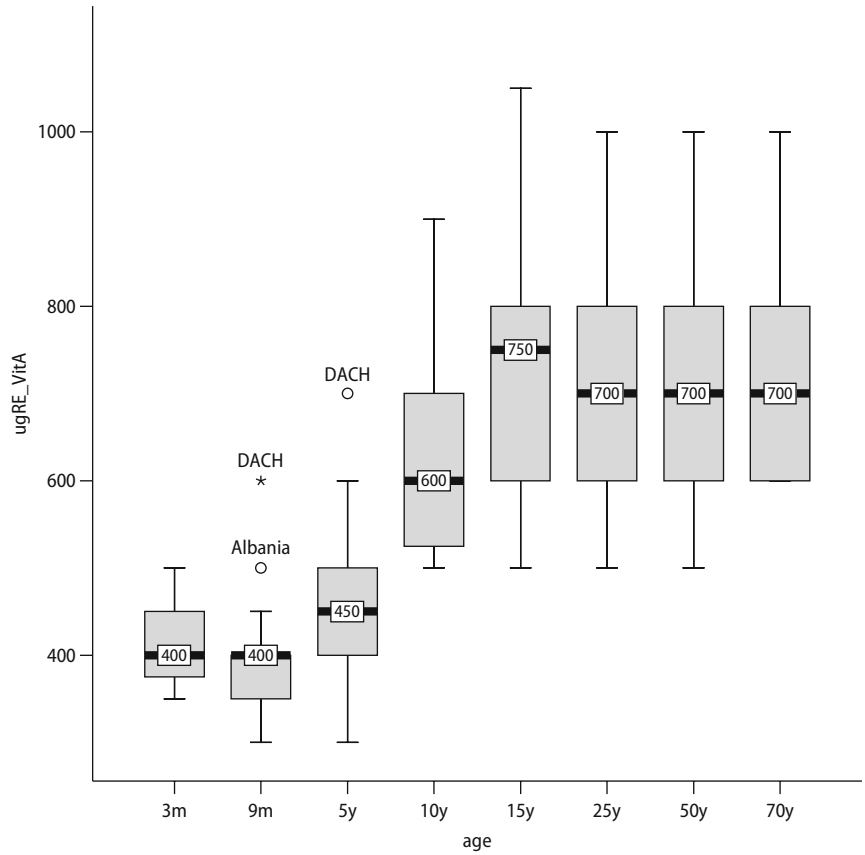

Fig. 2 Diversity of vitamin A recommendations for females in Europe expressed in μg retinol equivalents (RE) for selected ages. *x*-axis: age = 3, 9 months and 5, 10, 15, 25, 50 and 70 years. *y*-axis: μg RE vitamin A

groups are sometimes distinguished, for example for vitamin C, Bulgaria and the DACH-countries provide a separate recommendation for smokers. Other characteristics influencing requirements that are mentioned in recommendations for specific nutrients are: sunlight exposure, skin colour, menstrual blood loss, energy intake (especially for thiamin, riboflavin, niacin), protein intake (vitamin B6) or fat intake (vitamin E) and bioavailability for the nutrients iron and zinc.

Diversity in recommendations on vitamin A and vitamin D

Vitamin A

Tables 5 and 6 present the current available standardized recommendations for vitamin A (retinol equivalents, RE) by country and sex. Figures 1, 2 and 3 show the variability in these recommendations in box plots.

The median recommended intake of vitamin A for males is 400 μg for ages 3 and 9 months, 450 μg for age 5, 600 μg for age 10, and 900 for age 15, 25, 50 and 70 years.

For females median recommendations are the same to those for males of 3 and 9 months, and of 5 and 10 years old. For the other ages the median recommendation for females is 750 μg (15 years) and 700 μg (>15 years), which is lower than for males, i.e. 900 μg for ages ≥15 years . Vitamin A recommendations from the EC, Ireland, Italy, and the United Kingdom are lower than the median for all ages for both males and females and recommendations from Belgium only for males. Recommendations higher than the median for all ages are found in the DACH-countries, and Romania for both males and females.

For males the largest absolute difference in vitamin A recommendations between countries amounts to 500 μg RE/day (range at 10 years: 500–1,000 μg; range at 15 years: 600–1,100 μg). The smallest range is observed at age 3 months, i.e. 150 μg (range: 350–500 μg). For females, the largest variation is found at the ages 25 and 50 years, with a range of 500–1,000 ug RE/day. The smallest difference is similar to that found for males. For pregnant females the median for vitamin A recommendations is 800 μg and for lactating females 1,125 μg. The individual European recommendations range from 700 to 1,100 μg and from 850 to1,500 μg for pregnant and lactating females, respectively.

