

Experimental approach to measuring functional food consumption for risk factor surveillance

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Abstract

Objective: To develop and integrate the assessment of functional foods (FuF; manufactured foods with altered composition carrying a health claim) consumption into an existing risk factor surveillance system.

Design: FuF market research followed by an experimental FuF intake study incorporated into an ongoing community-based survey. Concurrent completion of a self-administered semi-quantitative FFQ and a self-administered, qualitative FuF frequency questionnaire (FuFFQ) followed by a face-to-face control step using FuF photographs and combined food group-based data analyses.

Setting: 'Bus Santé' risk factor surveillance programme, Geneva/Switzerland.

Subjects: Population-based random sample of 639 residents (52% women, aged 35–74 years) surveyed from September 2003 to April 2004.

Results: Local Geneva/French neighbourhood market research identified 148 FuF in five major FuF food groups which were compiled into a functional ingredient database. Prior to the face-to-face verification, 210 (33%) individuals categorized themselves as FuF consumers, 429 (67%) as non-consumers. The control step revealed that 70% of the 639 participants were already familiar with the FuF concept, and thus were correctly self-categorized as FuF consumers or non-consumers. For the remaining 30% of participants the true FuF consumption status was established, resulting in a final number of 285 FuF consumers (45%; 12% net increase) and 354 (55%) non-consumers.

Conclusions: The developed self-administered, brief, qualitative food group-based FuF frequency check list in combination with an FFQ and a photo-assisted control step provides a flexible assessment tool for measuring FuF consumption in the context of a specific fluctuating FuF market and may be applicable to other population settings and times.

Keywords
Functional food
Dietary assessment methodology
Photographs

Functional food (FuF) is a complex, scientifically driven nutritional concept for which no simple, universally accepted definition exists⁽¹⁾. In Europe, the FuF concept includes foods and food components whose composition has been changed and that have been demonstrated to beneficially affect body functions beyond adequate nutritional effects, thus contributing to the promotion of health and well-being and/or the reduction of disease risk⁽²⁾. FuF does not represent a well-characterized food entity, but instead comprises foods of specific composition from a variety of food groups. The intake of FuF is therefore not necessarily captured and/or identified with currently used dietary assessment instruments, particularly those based on closed food lists such as an FFQ. Moreover, many national food composition tables

do not systematically list FuF and functional non-nutrient ingredients, such as phytosterols or pro- and prebiotics. Food safety researchers usually simulate prospective FuF component intakes on the basis of previously existing population food consumption data and hypothesized functional component concentrations in specific carrier products^(3–5). However, with a steadily growing FuF market^(6,7) it is becoming increasingly important to include an assessment of FuF consumption when monitoring diet and health. When queried about their consumption of FuF the general public may be uncertain about the kinds of products being investigated. Special assessment procedures are needed to identify FuF consumers and to estimate their FuF consumption.

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The present report shows how a multistage FuF assessment procedure using FuF photographs was successfully integrated in the 'Bus Santé' risk factor surveillance system (Geneva, Switzerland) without changing existing instruments nor greatly increasing the survey burden on participants.

Methods

The present experimental study (n 639: 332 women, 307 men) was conducted from September 2003 to April 2004 in the Swiss canton of Geneva as an integral part of the community-based Bus Santé surveillance programme. From 1993 to 2004, annual random, population-based, cross-sectional samples of the non-institutionalized residents of the canton of Geneva, ages 35–74 years, were monitored for the prevalence of cardiovascular risk factors. Data collection was based on three self-administered questionnaires on health, diet and physical activity that were checked for completeness during an individual appointment at a mobile epidemiological unit and combined with a series of anthropometric, clinical and biological measures, as described elsewhere⁽⁸⁾.

