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Food composition issues – implications for the development of food-based dietary guidelines

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Abstract

Sound food composition databases that are both comprehensive and representative of available foods are an essential basic tool to develop Food Based Dietary Guidelines (FBDG). The main drawbacks of current food composition databases available in the European Union are: partial coverage of foods and nutrients, variability of analytical data, lack of accuracy in the description of food items, need for harmonisation of the expression of nutrients. An inappropriate use of these databases could lead to gross errors in the assessment of the nutrient intake levels, in the identification of the major sources of a nutrient, in the comparison of data between countries and in the analysis of time trends. Inadequacy of food composition data is, in part, responsible for the failure to understand some relationships between nutrient intakes and health or disease and for difficulties in establishing quantitative dietary guidelines in terms of nutrients. Recommendations are made for the compilation of future food composition databases and tools are proposed to enhance the quality of existing data. A careful study of the food composition databases is always necessary before nutrition recommendations are given and before trends in nutrient intakes are interpreted.

Keywords
Food
Composition
Food analysis
Databases
Harmonisation
Nutrient
Codification
Food based dietary guidelines

Introduction

Sound food composition databases that are both comprehensive and representative of available foods are essential basic tools to get reliable information on the relationship between nutrient intake and health, the relationships between nutrients and foods and thereby to develop Food Based Dietary Guidelines (FBDG). They represent a unique tool for assessing nutrient and energy intakes in the context of two-phases methodologies in which the collection of food intake data represent the first phase and the calculation of nutritional values the second one[1]. The absence of some data (missing values) represents one of the most important problems that must be tackled by those using food composition databases[2]. However, they are not the only aspect to be taken into account. The quality of both food consumption data and food composition data must be simultaneously considered. The quality of food consumption data is influenced by the dietary method used, the length of the study period, the number of individuals studied and the procedures for data checking, whereas the quality of food composition data is influenced by the control of variation in food composition, the accuracy of description of food items, the methods of analysis and the mode of expression of the data[3–5].

Most countries of the European Union have their own National Tables of Food Composition but the quality of these data is a critical point. A large amount of work has been done in this field since 1970's, due to International and European efforts[3,6]. The International Food Data Systems Project (INFOODS = International Network of Food Data Systems) carried out within the United Nations University's Food and Nutrition Program provided guidelines on the organisation and content of food composition tables and databases, methods for analysing foods and compiling tables, and procedures for the accurate international interchange of the data[7]. In Europe, the Eurofoods initiative was developed in the 1980's with the aim of co-ordinating the manner in which food composition tables were produced in the various European countries and of developing computerised nutritional databases. This initiative received further impetus with the establishment of the Eurofoods-Enfant Concerted Action Project within the framework of the FLAIR (Food-Linked Agro-Industrial Research) Programme of the Commission of the European Community. The work of Eurofoods-Enfant project on increasing the quality of food composition databases has continued since 1994 with the five year COST Action 99-project[8,9]. Guidelines for the production, management and use of food composition data were published in early 1990's[3]. Among other activities, one

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project was focused on collecting data related to nutrient losses and gains in the preparation of foods with a view to recommend factors for use in the calculation of the nutrient content of foods and recipes[10]. Several studies have compared values of nutrient intake obtained from the chemical analysis of composite diets with values computed by use of food composition tables or databases and showed gross bias in the intake assessment[11], in particular for minor constituents. The most recent analysis of the situation in this field has been performed within the frame of the European Prospective Investigation into Cancer and Nutrition (EPIC) through an in depth study of the compatibility of food composition tables available in nine European countries for all nutrients[12]. Problems related to food composition databases are under lively discussions and awareness in this field has increased.

The aim of this paper is to provide a short review of the different drawbacks of current food composition databases, their implications in terms of food and nutrition policy, particularly for the formulation of FBDG and describe some of the tools available to enhance the quality of data derived from food composition databases.

Missing values (partial or limited coverage of foods and nutrients)

A first drawback is that of partial or limited coverage of foods and nutrients. According to the EPIC study, the most important macronutrients and minerals are well covered in European food composition databases, but fractions of nutrients (such as fractions of carbohydrates) and vitamins are stated less extensively in some countries and in particular in Southern European tables[12]. Other nutrients are generally present but the data may be lacking for some foods or be available only for raw foods. However, tables of food composition never include all processed foods available on a national market. The true range of food items available for consumption is almost impossible to document due to the continuous introduction of new products and variation in recipes. The number of branded processed foods available in an industrialised country is of the order of 10 000 and the total number of foods consumed, if composite dishes are included, is probably of the order of 100 000 which renders this task virtually impossible.

