RESEARCH COMMUNICATION

Development of a Data-based Short Food Frequency Questionnaire for Assessing Nutrient Intake by Middle-aged Japanese

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Abstract

Objective: Development of a data-based short food frequency questionnaire (FFQ) for evaluating intake of nutrients by middle-aged Japanese. Methods: Of 102 foods listed in the formerly developed semi-quantitative FFQ, foods having similar nutrient contents were combined into 72 foods/food groups by research dietitians. Nutrient contents were computed by multiplying the weight of foods consumed and its nutrient contents. Next, a cumulative multiple regression coefficient up to 0.85 was applied, and 47 foods/food groups were chosen for a brief FFQ for assessing intake of 21 nutrients including energy, protein, fat, carbohydrate, vitamins, minerals, and dietary fibers. Results: The 47 foods/food groups comprised rice, bread and noodles (3), margarine/butter (2), eggs (1), milk and dairy products (2), soybean and soybean products (3), miso-soup (1), meat including beef, pork and chicken (4), fish (3), other fish, shellfish and fish products (4), green-yellow vegetables (5), other vegetables and mushrooms (3), edible roots (4), seaweeds (1), mayonnaise (1), fried dishes (2), seeds (1), fruit (2), beverages, including alcohol (3), and confectioneries (2). Conclusions: The evidence-based short FFQ efficiently covered the intake of 21 nutrients, and may be competent to rank the middle-aged general public Japanese according to intake of nutrients.

Key Words: food frequency questionnaire - food intake - nutrient intake - multiple regression - weighed diet record

Asian Pacific J Cancer Prev, **5**, 40-43

Introduction

In order to assess population/individual intake of foods and nutrients, several methods are available, including the diet record (DR) /weighed diet record (WDR), 24 hour recall, and duplicate method, as well as biomarker approaches, taking advantage of blood and urine parameters (Margetts and Nelson, 1990; Thompson and Byers, 1994; Willett, 1998). There are strengths and weaknesses for each procedure. Selection criteria may depend on the nature of the protocol, including the aim, time frame, dietary elements and subjects studied. For example, 24 hour recall or DR/WDR may be chosen for evaluating *population* values. For collecting information on *individual* habitual intake of foods/food groups for cohort and case-control studies, the food frequency questionnaire (FFQ)/semi-quantitative food frequency questionnaire (SQFFQ) is more often employed.

Recently, using multiple regression analysis (MRA) (Byers et al., 1985; Hankin et al., 1968; Overvad et al., 1991) as well as contribution analysis (CA) (Block et al., 1985; Freudenheim et al., 1993), we designed an evidence-based SQFFQ on the basis of WDRs from 351 participants (Tokudome et al., 1998). Calibration/validation and reproducibility studies in terms of the food list, intake frequency, and portion size were executed, as detailed elsewhere (Imaeda et al., 2002; Tokudome et al., 2001); however, the SQFFQ was primarily designed for the JADE (Japanese Dietitians' Epidemiologic) Study. For epidemiologic studies of the general middle-aged populace, we here evolved a self-administered brief FFQ by MRA.

Subjects and Methods

Subjects and Selection of Foods/Food Groups

The subjects and methods for developing the SQFFQ were described elsewhere (Tokudome et al., 1998). In brief, nutrient intake by food was computed by multiplying the food intake (in grams) and the nutrient content (per gram)

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of food as listed in the Standard Tables of Food Composition, Version 4 and the Follow-up of the Standard Tables of Food Composition, Version 4 (Resources Council, 1982; ibid, 1992). In all, 102 foods/food groups were listed in the SQFFQ. Those foods/food groups having similar nutrient contents were combined into 72 foods/food groups by research nutritionists (Figure 1). Next, forward MRA was performed with total intake of specific nutrients as the dependent variables and overall amounts of nutrients from 72 foods/food groups as the independent variables from 351 individuals (Byers et al., 1985; Hankin et al., 1968; Overvad et al., 1991). Foods/food groups with a cumulative multiple regression coefficient/cumulative R^2 up to 0.85 were chosen (SAS, 1999).