In a first step the project basis was established and the general assessment procedure was planned, including a project-specific FuF definition (Fig. 1). Although many conventional foods such as cereals, fruits and vegetables contain functional ingredients, corresponding to a general understanding of functional food in Europe^(1,2) the present study focused on foods for which the composition was altered in such a way that an additional health-promoting effect was claimed for the product by the manufacturer(s). In April 2003 target population food market research was conducted. The Swiss city and canton of Geneva is surrounded by France, and study participants may shop in Geneva and across the border in the nearby French communities. Hence, the two largest and much frequented supermarkets close to major border crossings, out of seven regionally represented French supermarkets, were included in the FuF market research. After screening all marketed food items corresponding to the project-specific FuF definition, the following information was systematically assessed and food photographs were taken: (i) manufacturer and brand/trademark; (ii) product name and description; (iii) package and portion sizes; (iv) price; (v) functional ingredient(s) per 100 g, with indication if derived from a naturally nutrient-rich food component (e.g. specific fatty acid-rich oils) or from fortification beyond the usual concentration (not considering re-vitamination) or from the addition of supplemental ingredients usually not present; and (vi) detailed specification of the type of nutrition or health claim⁽⁹⁾, including the claim text and any other health-related labelling. Subsequently the major FuF food groups were identified, a corresponding food

group-based FuF composition database for key functional ingredients was compiled, and a FuF photo library was established.

Because the existing validated, self-administered, semi-quantitative FFQ (ninety-one food items, 4-week reference period, seven frequency categories from never to at least twice a day)⁽¹⁰⁾ did not explicitly consider FuF and could not be modified during the survey, a supplemental, self-administered, qualitative FuF frequency questionnaire (FuFFQ) was developed. Assessing consumption of FuF from the identified main food groups, it employed exactly the same reference period and frequency categories employed in the Bus Santé FFQ (Table 1). A preparatory pilot test, conducted during May–June 2003 in a general Bus Santé survey sub-sample of thirty women and thirty men, had shown that 97% did not know what FuF was. We therefore used in the FuFFQ the single best-understood of several pilot-tested descriptions of the FuF concept as utilized by the lay press (Table 1). In a multi-stage approach, the potential impact of FuF consumption on nutritional balance was estimated by first applying the self-administered FFQ and FuFFQ concurrently, followed by a face-to-face verification step using FuF photographs (Fig. 2). This in-person control step was intended to identify true FuF consumers and non-consumers and to assess each participant's awareness of the FuF concept. For FuF consumers who had completed both questionnaires, combined food group-based individual data analyses of the FFQ and the FuFFQ were performed assuming the following: (i) when completing the FFQ for type, frequency and quantity of food consumption, participants did not distinguish between conventional foods and their functional food equivalents; (ii) when completing the FuFFQ, participants exclusively reported their FuF consumption; (iii) FuF consumers ate a selection of different foods within and across FuF food groups; and (iv) the corresponding intake of functional ingredients per food group was within the range of concentrations per 100 g of FuF as identified in the FuF market research described above.

McNemar's two-tailed test⁽¹¹⁾ of the null hypothesis of being familiar with the FuF concept and thus of the marginal homogeneity of being categorized as a FuF consumer or non-consumer before and after the face-to-face control step using FuF photographs was employed.

Results

Overall 148 FuF were identified, of which 62% (ninety-two) were found in the French and 38% (fifty-six) in the Geneva grocery stores and supermarkets. The market research confirmed that the identified FuF did not represent a specific food entity but were parts of the following five major food groups: cereal products (54%), milk and dairy products (21%), beverages (12%), fat

