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Original Article

Nutrient content patterns of Finnish foods in a food composition database

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Abstract

Dietary pattern analysis has recently been used in nutritional epidemiology. However, there has been little research on nutrient co-occurrence patterns in foods although they are useful for understanding associations of nutrients in foods. In this study, nutrient content data of Finnish foods were submitted to factor analysis. From the food composition database Fineli®, 530 basic food items and 106 common nutrients were selected. Nutrient patterns were analysed in two data sets, *nutrient values* (/100 g) and *nutrient densities* (/1 MJ), with principal component solutions of factor analysis. Four patterns, explaining 36–39% of total variance in nutrient content, were identified for both solutions. The patterns in the *nutrient value* solution were characterised by: (1) fish, meat, dairy products, legumes, seeds, nuts; (2) vegetable fats; (3) staple foods; and (4) offal foods (liver, kidney). In the *nutrient density* solution, the patterns were characterised by: (1) vegetables and berries; (2) low fat fish, meat and dairy products; (3) mushrooms and offal foods (liver, kidney); and (4) vegetable fats. These patterns were consistent with prior knowledge of nutrient composition. The basic structures of nutrient content among foods seem to have held constant over recent decades. The study also attests to the benefit of increased consumption of vegetables, fruit and cereals.

Keywords: Pattern; Factor analysis; Food-based dietary guidelines; FBDG; Food composition database; FCDB

1. Introduction

Dietary reference intakes (DRIs) are recommended quantitative estimates for intake of different nutrients (Food and Nutrition Board, Institute of Medicine, 2000). Food-based dietary guidelines (FBDG) recommend and guide consumption of foods instead of intake of nutrients. FBDG strategies have been put forward (FAO/WHO, 1998) to help to apply DRIs. With FBDG the recommended nutrient intakes can be adapted to the cultural context of the consumers (Gibney, 1999). The FBDG approach is multi-nutrient, whereas DRIs are specified separately for each nutrient. The multi-nutrient approach aims to take nutrient associations into account. The entire nutrient content of foods is under consideration when FBDG are created and evaluated because when such guidelines are implemented, the intake of several nutrients changes simultaneously. Promoting consumption of one healthful food may result in the increased intake of many different nutrients, so several desirable changes in intake can be attained simultaneously. On the other hand, not all co-occurring changes in intake of nutrients or non-nutrients are always intentional and desirable. For example, when consumption of fish increases, intake of contaminants may also increase (Valsta, 1982; Hulshof et al., 2001).

Nutrients appear in foods commonly according to the biological origin of those foods. The tendency of nutrients to occur simultaneously was recognised well before FBDG were introduced: in many countries food grouping systems have been used in dietary guidelines and nutrition education for decades (Ahlström and Räsänen, 1973; Painter et al., 2002). Foods have been classified into basic groups mainly according to biological origin or some other criteria, with the implication that a balanced and adequate

Abbreviations: FBDG, food-based dietary guidelines; FCDB, food composition database

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diet is attainable if food items from each group are consumed daily.

Methods that allow for the simultaneous study of many variables, in this case food nutrients, can be useful tools to obtain background information for developing FBDG, because they lead to a better understanding of nutrient associations. Factor analysis (Mardia et al., 1979) is a statistical approach that permits analysis of the entire nutrient content of foods in one step. It is a multivariate modelling technique which lets researchers examine underlying patterns in a number of observed variables. It identifies the strongest, most prominent associations among the variables based on the correlation matrix. The value of using factor analysis may be exploration of the structure of associations in a set of variables, or it may be data reduction, i.e. a simpler description of the data involving fewer variables.

Dietary patterns analyses have recently been popular in nutritional epidemiology (Hu, 2002; Balder et al., 2003), on the assumption that dietary patterns give more insight into the relation between diet and diseases than analysis of single nutrients or foods. In contrast, patterns of nutrient content in individual foods—the building blocks of a diet—have only rarely been analysed. One example is a Finnish study from the 1980s in which nutrient content patterns were analysed (Valsta, 1982; Hulshof et al., 2001).

In addition to serving as a foundation for FBDG, nutrient content pattern analysis of foods is useful for meaningful grouping of foods in a food composition database (FCDB). When an FCDB is used in dietary or nutrient pattern analysis, good quality of the database is important, so that artifacts resulting from this source of data could be avoided.

In this study, we analysed the nutrient content patterns of Finnish foods included in the national FCDB of the early 2000s to obtain information about associations of nutrients among food items. Additionally, we explored whether the increase in food items in recent years and the development of the FCDB have had an effect on the nutrient content patterns of Finnish foods, by comparing our results with a similar type of analysis carried out about 20 years ago (Valsta, 1982; Hulshof et al., 2001).

2. Data and methods

2.1. Data

Selection of foods: A sub-sample of food items from the Finnish National FCDB, Fineli® (Ovaskainen et al., 1996; National Public Health Institute, 2001; Ovaskainen et al., 2001) was selected and a data sheet for nutrient values of these food items was constructed. Basic food items ($n = 530$) of Finnish food were selected from the total of 720 food items of FCDB Fineli®. The food items were included as ingredients, mainly in fresh, uncooked and edible form (e.g. fruits were chosen without skins and stones). Modified foods, foods for specific population groups, foods with only few recorded nutrient values in the database and foods with very abnormal nutrient content (e.g. salts and baking powder) were excluded. Because the number of food variables used as input in the factor analysis is likely to influence the resulting patterns, foods that differed only slightly from some other form of the same food were excluded. The selected foods in the major food groups of the FCDB Fineli® are presented in Table 1. The major food groups in Fineli® were constituted in adaptation of the grouping suggested by Greenfield and Southgate (1992).

Selection of nutrients: All common nutrients and some non-nutrients (e.g. phytosterols and heavy metals) with the best coverage of nutrient values in the database ($n = 106$) were included. (For simplicity, we use the term 'nutrient' throughout even though certain non-nutrients were included to the sample.) Nutrients were selected so that colinearity of nutrients was avoided: variables defined as weighted sums of others were excluded in favour of the components. For example, energy was excluded in favour of protein, fat, carbohydrate and alcohol, and a sum of plant sterols was excluded in favour of isomers of plant sterols. Only the most important fatty acids were included: consumption >100 mg/day calculated according to the Food Balance Sheet 1999 (Information Centre of the Ministry of Agriculture and Forestry, 2001) was used as a selection criterion. The essential amino acids were included in the analysis.

Matrix of nutrient values of the selected foods: The nutrient values in the FCDB are based on chemical analyses of each food item or estimated from other

Table 1
Description of types of nutrient values of the selected foods by major food groups[a]

Food group	Number of selected foods	Proportion (%) of nutrient values[b] by value type		
		Original, recorded values (domestic analyses[c])	Values derived from recorded values by recipes (%)	Missing values (%)
Cereals	61	59 (11)	26	15
Potatoes	7	73 (21)	10	17
Vegetables, mushrooms	90	65 (15)	23	12
Fruit and berries	69	62 (13)	24	14
Dietary fats	46	55 (12)	16	29
Dairy products	71	57 (13)	21	22
Meat (incl. liver, kidney)	76	67 (12)	12	21
Fish and eggs	42	56 (12)	12	32
Other (mainly beverages and sweets)	68	35 (8)	36	29
Total	530	59 (13)	20	21

[a]Major food groups in the Finnish FCDB Fineli®.
[b]The total number of selected nutrients was 106 nutrients/food.
[c]Includes also values calculated or imputed from related foods.