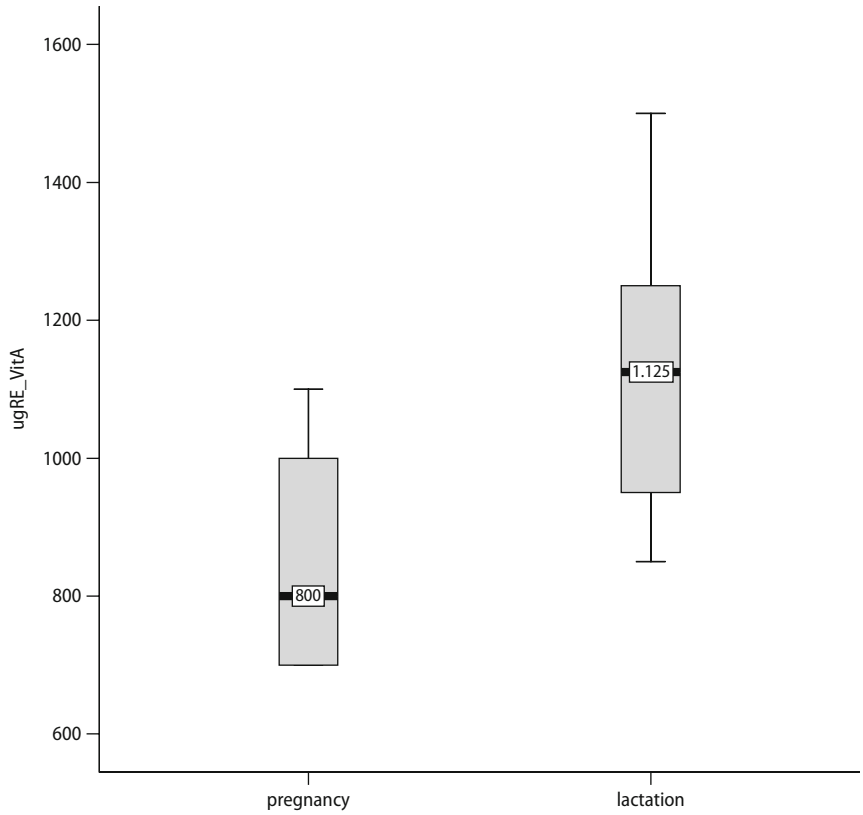

Fig. 3 Diversity of vitamin A recommendations for pregnant and lactating females in Europe expressed in μg retinol equivalents (RE) for pregnant and lactating women. *x*-axis; pregnancy, lactation. *y*-axis; μg RE vitamin A

When comparing methodological approaches for European vitamin A recommendations, all publications provide an RDA, except the Netherlands recommendations, which provide an AI (Table 2). The defined population groups in the different recommendations vary largely (Table 4). However, in each publication vitamin A recommendations are mostly the same from the age of 15 up to 70 years. Comparing publication dates, Spain and the DACH-countries that were published more recently provided high values, although the relatively high Netherlands recommendations were published in 1992 and the low WHO/FAO recommendations in 2004.

The criteria for adequacy or the health endpoints used for defining vitamin A recommendations, were not always reported in the questionnaire responses or background documents (data not shown). 'General health' and 'preventing deficiencies' were most frequently mentioned. In the Netherlands (high values) Belgium (values just below the median) and the DACH-countries (high values) 'an adequate reserve in the liver' was the main functional criteria of nutritional adequacy. Most vitamin A recommendations are based on data from observational cohort studies, or expert committees. Information on the type of evidence on which recommendations were based was, however, not always clear from the questionnaire responses and the type of evidence was unknown for some countries (Lithuania, Serbia, The former Yugoslav Republic of Macedonia) (data not shown). If, and what, assumptions were made when defining vitamin A recommendations was not clear from the information provided in the questionnaires response or from the reports.

Vitamin D

Table 7 and 8 and Figures 4, 5 and 6 present an overview of the available standardized recommendations on vitamin D. The median of recommended intake for males is 10 μg for age 3 and 9 months, 6.25 μg for age 5 years, 5 μg for age 10, 25 and 50 years and 7.5 μg for age 15 and 70 years. For females the medians of vitamin D recommendations are the same as for men, except for the median at age 70 years which is 10 μg for females and 7.5 μg for males.

No publication includes values that are below the median for all ages. In the Netherlands (except for men at age 70 years), the Russian Federation (>1 year) and the United Kingdom (≤64 years) vitamin D recommendations are below the median. The differences between countries are largest for infants in the age of 3 and 9 months, with values ranging from

Table 7 Overview of micronutrient recommendations on vitamin D (μg) for selected population groups in Europe*: males

Source			Population groups							
Ref no.	Year	Country	3 months	9 months	5 years	10 years	15 years	25 years	50 years	70 years
[4]	2005	Albania	5	5	5	5	5	10	10	
[16]	2006	Belgium	12.5	12.5	7.5	6.3	6.3	6.3	6.3	10
[27]	2005	Bulgaria	5	5	5	5	5	5	5	10
[13]	2004	DACH countries	10	10	5	5	5	5	5	5
[45]	2006	Estonia		10	7.5	7.5	7.5	7.5	7.5	10
[25]	2001	France	22.5	22.5	5	5	5	5	5	5
[1]	2005	Hungary	10	10	10	10	10	5	5	5
[43]	2006	Iceland		10	10	10	10	10	10	15
[12]	1999	Ireland	8.5	7	5	5	7.5	5	5	10
[18]	1996	Italy		17.5	5	5	7.5	5	5	10
[19]	2001	Latvia	10	10	10	10	10	5	5	5
[20]	1999	Lithuania	10	10	5	5	5	5	5	5
[22]	2000	Netherlands	5	5	2.5	2.5	2.5	2.5	2.5	7.5
[10]	2004	Nordic countries		10	7.5	7.5	7.5	7.5	7.5	10
[25]	1996	Poland	10	10	10	10	10			5
[27]	1990	Romania	10	10	10	10	7.5	5	5	5
[29]	1991	Russian Federation	10	10	2.5	2.5	2.5	2.5	2.5	2.5
[41]	1994	Serbia			10	10				
[19]	1997	Slovakia	7.5	10	7.5	7.5	10	7.5	5.8	5
[30]	2007	Spain	10	10	10	5	5	5	10	15
[28]	2001	The former YR Macedonia	7.5	10	10	10	10	5	5	5
[36]	1991	United Kingdom	8.5	7	0	0	0	0	0	10
[6]	1993	EC		17.5	5	5	7.5	5	5	10
[50]	2004	WHO/FAO	5	5	5	5	5	5	5	15

*DACH countries = Austria, Germany, Switzerland; Nordic countries = Denmark, Finland, Norway, Sweden; The former YR Macedonia = The former Yugoslav Republic of Macedonia;
EC European Commission, *WHO/FAO* World Health Organization/Food and Agricultural Organization
Croatia, Federation of Bosnia and Herzegovina and Republika of Srpska (entities of Bosnia and Herzegovina) and Montenegro are excluded from the table because no recommendation report was available for the author. The Czech Republic was excluded due to lack of published source

5 μg (Albania, Bulgaria, Netherlands and WHO/FAO) to 22.5 μg (France) and smallest for the ages of 5, 10, 15, 25 and 50 years with values ranging from 2.5 μg (the Russian Federation, the Netherlands) to 10 μg a day.

