

Introduction

Dietary assessment of micronutrient intakes: a European perspective

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The shifting focus from infectious to non-communicable diseases has changed what and how nutritional epidemiology evaluates in the relationships between foods, nutrients and the occurrence of disease. The classically applied vision based on individual nutrients, ‘research from the bottom up’, has now been complemented with new approaches, such as applying the analysis of food combinations (dietary patterns) to study exposure and outcome. Methods of estimating nutrient adequacy have also changed over time, starting from calculating the nutrient adequacy ratio to the use of the probabilistic approach. In the present work constituting Research Activity 1.1, conducted within the EUROpean micronutrient RECommendations Aligned Network of Excellence, we have set out to rationalise and harmonise the science of estimating micronutrient intake and nutritional adequacy in Europe. A review of food and nutrition initiatives previously conducted in Europe is presented to set the background and context for the present efforts towards developing a harmonised framework on the dietary assessment of micronutrient intakes.

Micronutrient intake: Dietary assessment: Europe: Nutrient adequacy: Harmonisation

Nutritional epidemiology encompasses the science of studying the nutritional status of populations as well as the science of analysing the relationships between foods, nutrients and the occurrence of disease. Although nutritional epidemiology is a relatively recent subject area, the identification of numerous nutrients by means of epidemiological methods dates back at least 200 years. Its initial focus is centred on the study of deficiency diseases. By the middle of the 18th century, Lind had already demonstrated that consuming fresh fruits and vegetables could lead to curing scurvy, which ended up being the compensation for a vitamin C deficiency. Similar results were observed for other deficiency syndromes such as beriberi, pellagra or Keshan’s disease during the 18th and 19th centuries, much earlier than the discovery of the actual vitamins involved.

However, nutritional epidemiology has modified its objectives over the last few decades. The primary interest of nutritional epidemiologists in recent years is the rigorous study of the most prevalent pathologies in western society, in particular cardiovascular diseases (CVD) and cancer as

well as other pathologies such as diabetes, osteoporosis, cataracts, neurological diseases or congenital malformations. In reference to diet, this has customarily been expressed in terms of chemical composition, for example, according to the amount of nutrients it contains. Moreover, diet can concurrently be described in terms of foods or food groups. In nutritional epidemiology, the classic approach consists of determining the exposure to essential nutrients that are mainly defined from a biochemical perspective. The effect of each type of macronutrient (carbohydrates, proteins or different types of fats) was the focus of most studies conducted in the sixties, seventies and even during the eighties. At the end of the eighties and beginning of the nineties, interests focused on the study of micronutrients with particular emphasis on vitamins and antioxidants. During the second half of the nineties, research evolved towards the analysis of a number of particular foods. However, the inter-relationships established between dietary exposures led to analysing diet in terms of dietary patterns, as subjects did not consume only one type of nutrient or food, but rather a

Abbreviation: HBS, Household Budget Survey.

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combination of them. As such, the classically applied vision is based on individual nutrients and groups them into complex structures. This analytical approach is known as 'research from the bottom up'. Nowadays, a complementary approach is recommended. Thus, when a dietary pattern is associated with a given outcome, an analysis can be conducted to identify which components of the pattern are responsible for the observed relationship. In this approach, the starting point is the complete dietary pattern and subsequent analysis consists of studying components that are progressively more specific and their association with a given outcome. This type of analysis is known as 'research from the top down'. For example, the consideration of the Mediterranean diet as a healthy pattern has led to separate analyses of its individual components, as seen in the case of olive oil, fruits, vegetables, cereals or moderate alcohol consumption in the form of wine.

On the other hand, for nutritional epidemiologists who are involved with nutrition policy, and thus responsible for the planning, implementing and evaluation of nutrition surveys and programmes, the focus of their interest is based on other objectives. Their primary concern centres on analysing the complex process of estimating the risk of inadequate nutrient intake, despite the fact that the intake recommendations produced are widely surpassed in developed countries, and generally speaking, constitute an issue of limited relevance in the light of the increasing prevalence of degenerative diseases observed in the majority of these countries. Methods of estimating nutrient adequacy have also changed over time. Originally, the population with intakes higher than the recommended level was used as the reference, and more recently, the use of the probabilistic approach and the requirement levels as a reference value have been recommended. Ultimately, the risk estimates of micronutrient inadequacies, unless used to support supplementation or fortification, need to be translated into dietary guidelines, which can also be defined by using dietary pattern questionnaires or diet indexes. However, the complexity and costs underlying the evaluation of micronutrient consumption often do not compensate for the scarce use of all the nutritional information being collected. Are food guides intended to support or aim for optimal nutritional adequacy or for an ideal binomial pattern between diet and health? Are we talking about the same purpose but using different languages or instruments?

