The role of, and potentials in, nutrient calculation in the fields of nutrition sciences

Doctoral theses

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Introduction

The proportion of nutrition-related, non-infectious diseases, and in particular such chronic diseases as obesity, diabetes, cardiovascular diseases, hypertension, strokes, and certain cancers, shows an increasing trend worldwide. This fact has enormous social and economic significance. For the prevention and treatment of such diseases, it is of primary importance to be aware both of individuals' and resident groups' food consumption, consequential energy and nutrient intake, which are estimated by energy and nutrient calculation.

In a narrower sense, nutrient calculation is a 'translation' of foodstuff, raw materials, recipes and diets into nutrient components and energy content. In a broader sense, however, it is a complex model system that allows you to calculate, for instance, derived composition data and different losses, and to monitor the conversion of certain nutrients into each other, within the framework of practical use. Such work is inconceivable today without the existence of food composition tables created under scientific principles and recipe databases based on those tables. Also, the use of special software programs are required to resolve specialised professional tasks.

Nutrient calculation programs relying on food composition tables are used in the following fields of dietetics:-

- Dietary assessment by nutrition questionnaire surveys;

- Preparation of dietetic recommendations;
- Dietary nutrition planning and advising (patient education);
- Food safety and labelling;
- Mass catering and its auditing/control;
- Health education, nutritional intervention, information to, and raising awareness of, the population; and
- Product development in food industry.

Objective

While at national level the First Hungarian Representative Dietary Survey (1985-88) was analysed with the help of a special mainframe computer of the university, in the above fields there was no electronically recorded food composition table or a nutrient calculation program available to be run on personal computers, for years, including 1994 when I began my study that serves as the basis for this paper. While in the initial phases of my work I set such technical objectives as to create those tables and programs, the objectives have undergone continuous expansion and modifications over the last 18 years, to become so articulated as follows:-

- From technical and operational viewpoints: to select and test fit-for-purpose database management software items.

- Data collection to incorporate energy and nutrient contents of each of the key foods consumed in Hungary, and of the widest possible circle of the more rarely consumed or imported foodstuff.
- To create a composition table most compliant with international recommendations, recording the loss for cleaning or, more directly, the edible parts of foods.
- Collecting, based on the available literature, the recipes that cover Hungarian nutrition and cooking traditions in the widest possible circle.
- Developing an electronically recorded recipe database, keeping records of vitamin loss coefficient data in response to heat treatment subject to the cooking process.
- Integrating metabolic values expressing the energy demand of various forms of activities and movements and of sports, and the recommended domestic energy and nutrient intake, subject to age, gender and physical activity category, into the background database of the software.
- Creating a complex software program for energy and nutrient calculation and for dietary planning; developing opportunities to collate analysis results from various nutrition questionnaires, and the intake values recommended in the decree about mass catering.

- Ensuring compatibility with the more important food coding systems used in Europe, with code-by-code references.
- Elaborating an algorithm capable of automatically planning customised diets in conformity with pre-determined energy and nutrient targets and with other parameters, and producing a software application thereof.

Methodology

In my work I used spreadsheet and database management software programs running on DOS and, later, Windows operation systems in combination with SQL (structured query language).

The food composition data sources used

As data sources, I only used already existing and legally accessible data collections:

- Revised and extended eleventh edition of Hungarian Food Composition Table for domestic foodstuff.
- For imported foodstuff, the data published in English, German and Danish printed composition tables and, in parallel with the birth of internet, public sources from the overseas and from Europe: Finnish, Danish and English nutrient tables.

Recipe data sources

The recipe collection was compiled from domestic and international professional books on how to develop recipes for general purposes and for mass catering, including the calculation of the vitamin losses resulting from kitchen technology procedures.

Domestic *energy and nutrient requirement values, recommendations on food consumption*, as well as the requirements set forth in the *mass catering decree* in force were all incorporated into the database of the program.

In the course of individual dietary planning and assessment, a subject's *metabolic rate*, *energy demand* dependant on their physical activities, *body mass index* and *nutritional status* indicator are calculated.

Findings

Electronically recorded food and nutrient database

The most important (in total 90) macro- and micro-nutrients, which, to our current knowledge, are of the highest importance from the viewpoint of public health, and the values derived from them (e.g. volume of essential amino-acids, sodium/ potassium ratio) have been calculated in the food composition table. At the onset of my study, ca. 750 types of basic foodstuff was selected into the database, and the continuous data expansion

and maintenance efforts have increased their number to nearly 1200 by now. I used a dietetic classification suitable to group foodstuff and to filter their queries. Recording the loss for cleaning allowed the edible part to be calculated. The nutrient content of food was specified for an amount of 100 grams of cleaned, i.e. edible part of the food in line with international standards.

In a remarkable circle of foodstuff, I used the average values of repeated measurements to establish the mass equivalent records of common units of measure used in households (such as spoonful, slice, medium size), also taking into consideration the specific weights of liquids in the conversion between mass and volume, and integrated those records in the database of the software program.

In a subsequent stage of my study, I aligned, item by item, the domestic identification codes of the foodstuff in the database to the code set in the Codex Alimentarius, and also harmonised them with the European Food Safety Authority's FoodEX codes, making the database compatible with those systems.

Electronically recorded recipe collection

Based on recipes used in households and mass catering that properly cover domestic eating habits, I recorded nearly 3200 recipes in the beginning, and I have increased their number to

5600 over years. Recipes are stored together with recommended modes of preparation, calculated energy and nutrient content. In consideration of the extent to which kitchen technology intervenes in preparing a recipe, I elaborated a vitamin loss calculation algorithm based on data from literature, allowing vitamins to be calculated much more accurately in dietary planning and assessment. With the dietetic classification developed to this end, the recipe collection can be searched and filtered in various ways for multiple criteria, and can be further extended as required by the user.