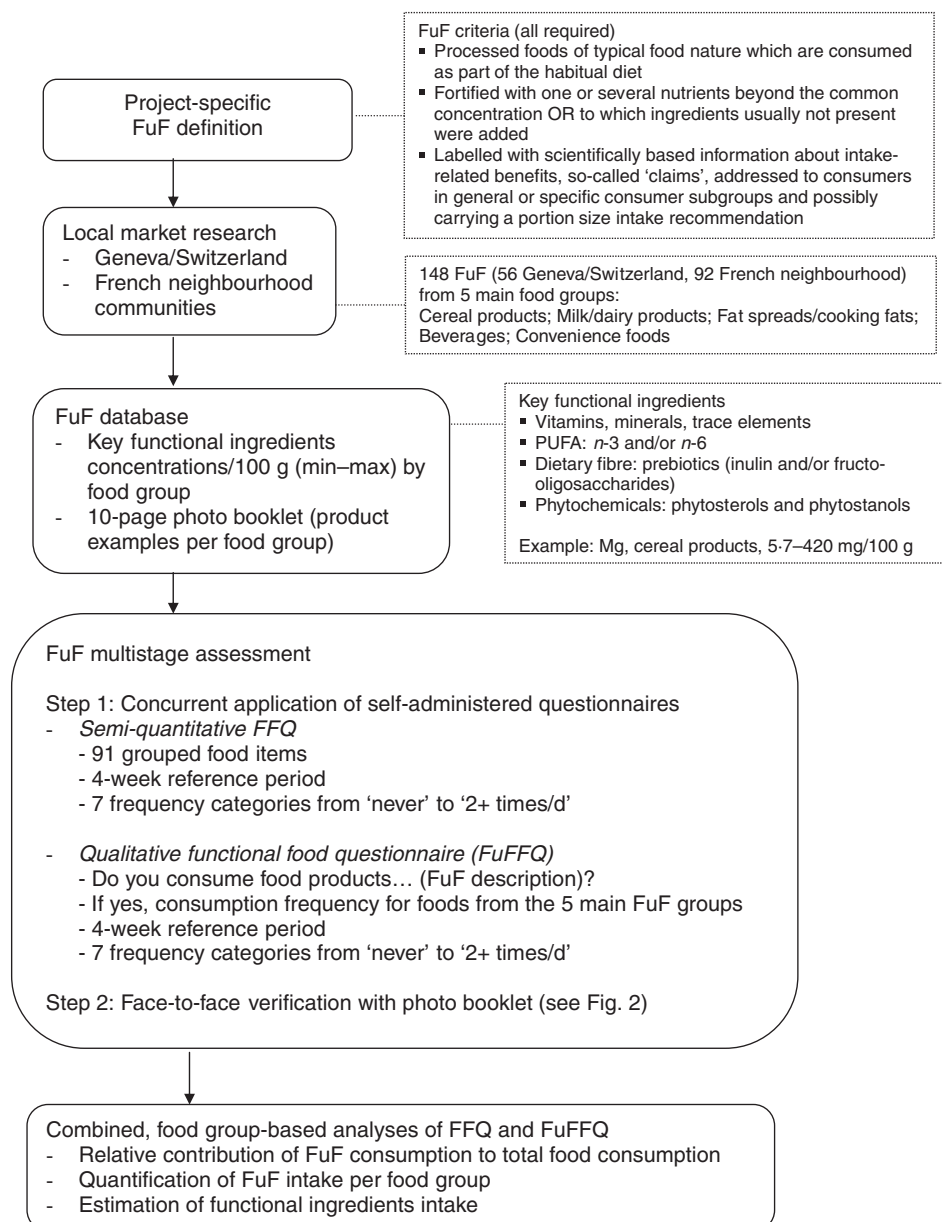


Fig. 1 Flow chart of the general project plan for the assessment of functional food (FuF) consumption at the population level, Bus Santé survey, Geneva, Switzerland, 2003–2004

spreads and cooking fats (9%) and convenience foods, such as soups, fruit preparations, etc. (4%). Consequently these five food groups were chosen as the actual FuF consumption assessment units.

The key functional ingredients provided by the 148 FuF were: vitamins A, C, E, D, B₁, B₂, B₆, B₁₂, niacin, pantothenic acid, biotin and folic acid; minerals Ca and Mg; trace elements Fe and Zn; *n*-3 and *n*-6 PUFA; prebiotics fructo-oligosaccharides and inulin (which are recognized as having dietary fibre properties); and phytochemicals, i.e. plant sterols and plant stanols. The compiled functional ingredient composition table listed the food group-specific range of the ingredient concentrations per 100 g⁽¹²⁾.