In Research Activity 1.1 of the EUROpean micronutrient RECommendations Aligned (EURRECA) project, we have tried to rationalise and harmonise the science of estimating micronutrient intake and nutritional adequacy in Europe, without losing the sight of the need to associate this with the evaluation of dietary intake patterns within the context of nutritional epidemiology. The first task that was called for was to review antecedents of work already conducted in previous European projects. What immediately stood out was that more efforts had been employed towards evaluating questionnaires or tools rather than the ways that the food and nutritional information obtained had been utilised and analysed. The following summarises relevant antecedents in Europe with respect to food and nutrition studies.

European Community Concerted Action on Nutrition and Health⁽¹⁾ (EURONUT) constituted the first European project having a nutrition focus and it attempted to identify relevant dietary factors in epidemiological research based on

the use of 3 d estimated food records. The SENECA (Survey in Europe on Nutrition and the Elderly: a concerted action (1988–9))⁽¹⁾ study's baseline survey was carried out as part of the EURONUT project. This study aimed to evaluate the relationship between diet, nutritional status, health and performance as well as to identify mean values and distributions and the relative magnitudes of food and nutrient intakes in the elderly. Methods applied included a 3 d estimated food record and a FFQ (frequency checklist of foods, based on the meal pattern of each particular country).

The WHO Monica (Multinational MONitoring of trends and determinants in CVD)⁽²⁾ project ran from the 1980s to the 1990s, whose objective was to describe trends in dietary patterns in Europe and how they related to trends in CHD. Dietary instruments applied in the present study included 3 or 7 d dietary records (weighed records and use of household measurements).

The EPIC (European Prospective Investigation into Cancer and Nutrition (1992–ongoing))⁽³⁾ cohort study aims to investigate the relationships between diet, nutritional status, lifestyle and environmental factors and the incidence of cancer and other chronic diseases in ten participating countries. Three dietary methods were applied: a self-completed diet questionnaire; an interview-based diet questionnaire; a FFQ. Software (EPIC-SOFT) was later developed and translated into various languages for calibration studies using 24 hour recalls applied to a subsample of subjects in each participating centre.

The main objective of the DAFNE (Data Food Networking (1993–ongoing))⁽⁴⁾ project is to assemble and harmonise national household budget survey (HBS) datasets that have been compiled into an HBS food databank drawn from sixteen participating European countries. This involved developing the methodology for estimating the daily availability of selected nutrients using food data from the national HBS and compiling a protocol for collecting information on meals consumed outside the household. The applied method utilises data from the databank based on HBS: purchases; own products; gifts (total food expenditure, expenditure per food item and expenditure per meals out of home).

EURALIM (European Information Campaign on Diet and Nutrition)⁽⁵⁾ was carried out from 1996 to 1998 and sought to collate and recode CVD risk factor variables from different European studies in order to create a common database. From the resulting analysis of the available data, distributions of CVD risk factors from various European populations were compared and presented as a brochure for the general public. This information included European differences in risk factor prevalence and the most relevant international differences in relation to diet and nutrition, which was translated into several languages.

The EFCOSUM (European Food Consumption Survey method (1999–2001))⁽⁶⁾ project encompassed a total of twenty-three European participating countries whose aim was to define a method for monitoring food consumption in nationally representative samples of all age–sex categories in Europe in a comparable way so as to assess energy and macronutrient intake. A secondary objective was to indicate how to make the existing food consumption data comparable and available to the health monitoring system. The 24 hour recall method was selected as the best and most cost-effective method (e.g. applicable in large populations of different

ethnicities; relatively low respondent and interviewer burden; etc.). For determining the population distribution of usual intake, repeated 24-hour recalls were recommended so as to correct for within-subject variation. The EPIC-SOFT program, developed by the International Agency for Research on Cancer, was recommended as the first choice to collect food consumption data in future pan-European monitoring surveys.