Nutrients Selected

The following 21 nutrients were selected: energy, protein, fat, carbohydrate, vitamins (including carotene, and vitamins A, C, D and E), minerals (calcium and iron) and total dietary fiber (TDF) (including soluble DF and insoluble DF). The fat was divided into cholesterol, saturated fatty acid, mono-unsaturated fatty acid (including oleic acid), poly-unsaturated fatty acid (PUFA), n-6 PUFA, n-3 PUFA, and n-3 HUFA (including eicosapentaenoic acid [EPA, 20: 5n-3] and docosahexaenoic acid [DHA, 22: 6n-3]).

Food Intake Frequency and Weight Assigned

Food intake frequencies were classified into eight categories: that is, never or seldom, 1-3 times per month, 1-2 times per week, 3-4 times per week, 5-6 times per week, once a day, twice a day, and 3 or more times a day, and weights assigned were shown in Table 1.

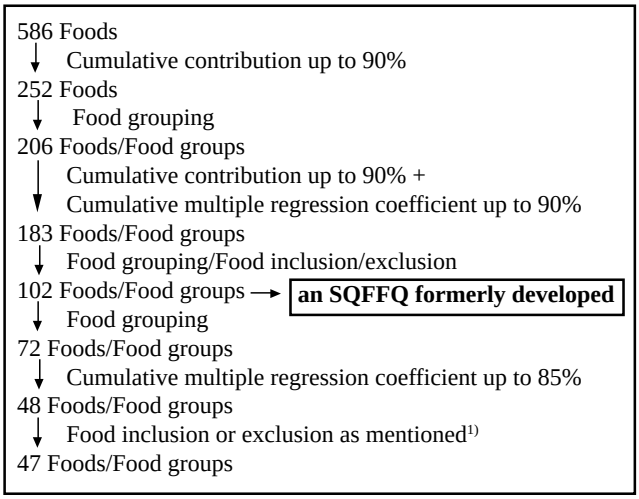

Figure 1. Flow Chart for Development of the Short FFQ

1) Stirr-fried dishes were grouped into fried dishes. Fried dish was categorized into deep fried and light fried because the oil portion size differs. For *Tofu*, *Hiyayakko* (chilled *tofu*) and *Yu-dofu* (hot *tofu*) were inquired separately but *Abura-age* (fried *tofu*) was included in *Miso* soup. Cookie and cake were deleted because they were miscategorized into Western style confectioneries. Sesame was deleted because it is difficult to estimate portion size. Green tea was included because it typically contains flavonoids and folate.

Portion Size

The mean portion size was calculated for respective foods from the one-day WDRs, and typical/standard values and/or natural units from the literature were also cited for evaluating intake of nutrients of interest.

Staple Foods

Rice, bread and noodles are the Japanese staple foods which provide most nutrients. They were here investigated in a special manner: namely, taking into account the intake frequency and portion size for breakfast, lunch, and supper, separately. The intake frequencies were categorized as follows: never or seldom, 1-3 times per month, 1-2 times per week, 3-4 times per week, 5-6 times per week and daily. The portion size was also determined in an open-ended manner..

Lifestyle Items

In addition, lifestyle items were included in the questionnaire, with parameters such as smoking, drinking, physical exercise, sleeping hours, and intake of vitamin and mineral supplements, as well as functional (or designer) foods.

Results

Number of Foods/Food Groups Contributing to Nutrients Selected

The foods/food groups contributing to the nutrients selected are listed in Table 2. For example, the n-3 HUFAs and vitamin D were each provided by specific foods/food groups, while iron was contributed by a total of 17 foods/food groups.