Variability of analytical data

Differences of analytical data between tables are both actual (due to variability in the composition) and artifactual.

Foods, as biological materials, exhibit natural variations in the amounts of nutrients contained. Variability is higher for some nutrients, especially micronutrients[13] and this variability is increased by different methods of plant and animal husbandry, storage, transport and marketing. Processed foods also vary because of variation in the composition of ingredients and changes in formulation and production.

On the other hand, artifacts are mainly related to inadequacy of sampling, differences in analytical methods, lack of use of quality assurance programmes, differences in deriving protein values, carbohydrates (e.g. by difference/summation), in calculating energy values. There is a strong need for the harmonisation of methods. Problems also arise when tables of food composition include both data from recent analysis and from old ones. For example, differences in iron content between two types of meat reported in the same table can be due to the fact that quality of analysis was improved between one and the other.

Changes in methods of analysis is a major source of differences between old and new tables. Extreme caution is therefore necessary before deriving conclusions in relation to changes in the composition of foods.

Accuracy of description of food items

A crucial point for the comparability of food composition data between countries is that of the definition of foods. The usage of free language can lead to misunderstanding because the same food product could be named in different ways and, on the other side, different products could be indicated by the same name (e.g. fish names are a typical case). Furthermore, some features of the food could be neglected because they are considered obvious. For example, it is important to know whether 'apple' is peeled or not and what variety of apples are included into the food item, whether 'meat' is free of fat or not. This becomes very important in order to ensure a correct link between food composition data and food consumption data.

One way of overcoming problems posed by the use of free language is to assign a numerical code to each single food item; the code should summarise the main food characteristics in order to facilitate such a linkage. At present, an optimal unique food coding system is difficult to be identified and one of the reasons is the diverse detail in which food consumption data and food composition data are respectively collected and compiled[14]. In fact, two different approaches have been developed at international level: the food coding system named Eurocode2[15] and the food description thesaurus LanguaL[16,17]. The first one highlights the food products features of interest to people carrying out surveys and the second one provides all facets of the description of food products. Both of these tools could be helpful for those compiling and using food composition data if they are appropriately adapted and integrated.

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Need for harmonisation of the expression of nutrients

The fourth drawback of food composition databases is that of differences in the description of nutrients. The current terms fat, protein and carbohydrates in food tables still refer, in most instances, to chemically inconsistent, so called 'crude' fractions in foods, which do not behave uniformly in digestion and human nutrition and are unreliable for energy calculations. In the case of carbohydrates and fibre, from a nutritional point of view, there would be a need to distinguish between glucose, fructose, galactose, sucrose, lactose, maltose, oligosaccharides, available starch, resistant starch and dietary fibre. Very few tables reach this level of detail and these substances are aggregated according to varying criteria. For example, there is controversy in relation to the opportunity of including resistant starch in the fibre category: according to some authors, only plant cell-wall NSP should be included in the definition and measurement of dietary fibre[18]. The comparison of food composition tables of nine European countries performed within the EPIC study has shown profound incompatibilities between the values for dietary fibre in the different tables[12].

Furthermore, the way of presenting nutrients and energy data either in the printed or in the computerised format could confound users. Some examples for tables in printed format are: energy could be reported in kcal, kJ or MJ; carbohydrates (or fractions) could be expressed as monosaccharides or polysaccharides; sodium could be indicated in milligrams or grams. For the computerised format, the definition of tag names for indicating exactly the same nutrient, obtained by the same analytical method and expressed in the same unit is one element to enhance data compatibility[7].

Implications for the development of food based dietary guidelines

The above mentioned problems will obviously have an important impact on the data which describe the nutrient content of European diets.

If the missing data of a table of food composition are taken as 0, as is often done, the nutrient intake of a population group can be grossly underestimated. On the other hand, if a table of food composition only includes raw products, its use may lead to gross overestimates of intakes of some nutrients: a large number of foods are consumed cooked, with a reduced content of some vitamins.

Variability of the expression of nutrients makes it difficult to assess the relationship between nutrient intake and diseases and also to harmonise recommendations. Thus, varying relations to colorectal cancer were shown by Kaaks & Riboli[19], depending on the definition/method used to define dietary fibre, due to incompatibilities between the values of the different European countries. Difficulties deriving from differing modes of expression led WHO to express population goals for fibre in terms of both Non Starch Polysaccharides and as total dietary fibre[20].