Similar recommendations for vitamin D are given for pregnant and lactating females, varying from 5 to 11.3 μg, with a median of 10 μg. The former Yugoslav Republic of Macedonia gives the highest recommendation and Albania, Bulgaria, the DACH countries, Romania, and the WHO/FAO (5 μg) the lowest.

Most countries provide an RDA for vitamin D, except for Belgium (acceptable range and AI), the EC (acceptable range), France (AI), and the Netherlands (AI). These AIs and acceptable ranges are not higher over all ages than the other recommendations. The lowest recommendations were published by the Russian Federation and the United Kingdom in 1991 but also by the Netherlands in 2000.

In general, criteria for adequacy on which recommendations are based are 'health' and 'prevention of deficiency as measured by the serum level of 25–hydroxy vitamin D3'. 'Appropriate bone formation' is mentioned as a criterion for adequacy in the questionnaire from Belgium, Italy, and the Netherlands (data not shown). Vitamin D recommendations appear to be based most often on expert's opinion or on values that are borrowed from another country. Several countries reported that some assumptions were made when setting up vitamin D recommendations: the Italian recommendations are based on the assumption that in the Italian environment sun exposure guarantees adequate physiological vitamin D production. They provide a range starting from 0 μg for people with an adequate sun exposure. The upper level of the range applies to people without sunlight exposure (10 or 25 μg depending on the age). Also the United Kingdom recommendations for adults are 0 μg a day, based on the assumption that sun exposure will provide the amount sufficient for an adequate vitamin D status during summer and allow for stores to be laid down to support vitamin D status in winter. The Netherlands recommendations define normal exposure to sunlight as daily 15 min with at least hands and face uncovered, whereas the Nordic countries assume that exposure of the face, arms,

Table 8 Overview of micronutrient recommendations on vitamin D (μg) for selected population groups in Europe: females

Source			Populations groups									
Ref no.	Year	Country	3 months	9 months	5 years	10 years	15 years	25 years	50 years	70 years	Pregnancy	Lactation
[4]	2005	Albania	5	5	5	5	5	10	10		5	5
[16]	2006	Belgium	12.5	12.5	7.5	6.3	6.3	6.3	6.3	10	10	10
[27]	2005	Bulgaria	5	5	5	5	5	5	5	10	5	5
[13]	2004	DACH countries	10	10	5	5	5	5	5	10	5	5
[45]	2006	Estonia		10	7.5	7	7.5	7.5	7.5	10	10	10
[25]	2001	France	22.5	22.5	5	5	5	5	5	5	10	10
[1]	2005	Hungary	10	10	10	10	10	5	6	6	10	10
[43]	2006	Iceland	10	10	10	10	10	10	10	15	10	10
[12]	1999	Ireland	8.5	7	5	5	7.5	5	5	10	10	10
[42]	1996	Italy		17.5	5	5	7.5	5	10	10	10	10
[22]	2001	Latvia	10	10	10	10	10	5	5	5	10	10
[24]	1999	Lithuania	10	10	5	5	5	5	5	5	10	10
[14]	2000	Netherlands	5	5	2.5	2.5	2.5	2.5	2.5	7.5	7.5	7.5
[34]	2004	Nordic countries		10	7.5	7.5	7.5	7.5	7.5	10	10	10
[53]	1996	Poland	10	10	10	10	10			5		
[18]	1990	Romania	10	10	10	10	7.5	5	5	5	5	5
[29]	1991	Russian Federation	10	10	2.5	2.5	2.5	2.5	2.5	2.5	10	10
[41]	1994	Serbia			10	10						
[19]	1997	Slovakia	7.5	10	7.5	7.5	10	7.5	5.8	5	10	10
[30]	2007	Spain	10	10	10	5	5	5	10	15	10	10
[28]	2001	The former YR Macedonia	7.5	10	10	10	10	5	5	5	11.3	11.3
[36]	1991	United Kingdom	8.5	7	0	0	0	0	0	0	10	10
[6]	1993	EC		17.5	5	5	7.5	5	5	10	10	10
[50]	2004	WHO/FAO	5	5	5	5	5	5	5	15	5	5

DACH countries = Austria, Germany, Switzerland; Nordic countries = Denmark, Finland, Norway, Sweden; The former YR Macedonia = The former Yugoslav Republic of Macedonia;
EC European Commission, *WHO/FAO* World Health Organization/Food and Agricultural Organization
Croatia, Federation of Bosnia and Herzegovina and Republika of Srpska (entities of Bosnia and Herzegovina) and Montenegro are excluded from the table because no recommendation report was available for the author. The Czech Republic was excluded due to lack of published source

hands, and legs to sunshine for 6–8 min, 2 to 3 times a week is more than adequate to satisfy the vitamin D requirements. However, they indicate that dietary vitamin D is essential to ensure satisfactory vitamin D at northern latitudes. In setting vitamin D recommendations for the Polish population sunlight exposure was considered to be too diverse between adults and therefore no recommendation for adults was set (data not shown).

Discussion

The results from this comparison of micronutrient recommendations show similarity in concepts and definitions used to establish recommendations on micronutrient intake in European countries, but also considerable diversity in defined population groups and levels of current recommendations was observed as illustrated by two vitamins. In exploring elements of the paradigm, differences between publications in criteria of adequacy, type of evidence used, and assumptions made, were recognized that could explain disparities in recommendations between countries.