The use of the specifically prepared, food group-based FuF photo booklet in the face-to-face control step of the multistage assessment helped to successfully identify different consumer subgroups (Fig. 2 and Table 2). Prior to the face-to-face verification, 210 (32.9%) individuals categorized themselves as FuF consumers and 429 (67.1%) as FuF non-consumers. However, among these 639 study participants, the photo-assisted control procedure could identify two principal categories of individuals, comprising both FuF consumers and non-consumers: (i) 444 individuals (69.5%) who had actually been previously aware of the FuF concept and products as shown in the photo booklet, for whom the originally assessed FuFFQ data were used in the subsequent

Table 1 Functional food frequency questionnaire (FuFFQ) key elements*, Bus Santé survey, Geneva, Switzerland, 2003–2004

Question 1 using a FuF description	Do you eat or drink foods enriched with nutrients or other specific ingredients (e.g. vitamins, minerals, dietary fibres, probiotics), that are particularly suitable for the nutrition of women, the elderly, physically active people, individuals with elevated cholesterol levels, etc.?						
Answer	Yes or No → If YES, question 2						
Question 2	During the last four weeks, at what frequency have you consumed enriched foods from the following food groups?						
Answer	Frequency grid						
	Frequency						
Enriched foods	Never during the last 4 weeks	1 time per month	2 to 3 times per month	1 to 2 times per week	3 to 4 times per week	1 time per day	2 times or more per day
■ Cereal products	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>	7 <input type="checkbox"/>
■ Milk and dairy products	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>	7 <input type="checkbox"/>
■ Fat spreads and cooking fats	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>	7 <input type="checkbox"/>
■ Beverages	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>	7 <input type="checkbox"/>
■ Convenience foods (e.g. soups, fruit preparations, etc.)	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>	7 <input type="checkbox"/>

*English translation of the original French questionnaire (see www.epidemiology.ch)⁽¹¹⁾.

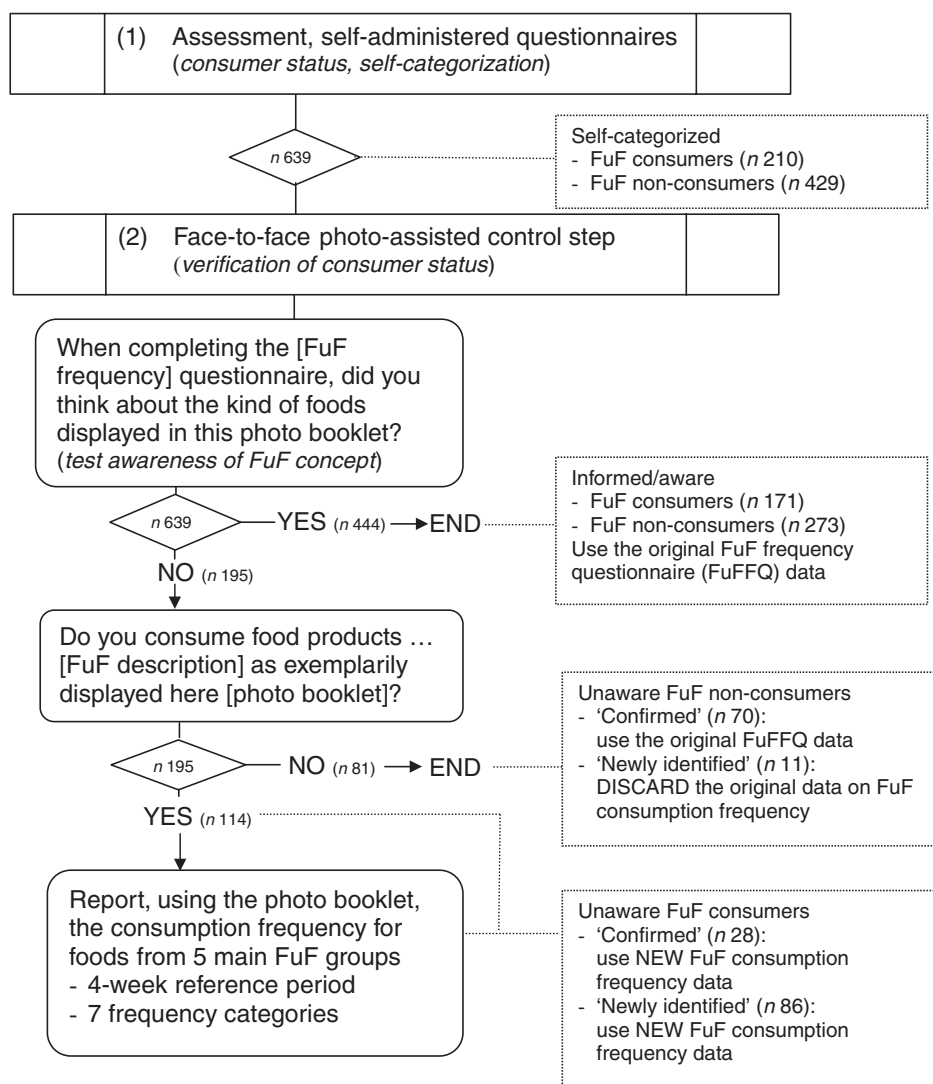
**Fig. 2** Flow chart of the multistage assessment of functional food (FuF) consumption. Self-administered assessment (1) and face-to-face control step (2) with FuF photo booklet, Bus Santé survey, Geneva, Switzerland, 2003–2004