When monitoring trends in nutrient intakes, some changes may be real changes others may be artefacts deriving from the food composition databases. Thus, part of the reduction of fat intake observed in the last decade in The Netherlands was artefactual due to improvement in the quality of food composition tables[21]. On the other hand, it is difficult to update tables of food composition in relation to changes of fat content or fat quality of foods: the fat content of meats changes over time because of measures taken in animal breeding, the quality of fats change rapidly in fat spreads because of changes of raw materials used in the production. This may cause a situation where a real change in the diet will not be seen because of old data in the food database.

The above analysis suggests that an inappropriate use of food composition tables available in European countries could lead to gross errors in the assessment of the nutrient intake levels, in the identification of the major sources of a nutrient, in the comparison of such data between countries and in the analysis of time trends. Inadequacy of food composition data could be in part responsible for the failure to understand relationships between nutrients and health or disease[22] so rendering difficult to plan adequate interventions.

Recommendations for the compilation of food composition databases

Since some of the information which is crucial for the correct use of a food composition database often lacks, some recommendations should be made for the compilation of future food composition databases.

Most food composition databases include compiled data. Knowledge of the origin of compiled data is essential in order to check for the analytical methods since old data could derive from incompatible analytical methods. Sources of data should be identified at the nutrient level: it is the only way to identify correctly the food being analysed and to verify the definition, analytical method and mode of expression originally used. It enables the user to trace whether nutrient values are derived from different samples, for a given food and/or from different methods which may not be compatible within a given table, for a given nutrient; and to correct them if possible and necessary. It also facilitates comparisons of data between countries. Furthermore, the comparison of food composition tables across countries and time could be improved by providing in the documentation the probability distribution of the

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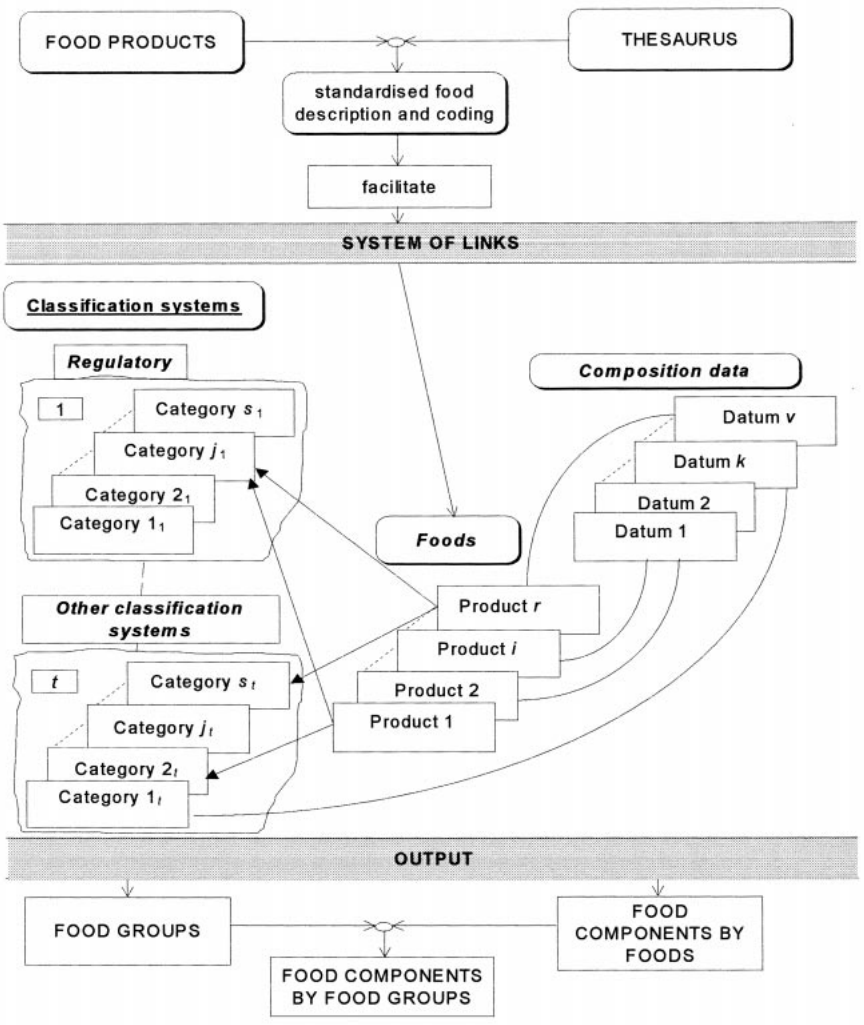

Fig. 1 Role of a thesaurus in facilitating the attribution of the right food composition data and the aggregation of foods into food groups

estimated values by applying statistical techniques like bootstrapping or Montecarlo.