Availability of current micronutrient recommendations

Many countries (13 out of 33) adopted recommendations from other publications, most frequently from the EC, WHO/FAO and IOM [6, 10, 50]. The EC report [6] was meant to provide practical advice and recommendations for a number of purposes including nutrition labelling and Community programmes on research and nutrition. The Scientific Committee for Food of the EC tried to harmonize existing national reports and also to include the most recent data. The WHO/FAO and the IOM publications both contain dietary reference values based on extensive scientific evidence evaluated by a large number of experts from all over the world or the United States/Canada respectively. They constituted an important source of information for all who work in the areas of nutrition, agriculture, food production and distribution, and health promotion [10, 50].

Due to the continuous changes in scientific knowledge, revisions of recommendations should be planned for every 5 to 10 years in order to keep them updated in the light of the most up-to-date scientific evidence [21, 52]. In view of this, the present overview

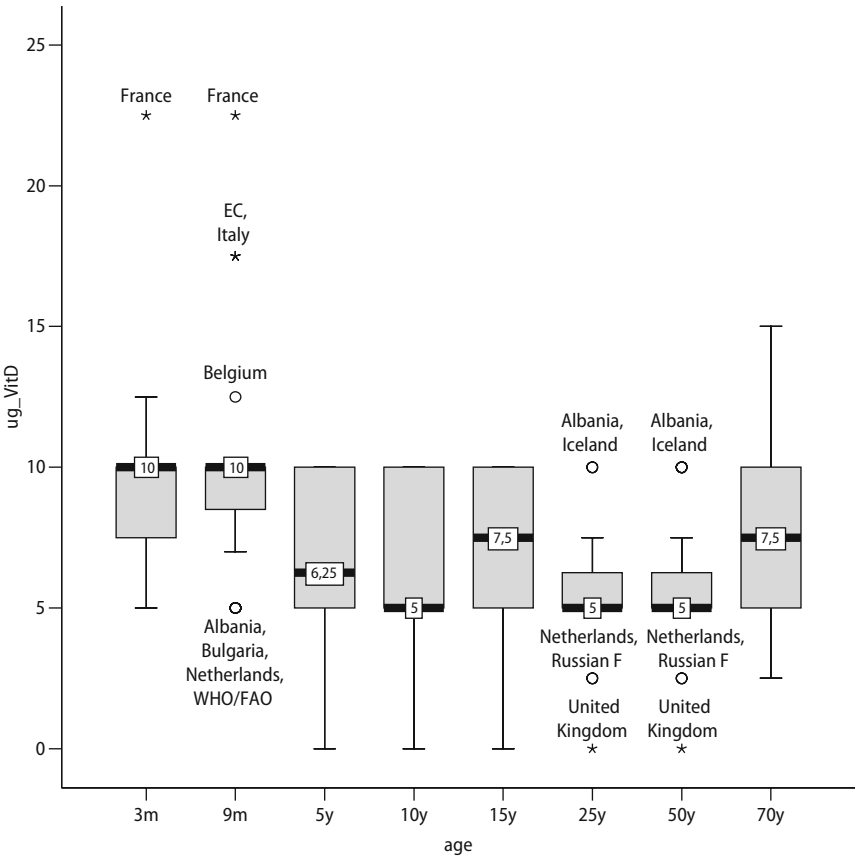

Fig. 4 Diversity in vitamin D recommendations for males in Europe expressed in μg for selected ages. *x*-axis age = 3, 9 months and 5, 10, 15, 25, 50 and 70 years. *y*-axis μg vitamin D. *The former YR Macedonia = The former Yugoslav Republic of Macedonia; DACH = Austria, Germany and Switzerland. The *boxes* indicate the interquartile range (IQR = x_{75}–x_{25}) in which the median (x_{50}) of all vitamin D recommendations is indicated by a *horizontal line*. *Vertical lines* connected to the *upper* and *lower side* of the *box* indicate values less than 1.5 IQR below the first quartile or above the third quartile. Values not included in this range are considered as an outlier and are indicated by *open dots* (more than three times IQR above x_{75} or below x_{25}) and *stars* (more than 1.5 times the IQR above x_{75} or below x_{25})

of recommendations is time bound, as some countries have already planned to revise their recommendations soon. Belgium, the Republika Srpska (entity in Bosnia and Herzegovina), the Czech Republic, Italy, Lithuania, Poland, Slovakia, the Netherlands and the United Kingdom will have some or all of their recommendations revised or set before 2010. The EC publication dates from 1993 and one of the tasks of the European Food Safety Authority (EFSA) is to update this advice from the Scientific Committee on Food on PRIs. The EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA) intends to start revising the micronutrients PRIs in 2008. EURRECA on the other hand works towards a general framework including harmonized approaches, methods and key terms to be used for the development of micronutrient recommendations. Therefore EURRECA will work in close collaboration with EFSA, to improve the process and scientific basis on which micronutrient recommendations for European populations can be developed.

Concepts and definitions

One of the factors that could explain differences between countries are the concepts and definitions which were used. However, all countries or regions included in this paper used recommendations that were based on an EAR with the recommended value usually defined as 2 SD above the average. In the comparison of vitamin A recommendations it appears that all publications provide an RDA, except for the Netherlands recommendations that provide an AI (Table 2). By definition an AI is higher than the RDA and therefore could explain the relatively higher values of the Netherlands recommendations. Most countries provide an RDA for vitamin D, but the recommendations of countries that provide an AI or an acceptable range for vitamin D were not higher over all ages than the others.