List of Foods/Food Groups

The 47 foods/food groups were included in the questionnaire: rice, bread and noodles (3), margarine/butter (2), eggs (1), milk and dairy products (2), soybean and soybean products (3), *miso*-soup (1), meat including beef, pork and chicken (4), fish (3), other fish, shellfish and fish products (4), green-yellow vegetables (5), other vegetables and mushrooms (3), edible roots (4), seaweeds (1), mayonnaise (1), fried dishes (2), seeds (1), fruit (2), beverages, including alcohol (3), and confectioneries (2) (Appendix).

Table 1. Food Intake Frequency and Weight Assigned

Frequency	Weight
Never or seldom	0
1-3 times per month	0.1
1-2 times per week	0.2
3-4 times per week	0.5
5-6 times per week	0.8
Once a day	1
Twice a day	2
Three or more times a day	3

Discussion

Following a systematic data-based procedure, we chose 47 foods/food groups for categorizing people according to 21 nutrients estimated. The questionnaire is concise and brief, and it could be self-administered to the general public. The food list was arranged considering Japanese dietary habits and lifestyle. Staple foods, for example, were listed first and related foods/food groups were itemized adjacent to one another. Although we included inquiries about intake of vitamin and mineral supplements and functional (or designer) foods, data on type (liquid, granule, tablet), quantity (portion size) and frequency were not sufficient to validly estimate consumption. Vitamin and mineral supplements are actually not so popular in Japan; however, we should take into account this drawback, particularly when executing relevant studies.

For choosing foods/food groups, there are two contrasting methods (Margetts and Nelson, 1990; Mark et al., 1996; Stryker et al., 1991; Thompson and Byers, 1994; Willett, 1998): one is based on CA (Block et al., 1985; Freudenheim et al., 1993), and the other on MRA (Byers et al., 1985; Hankin et al., 1968; Overvad et al., 1991). Each method has its respective advantages and disadvantages. The former approach is based on absolute intake of nutrients. Thus, the procedure is especially suitable for studies to clarify the association with energy intake and energy-adjusted intake of nutrients. The latter is based on the variance of nutrient intakes. The cumulative R^2 can generally be explained by a smaller number of foods than the cumulative % contribution. Substantial foods/food groups selected by MRA were covered by those chosen by CA; in addition, specific foods were chosen by MRA. Thus, the latter may be efficient for categorizing individuals, although it is unsuitable to compute absolute nutrient levels.

Table 2. Number of Foods/food Groups Contributing to 21 Nutrients with a Cumulative R^2 up to 0.85

Nutrient	Cumulative R^2	Number of food groups
Energy	0.861	14
Protein	0.858	15
Fat	0.856	11
Cholesterol	0.868	3
SFAs	0.867	8
MUFAs	0.873	7
PUFAs	0.864	8
n-6 PUFAs	0.872	7
n-3 PUFAs	0.904	4
n-3 HUFAs	0.872	1
Carbohydrate	0.869	7
Calcium (Ca)	0.852	10
Iron (Fe)	0.851	17
Carotene	0.928	2
Vitamin A	0.933	4
Vitamin C	0.894	7
Vitamin D	0.942	1
Vitamin E	0.856	9
TDF	0.855	13
SDF	0.854	10
IDF	0.866	13

Admittedly, the sample size for the one-day WDRs was not large, and the survey was performed in a selected area and in a specific season in Japan. It is known that within-individual variation is greater than inter-individual variation (Beaton et al.,1983; Margetts and Nelson, 1990; Mark et al., 1996; Nelson et al., 1989; Stryker et al., 1991; Thompson and Byers, 1994; Tokudome et al., 2002; Willett, 1998); however, we were here naturally unable to estimate inter- and within-individual variation on the basis of one-day WDRs. Although Japan is relatively small country in terms of area, the length from the North (latitude ca 45 degree) to the South (latitude ca 25 degree) is rather great. Accordingly there are wide varieties of foods consumed even though mass-transportation systems have been developed throughout the country. Furthermore, there are four seasons in Japan and seasonal variations in intake of foods, vegetables and fruit, in particular (Shahar et al., 1999; Tokudome et al., 2003; Ziegler et al., 1987). We should therefore take into account these variations in evaluating intake of foods and nutrients.