Table 2 McNemar test of the null hypothesis (H_0) of marginal homogeneity* of being categorized as a functional food (FuF) consumer or non-consumer before and after the face-to-face control step using FuF photographs†: Bus Santé survey, Geneva, Switzerland, 2003–2004

FuF consumer status	After face-to-face control step				Total
	Consumer		Non-consumer		
Before face-to-face control step (self-categorization)	199 (31.1 %) ‡		11 (1.7 %)		210 (32.9 %)
Consumer	aware-informed 171 (26.8 %)	unaware but confirmed 28 (4.4 %)	–	unaware–newly identified 11 (1.7 %)	
Non-consumer	–	unaware–newly identified 86 (13.5 %)	aware-informed 273 (42.7 %)	unaware but confirmed 70 (11.0 %)	429 (67.1 %)
Total	–	285 (44.6 %)	–	354 (55.4 %)	639 (100 %)
					McNemar test (two-tailed) $P_{\S} = 1.4 \times 10^{-15}$

* H_0 : % of participants who reported being FuF non-consumers before the control step but who were identified as actually having been FuF consumers after the control step = % of participants who reported being FuF consumers before the control step but who were identified as actually having been FuF non-consumers after the control step.
 †See Fig. 2 for consumer and non-consumer subcategories.
 ‡ n (% of 639).
 §Calculation based on the table entries in bold.

analyses; and (ii) 195 individuals (30.5 %) who had been unaware of the FuF concept and products at the time of the survey. For the latter unaware individuals the control step further permitted assessing via the photo booklet whether they were really FuF consumers (n 114) or not (n 81), as well as distinguishing between the two further subgroups of individuals who were: (i) ‘unaware but confirmed’ and (ii) ‘unaware newly identified’ consumers and non-consumers, respectively. The FuFFQ was completed again by the unaware FuF consumers.

Thus, after verification, a final 285 FuF consumers (117 men, 168 women) (44.6 %) and 354 FuF non-consumers (190 men, 164 women) (55.4 %) were identified. Overall, eighty-six (13.5 %) of the participants actually were categorized as FuF consumers after seeing the photo booklet despite having first reported being FuF non-consumers, compared with eleven (1.7 %) of the participants actually categorized as FuF non-consumers after seeing the photo booklet despite having first reported being FuF consumers (McNemar $P = 1.4 \times 10^{-15}$, Table 2). Another twenty-eight (4.4 %) and seventy (11.0 %) of the participants were confirmed as being ‘unaware consumers’ and ‘unaware non-consumers’, respectively, since they had reported being FuF consumers or non-consumers prior to verification without being familiar with the FuF concept.