Population groups in the current available micronutrient recommendations

To estimate the nutrient requirement of a specific population, first one needs data on requirements of a population with similar characteristics [21]. The definitions of age groups, each considered as relatively homogenous with regard to nutrient requirement, differ between countries, especially during childhood, puberty and at older age. This may be due to differences in reasoning in defining population groups; however in most publications these arguments are not

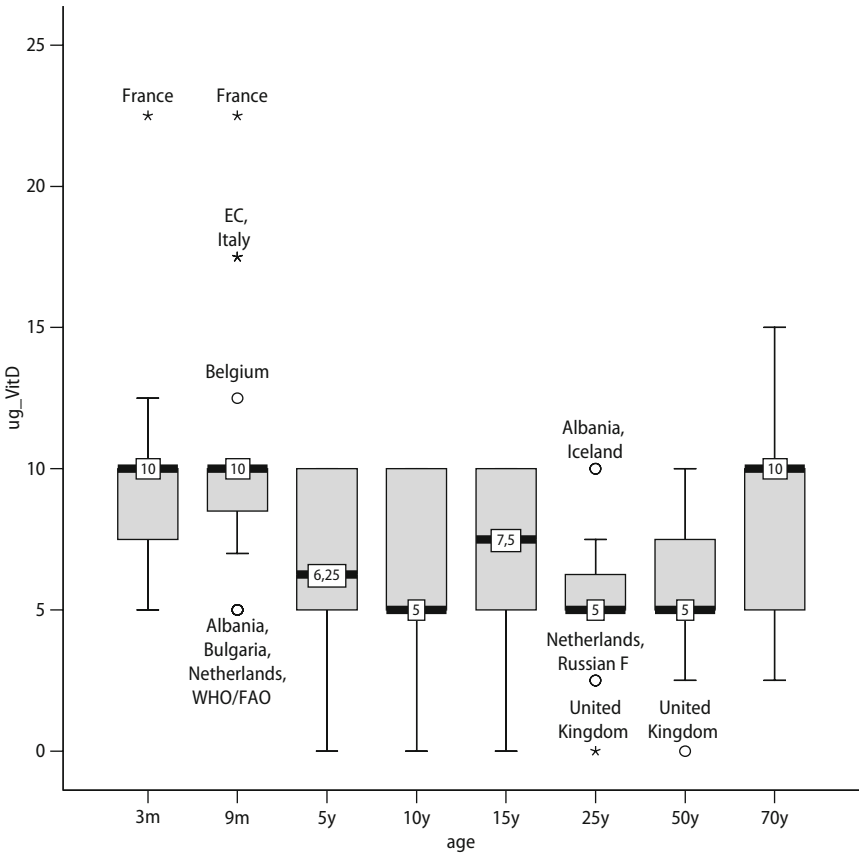

Fig. 5 Diversity in vitamin D recommendations for females in Europe expressed in μg for selected ages. *x*-axis age = 3, 9 months and 5, 10, 15, 25, 50 and 70 years. *y*-axis μg vitamin D

clearly described. An extreme example are the PRIs as published by the EC, that provide only one age group for adults (≥18 years) [6]. The report states that although elderly are prone to suffer from deficiencies due to a reduced food intake, inability to care for themselves or illness causing malnutrition, there is no evidence that micronutrient requirements of the elderly differ from those of middle-aged adults. Except for vitamin D the EC provide no different values for elderly. On the contrary, the Netherlands [14, 15], defined four age groups in adulthood, 19–21, 22–49, 50–64, and ≥65 years, using reference weights and heights from a representative sample of the population, and in doing so they follow the IOM [10]. These examples illustrate the differences in underpinning the definition of population groups.

In general, when data specific to physiological state are not available to estimate nutrient requirements, extrapolation from other growth states or a factorial approach, which estimates nutrient requirement based on the expected nutrient losses via e.g. urine, feces, and skin and accounting for differences in assumed bioavailability, are used instead [3, 52]. For some population groups, especially infants, children, adolescents, elderly, post-menopausal females, pregnant and lactating females, nutrient requirements are often extrapolated from the adult RDA. For the recommendations included in this overview it is not clear whether values are originally based on average requirements of the population group, or if they are based on requirements estimated by the factorial approach or extrapolation. Only for infants (0 to 1 years) it is often indicated that nutrient values are extrapolated from the composition of breast milk. Prentice et al. [38] showed that the wide differences in perceived nutrient requirements between countries might be partly attributed to real physiological and environmental differences, but were mostly due to the differences in judgements about the best methodological approach to use and in the way theoretical approaches were applied. Unless sufficient data on nutrient requirements will be available for all life-stage groups some time, extrapolation from one group to another is necessary. The scientific basis for the method chosen should be completely transparent and thoroughly described for each nutrient and life stage group [3]. Atkinson and Koletzko [3] recommend that for the harmonization of dietary reference values, standardisation of age groups should be biologically based (growth and pubertal stages) with consideration of relevant developmental milestones throughout childhood. This requires agreement and