In epidemiological studies, validity and reproducibility are two important components. Validity is defined as being free from bias, and reproducibility as being low in random variation. Those should be evaluated prior to actually applying an FFQ for investigations, including case-control and cohort studies. We thus propose relative validation of the present FFQ versus 7 day WDRs and blood parameters. With the latter, we would validate the FFQ against concentrations of plasma fatty acids because we are particularly interested in lifestyle-related diseases, including cancers, cerebrovascular disease and chronic heart disease, related to excess/imbalanced intake of fats/oils. Reproducibility studies are now underway with the public in community and company employee settings.

Acknowledgments

The study was partly sponsored by a Grant-in-Aid from the Ministry of Education, Culture, Sports, Science, and Technology, Japan. Authors thank Ms. Y. Kubo, Ms. Y. Ito and Dr. M.A. Moore for their technical and language assistance in preparing this manuscript.

References

Beaton GH, Milner J, McGuire V, Feather TE, Little JA (1983). Source of variance in 24-hour dietary recall data: implications for nutrition study design and interpretation. Carbohydrate sources, vitamins and minerals. *Am J Clin Nutr,* **37,** 986-95.

Block G, Dresser CM, Hartman AM, Carrol MD (1985). Nutrient sources in the American diet: quantitative data from the NHANES II survey. I. Vitamins and minerals. *Am J Epidemiol,* **122,** 13-26.

Byers T, Marshall J, Fiedler R, Zielenzny M, Graham S (1985). Assessing nutrients intake with an abbreviated dietary interview.

Am J Epidemiol, **122,** 41-50.
Freudenheim JL, Krogh V, D'amicis A, et al (1993). Food sources of nutrients of the diet of elderly Italians: I. Macronutrients and lipids. *Int J Epidemiol*, **22,** 855-68.
Hankin JH, Stallones RA, Messinger HB (1968). A short dietary method for epidemiologic studies. III. Development of questionnaire. *Am J Epidemiol*, **87,** 285-98.
Imaeda N, Fujiwara N, Tokudome Y, et al (2000). Reproducibility of a semi-quantitative food frequency questionnaire in Japanese female dietitians. *J Epidemiol*, **12,** 45-53.
Margetts BM, Nelson, M (1990). Design Concepts in Nutritional Epidemiology. Oxford: Oxford University Press.
Mark SD, Thomas DG, Decarli A (1996). Measurement of exposure to nutrients: an approach to the selection of informative foods. *Am J Epidemiol*, **43,** 514-21.
Nelson M, Black AE, Morris JA, Cole TJ (1989). Between- and within-subject variation in nutrient intake from infancy to old age: estimating the number of days required to rank dietary intakes with desired precision. *Am J Clin Nutr*, **50,** 155-67.
Overvad K, Tjonneland A, Haraldsdottir J, Ewertz M, Jensen OM (1991). Development of a semiquantitative food frequency questionnaire to assess food, energy and nutrient intake in Denmark. *Int J Epidemiol*, **20,** 900-5.
Resources Council, Science and Technology Agency, Japan (1982). Standard Tables of Food Composition in Japan, 4th ed. Tokyo: Resources Council, Science and Technology Agency, Japan (in Japanese).
Resources Council, Science and Technology Agency, Japan (1992). Follow-up of Standard Tables of Food Composition in Japan. Tokyo: Ishiyaku Shuppan (in Japanese).
SAS Institute, Inc (1999). SAS/STAT User's Guide. Ver 8, Cary, NC.
Shahar DR, Froom P, Harari G, Yerushalmi N, Lubin F (1999). Changes in dietary intake account for seasonal changes in cardiovascular risk factors. *Eur J Clin Nutr*, **53,** 395-400.
Stryker WS, Salvini S, Stampfer MJ, et al (1991). Contribution of specific foods to absolute intake and between-person variation of nutrients consumption. *J Am Diet Assoc*, **91**, 172-8.
Thompson FE, Byers T (1994). Dietary assessment resource manual. *J Nutr*, **124,** S2245-S317.
Tokudome S, Ikeda M, Tokudome Y, et al (1998). Development of data-based semi-quantitative food frequency questionnaire for dietary studies in middle-aged Japanese. *Jpn J Clin Oncol*, **28,** 679-87.
Tokudome S, Imaeda N, Tokudome Y, et al (2001). Relative validity of a semi-quantitative food frequency questionnaire versus 28 day weighed diet records in Japanese female dietitians. *Eur J Clin Nutr*, **55,** 735-42.
Tokudome Y, Imaeda N, Nagaya T, et al (2002). Daily, weekly, seasonal, within- and between-individual variation in nutrient intake according to four season consecutive 7 day weighed diet records in Japanese female dietitians. *J Epidemiol*, **12,** 85-92.
Willett W (1990). Nutritional Epidemiology. New York: Oxford University Press.
Ziegler RG, Wilcox III HB, Mason TJ, Bill JS, Virgo PW (1987). Seasonal variation in intake of carotenoids and vegetables and fruits among white men in New Jersey. *Am J Clin Nutr*, **45,**107-14.