Complex nutrient calculation and dietary planning program

Using the food composition table and the recipe collection, I have developed a nutrient calculation software program capable of performing multiple functions.

Performing group and mass catering duties

I have developed a software application which compares the daily intake values calculated on the basis of certain parameters of the fed group (gender, age, physical activity category) and of the raw material imposition, to the values in the tables of the attachment to the mass catering decree currently in force. The program module is suitable for planning sample diets.

Individual dietary planning and assessment

To support individual dietary planning, I developed a module that calculates the person’s metabolic rate from their age,

gender and somatic parameters, and in the knowledge of their physical activity profile it identifies their daily energy requirement. Physical activity can be described either in the form of simple categories or by specifying the periods spent on general and sports activities. The software module can process the data of the dietary log used in clinical practices. The energy and nutrient target values of planned/ controlled diets can be adjusted corresponding to the dieto-therapeutic requirements to which the program compares the current calculation results. Analyses can be displayed in the form of both tables and charts, and the comparison to food-based recommendations is assessed in the system called „healthy diet pyramid".

Processing of nutrition questionnaires

Out of the questionnaire-based methods used for dietary estimation in the framework of nutritional epidemiological studies in domestic and international practice, the *24h recall* and the standardised *three-day record* were integrated into the dietary planning module of the nutrient calculation software. The system can manage data records of thousands of people, and the calculated daily nutrient intake results can be exported in a format suitable for processing, even with weighing, to statistical program packages.

Under the umbrella of a separate computer application, *a semi-quantitative food frequency questionnaire* (or SQFFQ) was

developed. I compiled a food list of fix length, relying on general consumption habits known from previous studies on domestic eating habits and from macro-statistical data about households. Indicating the consumption frequencies and portion sizes of various consumption items as well as the supplementary questions about food qualities, the program performs the calculation of daily energy and nutrient intakes.

Developing an automatic dietary planning software program

Individual dietary planning that also meets individual needs is a time-consuming and tiring professional activity, and therefore the potential to plan diets meeting special dieto-therapeutic goals is rather limited. But exactly that fact justified my efforts to develop the nutrient calculation software which can meet predefined nutrient targets and other professional requirements by automatic dietary planning. The software program was named DietCAD (an acronym made up as a combination of the word ’diet’ and the term ’Computer Aided Design’).

In developing the software, I paid attention to the following important professional priorities:-

- potential to set the energy and nutrient goals of a diet,
- plannability of different diet types,
- balanced food structure,

- managing food groups or foods that can be excluded from a diet (e.g. in case of food allergy),
- taking into consideration seasonal food supplies,
- assignment of kitchen technologies that match a given diet type
- assignment of kitchen technologies,
- harmonic menu compilation,
- opportunity for automatic energy and nutrient optimisation.

Characteristics of the required diet and the planning process can be controlled by setting up a number of parameters, such as the diet type (e.g. general, slimming, lacto-ovo vegetarian), seasonality, or the price categories of the useable foodstuff. Not only can certain food groups be excluded (for instance for certain eating habits or food aversion) but in case of food allergy, for instance, specific foods (more than one at the same time) can also be banned from the planning process.

The program can optimise the nutrient values of a planned diet in line with preset targets by replacing foods and recipes by real alternatives fitting into a menu, and by modifying meal sizes (solely) to a rational extent. The diet resulting from the automatic planning process is an excellent basis which, following a professional revision and incidentally required modifications, will meet the preset nutritional goals and personal needs.

Conclusions, achievements

The primary motivation for my 18 years of work that my thesis relies on is my goal to make it possible for various areas of dietetics to use efficient nutrition-focused software programs, facilitating tasks that require special, energy and nutrient calculations. Following the goals I set in the various work phases, I achieved the following results:-

- At the onset of my work, I performed **data modelling** by using a large volume of generated test data in a database management software program equipped with proper parameters.
- Using the available domestic and international data sources, I collected, and recorded in the form of an electronic database, the **foods considered as of key importance** in domestic consumption, along with their **energy and nutrient contents.**
- In consideration of the most important international rules and recommendations on constructing nutritional databases, I created a **food composition database**. I used the special SQL programming language to implement such functions therein that allow for enquiries from, maintenance of, and modifications to, that database.
- To structure the food composition table, I elaborated a **food classification system**, and assigned **season-dependant loss**

for cleaning to each of the individually identified foods. It is an innovation that this procedure makes the recording of **edible parts of foods** manageable.

- Based on domestic and international literature and on dietetic professionals' experiences, I **collected and included in a database the recipes** which cover domestic eating and cooking habits in the widest possible circle. I supplemented the recipes with a standardised dietetic grouping and **recommendations on preparing the meals**. As an innovation, I implemented a **vitamin loss calculation** subject to vitamin types and to the **kitchen technology** used in preparing the recipes. The procedure significantly increases the reliability of the calculated vitamin intake values during dietary estimations.
- I created a **special dietary planning software program** based on the food composition table and on the data from the recipe collection. This nutrition-focused program can be used for:-
  - dietary planning and assessment for group and mass catering purposes,
  - calculating individual energy requirement and individual dietary planning,
  - recording data of, and evaluating, 'recall' and 'record' type nutritional questionnaires used in dietary estimations.

- Integration of **physical activity profiles** into the software and their application in **calculating individual energy requirements** are further innovations.
- I have developed an independent software application capable of processing and evaluating ***semi-quantitative food frequency*** **(SQFFQ) questionnaires**.
- Using the method of data collation, I made the elements of my food composition table **compatible with two coding systems** used and acknowledged in Europe.
- The **nutritional software capable of automatic dietary planning** that I have developed based on domestic food and recipe databases is a novelty even from an international perspective.

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