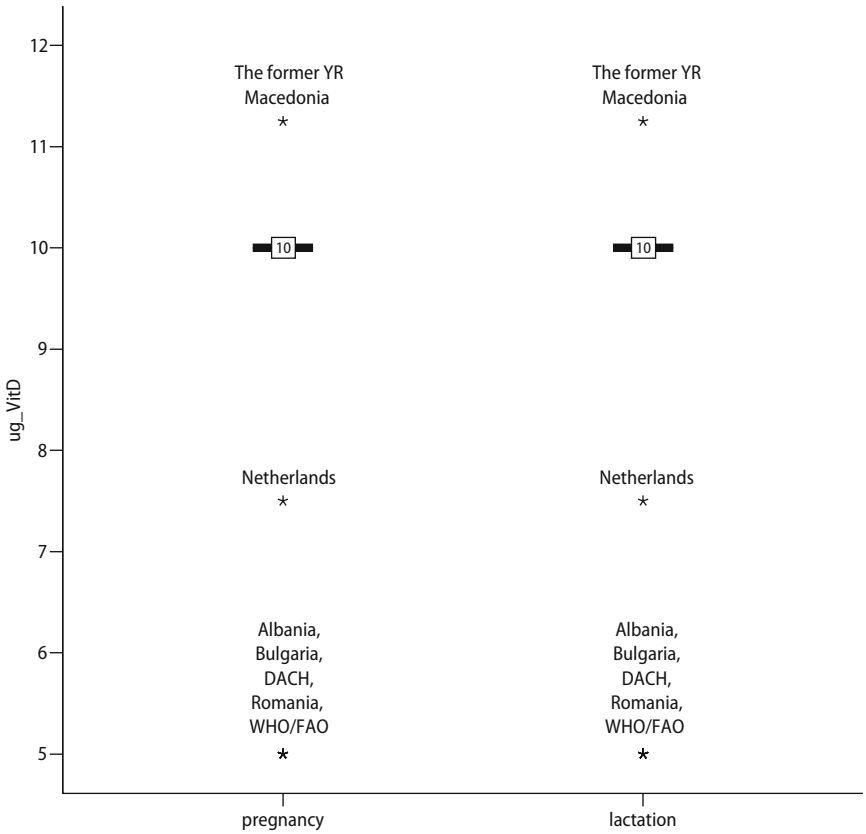

Fig. 6 Diversity in vitamin D recommendations for pregnant and lactating females in Europe expressed in μg for pregnant and lactating women. *x*-axis pregnancy, lactation. *y*-axis μg vitamin D

transparency on which data to use concerning growth standards, body sizes and composition, fetal and maternal accretion in pregnancy and milk composition, and on inclusion of appropriate adjustments (metabolic efficiency, weight change or physical activity).

In the comparison of vitamin A and vitamin D recommendations in this paper, values were mostly the same for the age of 15 up to 70 years within publications. Therefore it seems unlikely that differences in population groups are a key issue for disparities between publications. The definition of population groups might be an issue for other nutrients, but this needs to be studied further.

A few countries, Lithuania, Latvia, Poland, Romania and Slovakia, provide recommendations for different PAL. An explanation could be that these countries are all from eastern Europe where lifestyles might be less sedentary than in western Europe [47].

Criteria for adequacy, assumptions and type of evidence

As they may explain differences between recommendations, questions on the criteria/endpoint(s) used to determine adequate intake per nutrient were included in the questionnaire. This information was, unfortunately, often not included in the received reports. However, the answers were often formulated in a very general manner, for example 'health' or 'prevention of deficiencies'. This limited the comparison of criteria for adequacy. In all probability the question as included in the questionnaire was not clearly enough formulated, resulting in answers that were too less informative.

It is obvious that estimated requirements may vary with the endpoint or criteria for adequacy chosen. Nutrients have multiple sites of action in human metabolism and therefore it is possible to demonstrate abnormal function in one parameter measured or observed as a result of inadequate intake of a nutrient, while other parameters requiring the same nutrient intake appear adequate. For example a nutrient requirement based on the amount that prevents the clinical symptoms of a nutrient deficiency will be lower than one based on the amount that sustains nutrient stores or reserves [21]. Nutrient adequacy is a matter of definition, and may be a policy decision. Thus it is possible to have multiple requirements, each corresponding to a different indicator or criterion of adequacy. It is then up to nutrition and public health policy planners to determine which level of adequacy is desirable or

possibly attainable in the population group of interest [52].

Besides criteria for adequacy, the type of evidence used when establishing recommendations could explain differences between recommendations. In the questionnaire informants were asked to indicate the type of evidence that was used for each nutrient against a list with different possibilities (including RCT's, observational studies, mechanistic studies, experts' opinion, and borrowed from another country). Experts' opinion was the most frequently given answer, which unfortunately does not reveal on which types of evidence the experts have based their opinion, and how. Although some reports list all the experts that were included in the working groups, for the countries without clear background reports, this information was often missing.

The year of publication was used as a proxy for the age of the available scientific evidence. Even though publication years varied between 1990 and 2007, we cannot conclude that the year of publication was related to the level of the recommendation: For both vitamin A and vitamin D high intakes were recommended in both relatively old and recent publications, and the same was true for low values.

Opportunities: what can EURRECA do with this information on the status quo?

From the results of this comparison of micronutrient recommendations across Europe, it became clear that the concepts and definition used for setting them is quite similar throughout Europe. But even though many countries adopt and adapt recommendations from other publications, disparities remain. In our search for possible explanations for these disparities, we aimed at comparing different aspects of underlying approaches for setting up micronutrient values, but unfortunately there was a lack of transparency and completeness of the available information. An important opportunity for EURRECA is to develop tools to show how micronutrient recommendations can be devised for different population groups in a transparent manner. These tools should provide guidance on how to interpret data, how to take into account different criteria for adequacy and how to weigh different types of evidence in defining requirements. Expert committees throughout Europe can then use these tools to make decisions in a harmonized way and provide transparently based micronutrient recommendations.

In the EC call which led to the commissioning of EURRECA, vulnerable groups were identified as population groups that are prone to extremes of intake and those identified were: infants, children, adolescents, adults, pregnant and lactating females, post-menopausal females, elderly, immigrants and low income groups. Our overview shows that immigrants, low-income, post-menopausal females were never a specified target groups in any recommendation report. The only exception is iron recommendations for post menopausal females. Within EURRECA variation in micronutrient needs based on micronutrient status, functional status and especially health and physiological status will be identified and parameters (biomarkers) for vulnerability will be explored. Based on this information population groups to be considered vulnerable will be identified. Guidance can then be given on whether and in what way micronutrient recommendations should be extended to these groups.