[Appendix]

List of Foods/Food Groups Included in a Short FFQ

1. Rice
2. Bread (including White Bread, Bun etc.)
3. Noodles (Japanese noodle; *Udon* [Wheat noodle], *Soba* [Buckwheat noodle], Chinese noodle; *Ramen)*
4. Margarine
5. Butter
6. Milk
7. Yogurt
8. *Miso* soup
9. *Tofu* (Soybean curd) for *Hiyayakko*, *Yu-dofu*
10. *Natto* (Fermented soybean), Soybean
11. Egg
12. Chicken
13. Beef, Pork
14. Liver
15. Ham, Sausage, Bacon, Salami-sausage
16. Fish
17. Bone-edible small fish (e.g. *Shirasuboshi* [Boiled and semi-dried whitebait], *Shishamo* [Smelt])
18. Canned tuna
19. Cuttlefish, Squid, Octopus, Shrimp, Crab
20. Shellfish (e.g. Short-necked clam, Corbicula, Oyster)
21. Fish egg (e.g. *Tarako* [Cod fish egg], *Ikura* [Salted salmon egg], etc.)
22. Fish paste products (e.g. *Kamaboko*, *Chikuwa*)
23. *Ganmodoki* (Fried *tofu* paste), *Nama-age* (Fried *tofu*)
24. Potatoes (e.g. Potato, Sweet-potato, Taro, Yam)
25. Pumpkin/squash
26. Carrot
27. Broccoli
28. Green leaves vegetables (e.g. Spinach, *Komatsuna*, *Shungiku*, etc.)
29. Other green-yellow vegetables (e.g. Green pepper, String beans, etc.)
30. Cabbage
31. *Daikon* (Japanese radish)
32. *Kiriboshi-daikon* (Dry strips of Japanese radish)
33. Burdock, Bamboo shoot
34. Other vegetables (e.g. Cucumber, Lettuce, Bean sprouts, Onion, Chinese cabbage etc.)
35. Mushrooms (e.g. *Shiitake*, *Shimeji*, *Enoki*, etc.)
36. Seaweeds (e.g. *Hijiki* [Brown algae], *Kombu* [Kelp], etc.)
37. Mayonnaise (including Salad dressed with mayonnaise [e.g. Potato-salad, etc.])
38. Deep fried food
39. Light fried food
40. Citrus fruits (e.g. Orange, Tangerine, Mandarin orange, etc.)
41. Other fruits
42. Peanut, Almond
43. Western style confectioneries (e.g. Short cake, Cream puff, etc.)
44. Japanese style confectioneries (*Manju*, etc.)
45. Green tea
46. Coffee
47. Alcohol