The ENHRI (European Nutrition and Health Report (2002–2004))⁽⁷⁾ compiled available food and nutrient intake and health data from various sources. Objectives included the identification of major nutrition and health problems in participating countries and European union regions, and the identification of inadequacies of data collected in the participating countries, which would make comparability of collected data difficult. Assessment methods ranged from food balance sheets and HBS for food supply and availability trends, respectively; for energy and nutrient intake evaluation, the methods varied per country.

The purpose of the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence (2002–2006))⁽⁸⁾ project was to obtain reliable and comparable data in a representative sample of European adolescents. Issues covered ranged from food and nutrient intake, food choices and preferences, obesity prevalence, dyslipidaemia, insulin resistance, vitamin and minerals status, immunological markers for subclinical malnutrition, physical activity and fitness patterns, and variations of the nucleotide sequence in selected genes. The diet assessment method consisted of a self-administrated computer-assisted questionnaire based on a 24-hour recall.

HECTOR Healthy Eating Out (Habits, Determinants and Recommendations for Consumers and the European Catering Sector, 2006–2009)⁽⁹⁾ aims to enhance knowledge on eating out in Europe, to identify Europeans' dietary patterns when eating out, to determine how various lifestyle factors influence the eating out choices, to evaluate the practices of catering-related enterprises of varying sizes and their impact on their customers' dietary choices, to establish a methodological framework for monitoring food choices and to develop strategies and measures for promoting healthy eating out. A consortium was established drawing from the scientific community, consumer associations and twelve catering-related enterprises, including six small- to medium-sized enterprises. Data on out-of-home food expenditures, regularly collected through the national HBS, will be apparently used to develop a methodological framework with the aim of monitoring out-of-home food choices in Europe.

The EFCOVAL (European Food Consumption Validation (2006–ongoing))⁽¹⁰⁾ project is a continuation of work started from European Food Consumption Survey Method, whose objective is to further develop and validate a trans-European food consumption method to be used for the estimation of intake of foods, nutrients and potentially hazardous chemicals within the European population. The recommended method is the use of repeated, non-consecutive 24-hour periods ('24 h dietary recalls') applying rigorously standardised procedures, for reliable and comparable transnational data collection. Other aims are to adapt the EPIC-SOFT program to EFCOVAL goals, extend the application to younger population groups and to improve the methodology and statistical methods for translating short-term dietary intake information to usual intake estimates.

ILSI Europe recently held an expert group meeting on the micronutrient landscape of Europe⁽¹¹⁾. The ILSI Europe Addition of Nutrients to Food Task Force established an Expert Group on Patterns of Intake of Fortified Foods and Supplements to review data available in European union Member States on intakes of vitamins and minerals and to explore how a sound scientific basis for setting maximum amounts might be established. The Expert Group has collated, compared and critically reviewed intake databases in Denmark, Finland, Germany, Ireland, Italy, The Netherlands, Poland, Spain and the UK.

ENHR II (European Nutrition and Health Report II (2007–2009))⁽¹²⁾ is a continuation and expansion of the earlier project in 2004. The objective is to provide a comprehensive and up-to-date report on the nutrition and health situation in twenty-five European countries that focuses on diet, physical activity, tobacco use and alcohol consumption as well as to summarise food and nutrition policies at European/national level. Methods included the compilation of nutrition and health data collected from partners in printed and digital form according to harmonised criteria, and included the data from updated National or Regional diet and nutrition surveys.

The purpose of the IDAMES (Innovative Dietary Assessment Methods in Epidemiological Studies and Public Health) project⁽¹³⁾ is to elaborate guidelines that incorporate new and innovative instruments and methodologies to assess individual dietary intake, which includes alcohol, in adults participating in epidemiological studies and public health projects. The activity focusing on dietary methods in large-scale studies includes methods such as conducting a literature review and scoring the quality of relevant studies, secondary analysis of participating partners' data and an expert workshop to identify new methods that are feasible to implement. A pilot study applying the selected novel technologies will be carried out with the subsequent elaboration of best practice guidelines.

The EURRECA (EUropean micronutrient RECOmmendations Aligned (2007–2011))⁽¹⁴⁾ Network of Excellence is a sustainable initiative established to harmonise the way micronutrient recommendations are produced across Europe, with a specific focus on identifying and addressing those micronutrients of particular concern in vulnerable population groups. The development of evidence-based tools aims to improve the basis for the development of nutrient recommendations and food-based dietary guidelines across the European union. As part of this initiative, research activity on intake methods has sought to harmonise best practices for micronutrient intake adequacy assessment.