Conclusion

This paper provides an overview of the availability of micronutrient recommendations in Europe and provides information on the origin, concepts and definitions used, and population groups defined used for the setting of current available micronutrient recommendations in Europe. A comparison of vitamin A and vitamin D values is included in order to explore possible explanations for disparities between publications. The large variation in current recommendations for population groups as illustrated for vitamin A and vitamin D strengthens the need for guidance on setting evidence based, up-to-date European recommendations. Differences in criteria for adequacy or health endpoints, studies used to set recommendations, experts' opinions and assumptions are all likely to contribute to the identified variation, but the background information we collated does not allow us to disentangle the relative contribution of these different aspects due to lack of transparency. EURRECA has an excellent opportunity to develop tools to improve transparency on the approaches used, including the selection of criteria for adequacy. Weighing of evidence, and interpretation of data to support those who develop quality assured, evidence-based harmonized micronutrient recommendations across Europe and elsewhere.

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Conflict of Interest none.

References

1. Antal M (2005) Tápanyagtáblázat (New Food Composition Tables). Rodler I, Medicina Könyvkiadó Rt. Medicina Publishing Comp., Budapest
2. Ashwell M, Lambert JP, Alles MS, Branca F, Bucchini L, Brzozowska A, de Groot LCPGM, Dhonukshe-Rutten RAM, Dwyer JT, Fairweather-Tait S, Koletzko B, Pavlovic M, Raats MM, Serra-Majem L, Smith R, van Ommen B, van 't Veer P, von Rosen J, Pijls LTJ (2008) How we will produce the evidence-based EURRECA toolkit to support nutrition and food policy. Eur J Nutr Vol 47(Suppl):2–16
3. Atkinson S, Koletzko B (2007) Determining life stage groups and extrapolating nutrient intake values (NIVs). Food Nutr Bull 28:S61–S76
4. Berisha A, Bader E. Deligia C, Claude Dop M (2005) Nutrition country profile Republic of Albania
5. Catovic S, Kendic S, Catovic A (2000) Higijena ishrane sa dijetetikom. Sarajevo
6. Commission of the European Communities (1993) Nutrient and energy intakes for the European Community. Reports of the Scientific Committee for Food. Thirty first series
7. Croatian National Official Gazzette 81 (2004)
8. Directorate of Health and Social Affairs (2005) Norwegian recommendations of nutrition and physical activity. Oslo
9. Food and Agriculture Organization of the United Nations, World Health Organization (2002) Human vitamin and mineral requirements. Report of a joint FAO/WHO expert consultation. Rome, Food and Agriculture Organization of the United Nations and Geneva, World Health Organization (http://www.fao.org/DOCREP/004/Y2809E/Y2809E00.HTM. Accessed 19 February 2008)
10. Food and Nutrition Board, Institute of Medicine, National Academies (1997, 1998, 2000, 2001, 2003) Dietary reference intakes (DRIs) Estimated average Requirements. (www.nap.edu)
11. Food, Nutrition Council (1992) Dutch dietary reference values 1989 (in Dutch: Nederlandse normen 1989), 2nd edn. Food and Nutrition Council, Den Hague
12. Food Safety Authority of Ireland (1999) Recommended Dietary Allowances for Ireland, Dublin
13. German Nutrition Society (DGE), Austrian Nutrition Society (OGE), Swiss Society for Nutrition Research (SGE), Swiss Nutrition Association (SVE) (2000) Referenzwerte fur die Nahrstoffzufuhr/Reference values for Nutrient Intake, 1st edition in German-Frankfurt/Main
14. Health Council of the Netherlands (2000) Dietary reference values: calcium, vitamin D, thiamin, riboflavin, niacin, pantothenic acid, and biotin. The Hague: Health Council of the Netherlands; publication no. 2000/12
15. Health Council of the Netherlands (2003) Dietary Reference Intakes: vitamin B6, folic acid, and vitamin B12. The Hague: Health Council of the Netherlands; publication no. 2003/04
16. Hoge Gezondheidsraad (2006) Voedingsaanbevelingen voor Belgie, herziening
17. ILSI SEAR region (2005) Recommended dietary allowances (RDA) Harmonization in South East Asia. Monograph series, Singapore
18. Institute of Public Health (1990). Recommended amounts. Romania
19. Kajaba I, Šimončič R, Ginter E, Ondrejka J, Trusková I, Kaláč J, Bzdúch V (1997) Odporúčané výživové dávky pre obyvatelstvo Slovenska (8. revízia OVD). Výž. Zdravie, 4, 2:25–29. Official Journal of Ministry of Health, 28, part 7–8
20. King JC, Garza C (2007) International harmonization of approaches for developing nutrient-based dietary standards. Food and Nutrition Bulletin, vol 28. The United Nations University, United Nations University Press, p 1
21. King JC, Vorster HH, Tome DG (2007) Nutrient intake values (NIVs): A recommended terminology and framework for the derivation of values. Food Nutr Bull 28:S16–S26
22. Latvian Food Center (2001) Leteicamās enerģijas un uzturvielu devas Latvijas iedzivotājiem/recommended intake of energy and nutrients for Latvians
23. Leitch I (1942) The evolution of dietary standards. Nutr Abstr Rev 11:509–521
24. Lithuanian Ministry of Health, National Nutrition Center (order No 510) (1999) Recommended dietary allowances for Lithuanian population (energy, protein, fat, carbohydrate, vitamins and minerals). Valstybės žinios/Official Gazette, 1999, No. 102–2936
25. Martin A (Guest Editor-in-Chief) (2001). Nutritional recommendations for the French population. Sciences des aliments. Int J Food Sci Tech 21(4):309–458
26. Ministry of Health (2004) Reference dietary values (DACH), Ljubljana
27. Ministry of Health (2005) Ordinance No23 from 19 July 2005 for physiological normative requirement (DRI) for nutrition of the population (State Gazete 63/02.08.2005)
28. Ministry of Health and Republic Institute of Health Protection (2001) Nutrient recommendations as addition to Guidelines for Healthy nutrition of the population in Republic of Macedonia
29. Ministry of Health of Soviet Union (1992) Recommended dietary allowances for nutrients and energy for several population groups, Voprosy Pitanija 1992, no 2, p 6–15
30. Moreiras O, Carbajal A, L Cabrera, Cuadrado C (2007) Tablas de composición de alimentos. Ediciones Pirámide (Grupo Anaya, SA). 11ª edición revisada y ampliada. (278pp) (ISBN: 978-84-2133-8). Book chapter: Ingestas recomendadas de energía y nutrientes para la población española, pp 227–230
31. National Nutrition Council of Finland (2005) Dietary guidelines of Finland—nutrition and physical activity in balance. Helsinki
32. National Research Council, National Academy of Sciences (1989) Recommended dietary allowances, 10th edn
33. Nederlandse voedingsnormen, 2001
34. Nordic Council of Ministers (2004) Nordic Nutrition Recommendations 2004: Integrating nutrition and physical activity, 4th edition
35. Otten JJ, Hellwig JP, Meyers LD (2006) Dietary reference intakes (DRI) The essential guide to nutrient requirements. Institute Of Medicine. The National Academy Press, Washington
36. Panel on DRVs of the Committee on Medical Aspects of Food Policy (COMA) (1991) Dietary reference values (DRVs) for food energy and nutrients for the UK, Report on Health and Social Subjects 41
37. Pavlovic M, Prentice A, Thorsdottir I, Wolfram G, Branca F (2007) Challenges in harmonizing energy and nutrient recommendations in Europe. Ann Nutr Metab 51:108–114
38. Prentice A, Branca F, Decsi T, Fleisher Michaelsen K, Fletcher RJ, Guesry P, Manz F, Vidailhet M, Pannemas D, Samartin S (2004) Energy and nutrient dietary reference values for children in Europe: methodological approaches and current nutritional recommendations. Br J Nutr 92:S83–S146