Discussion

Assessing FuF intake in Switzerland is challenging because it shares borders with several European countries, i.e. France (as is the case for the Geneva study centre), Italy, Germany, and Austria. Certain consumers shop across borders and benefit from a different and, as was shown here, a larger than the local or national FuF market. Furthermore, different food legislation in Switzerland⁽¹³⁾ compared with the EU⁽¹⁴⁾ concerning FuF and/or the specific national enforcement and authorization related to fortification/addition practices render functional ingredient intake assessment and evaluation even more difficult. One of the largest challenges for food authorities and nutrition researchers will be to continuously survey the local/national and adjacent international FuF markets in order to update existing (international) food composition tables/functional ingredients databases, thus permitting more realistic intake analyses. In the face of diverse, fluctuating and/or growing FuF markets characterized by different food formulations and new product developments, flexible FuF intake assessment tools are required.

In the present study FuF was defined from a practical point of view. The project-specific definition (see Fig. 1, top right), which relied on the main principles of the FUFOSE (Functional Food Science in Europe) Consensus Document working definition⁽²⁾ and included as an

additional identification mark a labelling/communication aspect (claim, consumption recommendation), provided a useful tool for the local market research.

The developed FuF food group-based, self-administered, brief qualitative frequency check list provided the needed flexibility with regard to the FuF market and is thus a tool that may be applicable across different population settings and times. The food group approach is in line with other reports which highlighted that FuF are not perceived as an independent food group but as parts of food groups or product categories such as cereal products or snack bars^(15,16). Also, the perception of a FuF health benefit tends to be related to the nutritional quality or healthy image of the base product as such, e.g. a dairy product, rather than with any health claim or functional ingredients content⁽¹⁷⁾.

The application of the FuFFQ, which supplemented the existing FFQ, involved a small additional time investment for the participants. Although the photo-assisted face-to-face control step also required additional specific training of the survey staff, the extra burdens on staff and participants were acceptable because the multistage assessment procedure could be integrated and covered within the regular appointment time.

Nevertheless, the present FuF intake assessment showed that even when using a straightforward description of FuF (see Table 1) instead of the poorly understood, scientifically driven term 'functional food', the study participants still had diverse perceptions about the specific types of foods being investigated. The identification of individuals who were unaware about their actual FuF consumption or non-consumption – almost a third of the present study sample – had an important impact on the evaluation of this population's nutrient/functional ingredient intakes. The same issue may arise for researchers who do not share the same perception/definition of FuF but would like to compare FuF intake data across studies in different populations.

In summary, individuals responding to a FuF questionnaire must not only be presented with a definition or description of the types of foods being investigated, but also need visual aids to help them identify FuF. In the current study, presenting food photographs in a specific face-to-face control step enabled us to identify an additional eighty-six FuF consumers and eleven non-consumers who would have been misclassified otherwise. Thus, the overall observed net increase in the number of FuF consumers was seventy-five or 12%.

Conclusion

In assessment of FuF, the use of product photographs, or alternatives such as product packages, should become standard for maximizing the identification of true FuF consumers.

The methodological approach of asking about FuF consumption frequency by food groups appears to be applicable across different population settings and times, and thus offers the flexibility to respond to changes in the FuF market. The combination of the brief FuF food group-based, qualitative frequency questionnaire with an existing (semi-)quantitative dietary assessment instrument such as an FFQ allows for further quantification of ingredient intakes, and thus for monitoring and evaluating any potential protective or harmful impacts related to regular FuF consumption. A remaining key issue, an important area requiring cooperation with food manufacturers, will be to conduct ongoing FuF market surveys to continuously update existing food composition tables.

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