This supplement includes several systematic reviews and original papers dealing with how intake instruments affect nutrient intake adequacy assessment, controlling for misreporting, methods to assess nutrient intake adequacy, state of the art in Europe, the validity of diet patterns for micronutrient intake assessment, evaluating intake in special population groups and the use of novel technologies. The following institutions comprise the research teams that contributed to the work carried out in this activity: Nutrition Research Foundation (Spain); University of Las Palmas de Gran Canaria (Spain); National Institute of Public Health (Czech Republic); WHO Regional Office for Europe

(Denmark); Wageningen University (The Netherlands); University of Belgrade – Institute for Medical Research (Serbia); University of Oslo (Norway); the National and Kapodistrian University of Athens (Greece).

Without a doubt, this collective effort will contribute to harmonise the assessment of nutrient intakes across Europe as well as to minimise the use of inappropriate dietary instruments and estimation methods applied by diverse European researchers and policy makers. The future of nutrient intake assessment is amenable to new instruments and techniques, but needs an open discussion about the indicators to be used, for instance those that combine the assessment both of nutrient intake adequacy and of dietary patterns and food habits. It is also essential to subsequently apply the information obtained to the uses and possibilities of interventions within the context of nutrition policy.

References

1. de Groot LC, Verheijden MW, de Henauw S, *et al.* (2004) SENECA Investigators. Lifestyle, nutritional status, health, and mortality in elderly people across Europe: a review of the longitudinal results of the SENECA study. *J Gerontol A Biol Sci Med Sci* **59**, 1277–1284.
2. Krachler B, Eliasson MC, Johansson I, *et al.* (2005) Trends in food intakes in Swedish adults 1986–1999: findings from the Northern Sweden MONICA (Monitoring of Trends and Determinants in Cardiovascular Disease) Study. *Public Health Nutr* **8**, 628–635.
3. Ferrari P, Day NE, Boshuizen HC, *et al.* (2008) The evaluation of the diet/disease relation in the EPIC study: considerations for the calibration and the disease models. *Int J Epidemiol* **37**, 368–378.
4. Lagiou P & Trichopoulou A (2001) The DAFNE initiative: the methodology for assessing dietary patterns across Europe using household budget survey data. *Public Health Nutr* **4**, 1135–1141.
5. Morabia A, Beer-Borst S & Hercberg S (1998) Locally based surveys, unite! The EURALIM example. EURALIM Study Group. European Information Campaign on Diet and Nutrition. *Am J Public Health* **88**, 1153–1155.
6. Brussaard JH, Löwik MR, Steingrimsdóttir L, *et al.* (2002) A European food consumption survey method – conclusions and recommendations. *Eur J Clin Nutr* **56**, Suppl. 2, S89–S94.
7. Elmadfa I, Weichselbaum E, König J, *et al.* (2005) European nutrition and health report 2004. *Forum Nutr* **58**, 1–220.
8. Kersting M, Sichert-Hellert W, Vereecken CA, HELENA Study Group, *et al.* (2008) Food and nutrient intake, nutritional knowledge and diet-related attitudes in European adolescents. *Int J Obes* **32**, Suppl. 5, S35–S41.
9. HECTOR (2006–2009) *Healthy Eating Out – (Eating out: Habits Determinants, and Recommendations for Consumers and the European Catering Sector)*, <http://www.nut.uoa.gr/hector/> (accessed January 2009).
10. EFCHOVAL (2006–ongoing) *European Food Consumption Validation*, available at <http://www.efchoval.eu/> (accessed January 2009).
11. ILSI Europe. Workshop on the Micronutrient Landscape of Europe, 16–18 April 2008, Gubbio, Italy. ILSI Europe Report Series (in press).
12. EHNHR II: European Nutrition and Health Report II, available at <http://www.univie.ac.at/enhr/> (accessed January 2009).
13. IDAMES: Innovative Dietary Assessment Methods in Epidemiological Studies and Public Health, available at <http://nugo.dife.de/twiki41/bin/view/IDAMES/ProjectDescription> (accessed January 2009).
14. Ashwell M, Lambert JP, Alles MS, EURRECA Network, *et al.* (2008) How we will produce the evidence-based EURRECA toolkit to support nutrition and food policy. *Eur J Nutr* **47**, Suppl. 1, 2–16.