The merging of food composition data and food consumption data could be made more user friendly by the clear description of food items by both the compilers of food composition databases and those involved in food consumption surveys[23]. For example it is better to report 'mixed short/long pasta, boiled in distilled water with salt for 20 minutes' rather than simply 'cooked pasta'). Both food composition tables compilers and users should become familiar with the description of food products. The codification by LanguaL system[17] of large databases containing such information could be helpful to retrieve data whenever it is necessary. The role of such databases could be synthesised as illustrated in Fig. 1 according to the needs of processing data from food consumption survey[17]. This figure shows two different aspects in which food description is particularly important. The first one is related to the necessity of aggregating food items in different ways as required by different classification systems. The second one refers more specifically to the issue discussed in the present paper: users need to merge the collected food items with the corresponding composition data. The availability of a food description databank containing both types of links could facilitate the implementation of this step of data processing in a standardised way.

It is also important to distinguish between missing data because the nutrient has not been analysed and missing data because the value is zero or traces. One possibility is to use unreal values like negative figures and to develop procedures of evaluation of the weight of missing data in the assessment of nutrients[2].

Water content of food should always be included: it is needed to identify and compare foods correctly and to estimate water loss during cooking. Also the conversion factor used to obtain the protein content from the total nitrogen (N) measured values should always be reported.

There is a strong need for composition data of processed products. Priorities must be assessed when

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branded processed foods are selected for inclusion in food composition tables to obtain a reasonable coverage of food consumption. A further recommendation could be to use information from databases generated by large-scale food consumption studies in which single food products intakes were collected (open-ended section) in order to identify new food products and/or preferred preparation methods. In this way resources for increasing the number of food items will be used in a more rational way.

Finally, the inclusion of some non-nutrient phytochemicals should be more generalized and thought should also be given for inclusion of data on bioavailability of nutrients in future food composition databases.

Methods for the enhancement of food composition data bases

Some tools have been developed to make the best possible use of current databases of food composition. Databases are being developed for population studies: they are derived from tables of food composition but missing data are substituted with data from composition tables of other countries or from similar foods. Such an activity is delicate because of the risk of introducing bias. However, sometimes it is the only way to reduce underestimation risk. In this regard, cautions must be adopted such as careful choice of the food items from which to take the information (also for this reason it is important to publish qualified data). If the source is found to be reliable, single food items must be observed for detecting real similarities in macronutrients and energy content so that fractions (e.g. fatty acids) or minerals can be calculated by taking into account the diversity in basic composition. This type of work has been performed in Italy by Salvini *et al.*[2] on the basis of the Italian food composition table[24]. An additional issue regards the 'unspecified' food items that could occur in nutritional surveys (e.g. bread, meat, fish, and so on). There are two ways of tackling this issue: 1) to construct similar items in the composition table (e.g. by calculating a weighed mean of different composition data related to the considered food group – weights chosen from food consumption data from other sources or just the same) 2) to chose the most frequently consumed food items (e.g. in Italy fish could be well-represented by 'codfish').

Other challenges for the food composition data are the effects of food preparation on the nutrient content of the foods. In the Nordic countries there is an attempt to tackle with the problem of vitamin losses and gains in a harmonised way. The work that is carried out as a part of the so called Norfoods2000 project, is based on the principles presented by Bergström[10], and focuses to the main factors behind nutrient losses and gains in the preparation of foods, namely the food matrix effects and the effect of the length of the heat treatment used.

When a table of food composition data is based on compiled data for which the mode of compilation is doubtful or on rather old data, the best choice might be to use more recent data from other countries in addition to the newly analysed foods, as suggested by the EPIC study group[12]. When a dietary survey is performed, the food items which are not present in the food composition database are assimilated to other items and a composition array is assigned.

The use of databases with standard recipes for composite foods is a useful complement since all branded processed foods will never be included in food composition tables.

Conclusion and future perspectives

A careful study of the food composition databases is necessary before nutrition recommendations are given and before trends in nutrient intakes are interpreted. There is still a notable amount of work to be performed in order to have food composition databases both compatible and of good quality at European level.

A set of questions should be answered in the future: Which other food components should be included in food composition tables? Which food sampling techniques provide the highest possible degree of representativeness? How changes in composition due to new analytical methods can be managed?

In the meantime, some tools are available to enhance the quality of existing data. Good documentation seems to be the best temporary solution in order to allow the usage of presently provided data. In the future, co-ordinated actions will be needed to face the problems which remain to be resolved.

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