39. Public Health Institute of the Republic of Srpska (2005) Dietary qiudeline with reference values all micronutrients. Dragana Stojisavljević, MD, Dušanka Danojević, MD, Msc Janja Bojanić, MD, Ljubica Jandrić, MD; publication 2005/ No 1
40. Robertson A et al., eds (2004) Food and health in Europe: a new basis for action. Copenhagen, WHO Regional Office for Europe (http://www.euro.who.int/ InformationSources/Publications/Catalogue/20040130_8. Accessed 19 February 2008)
41. Službeni Glasnik Srbije (1994) Pravilnik o normativima društvene ishrane dece u ustanovama za decu. 50/94 (State Gazette RS (1994) Recommendations for collective nutrition of children 50/94)
42. Società Italiana di Nutrizione Umana (1996) Livelli di Assunzione Raccomandati di Energia e Nutrienti per la Popolazione Italiana (LARN) Revision
43. The Public Health Institute of Iceland (2006) Ráðleggingar um mataræði og næringarefni fyrir fullorðna og börn frá tveggja ára aldri. Reykjavík
44. The National Food Administration (2005) Swedish Nutrition Recommendations (SNR), website: http://www.slv.se/upload/dokument/mat/rad_rek/ SNR2005
45. Vaask, Sirje; Liebert, Tiiu; Maser, Mai; Pappel, Kaie; Pitsi, Tagli, Saava, Merileid; Sooba, Eve; Vihalemm, Tiiu, Villa, Inga (2006) Tervise Arengu Instituut. Eesti toitumis- ja toidusoovitused
46. Van Staveren WA (2004) Voeding, Levensloop en Loopbaan. Farewell speech, Wageningen University
47. Varo JJ, Martínez-González MA, de Irala-Estévez J, Kearney J, Gibney M, Alfredo Martínez J (2003) Distribution and determinants of sedentary lifestyles in the European Union. Int J Epi 32:138–146
48. World Health Organization (2003) Diet, nutrition and the prevention of chronic diseases. Report of a joint WHO/FAO Expert Consultation. Geneva, World Health Organization (WHO Technical Report Series, No. 916; http://whqlibdoc.who.int/trs/ WHO_TRS_916.pdf. Accessed 19 February 2008)
49. World Health Organization (2003) Integrated prevention of noncommunicable diseases. Global strategy on diet, physical activity and health: process of development and draft resolution. Report by the Secretariat. Geneva, World Health Organization, (http:// www.who.int/gb/ebwha/pdf_files/ EB113/eeb11344.pdf. Accessed 19 February 2008)
50. World Health Organization, Food and Agriculture Organization of the United Nations (2004) Vitamin and mineral requirements in human nutrition, Second edition. Geneva, World Health Organization and Rome, Food and Agriculture Organization of the United Nations (http://whqlibdoc.who.int/ publications/2004/9241546123.pdf. Accessed 19 February 2008)
51. World Health Organization Regional Office for Europe (2000) CINDI dietary guide. Copenhagen, World Health Organization Regional Office for Europe (http://www.euro.who.int/document/e70041.pdf. Accessed 19 February 2008)
52. Yates AA (2007) Using criteria to establish nutrient intake values (NIVs). Food Nutr Bull 28:S38–S50
53. Ziemlanski S, Bulhak-Jachymczyk B, Budzynska-Topolowska J, Panczenko-Kresowska B, Wartanowicz M (1996) Recommended dietary allowances for polish population (energy, protein, fat, vitamins and minerals)