NUTRITIONAL EPIDEMIOLOGY

Development of a Food Frequency Questionnaire in Japan

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The three-consecutive-day weighing method, in which foods as raw materials are weighed separately before they are cooked, is the most popular dietary assessment method among Japanese dietitians, because this dietary survey method has been adopted in the national nutrition survey for half a century. Under such circumstances, there have been only a few studies aiming to develop and validate a food frequency questionnaire (FFQ) method. The food list of a few FFQs ever used dealt with individual food items alone, but not mixed dishes. Therefore, a frequency questionnaire was very difficult for people not involved in cooking daily to answer. In order to enable subjects to answer a questionnaire more accurately, a new FFQ which has a food list with 122 single foods and recipes was developed. These foods and recipes were identified from 805 24hr-recalls of males and females aged 40-69 years old in Shiso County, Hyogo Prefecture, Japan.

During consecutive 56 or 63 days, 67 junior college students in a dietitian course recorded their diet intake. Within a week after the diet record, they answered the newly developed FFQ. Pearson correlation coefficients between energy adjusted nutrient intakes assessed from the FFQ and those from dietary records were calculated. These correlation coefficients ranged from 0.21 for retinol potency to 0.74 for calcium. These data indicate that the newly developed FFQ provides a useful measurement of many nutrient intakes over a two-month period.

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PROBLEMS WITH DIETARY ASSESSMENT IN JAPAN

In the recent decade it has been increasingly common for epidemiologic studies of nutrition in many countries to use the semi-quantitative food frequency questionnaire (FFQ) for dietary assessment^{1,2}. The reasons why the FFQ has become the method most often used by investigators are : firstly it is a quick and relatively inexpensive method compared with several other dietary survey methods, and secondly it is able to measure individuals' or groups' current and past intake. The basic food frequency questionnaire consists of two components : a food list and a frequency response section in which subjects report how often they ate each food item. Questions related to further details of quantity may be appended.

In Japan, however, this method has not been very popular. The most popular method for dietary assessment is a three-consecutive-day diet record, in which subjects weigh all food items before cooking them. This dietary survey method has been adopted in the national nutrition survey for a long time.

The national nutrition survey held in Japan today originates from the survey conducted in Tokyo by the nutrition department in the Welfare Ministry under the direction of the GHQ in December, 1945. In those days Japanese people were suffering from extreme food shortages after the defeat in World War II in August, 1945. The production of rice, their staple food, had been reduced as low as the level in the early 20th century. Under these deprived circumstances, the primary objective of the first nationwide nutrition survey was to obtain basic data needed to procure food for people in 1946. Thanks

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to a series of food procurement measures, Japan managed to overcome the deprived conditions and in 1957 the nutritional improvement (eiyou-kaizen) law was established. In accordance with that law, the national nutrition survey has been conducted ever since for the dual purpose of obtaining data on citizens' health conditions, food and nutrient intake, and clarifying relations between nutrition and health.

In the survey the household consumption method has been consistently in use from the very beginning. The national survey had its start in the food-deprived times when meals were simple and mainly dependant on raw materials: there were few processed food items nor opportunities to dine out. This condition made it fairly easy not only to measure raw food prior to its cooking, but also to estimate a particular family's overall intake situation from family-based measurement. However, during high economic growth periods from 1960 to 1974, Japanese people's life styles underwent great changes and became modernized. With the spreading of processed food, there was an increasing tendency to depend upon it for their daily basic food and to dine out. Instead of families eating the same meal together as they used to, now they could afford to eat different dishes according to their individual tastes. This new dietary habit has come to complicate the nutrition survey, making it difficult to estimate individual persons' intake from household consumption data. Therefore, in order to further look into relations between health and food intake, it is imperative to obtain data on individual persons' dietary habits. This is where the FFQ comes in, because it can measure individuals' habitual intake. In the near future, the FFQ will become a more popular dietary assessment method in Japan.

What should be noted about the national nutrition survey is that it has contributed a great deal to the development and dissemination of the FFQ in our country. The survey has been done with randomly selected 6,000 to 7,000 families for as long as half a century with a considerable number of dietitians involved in it. The three-consecutive-day weighing method, in which foods as raw materials are weighed separately before they are cooked, is well known among dietitians.

The FFQ, when it is used in Japan, adopts individual food items or food group, such as beef, pork, eggs, fish, vegetables etc., as its food list. Though we eat single food items in our daily life (eg. "drink milk" and "eat an apple"), we more often eat various food items as mixed dishes. This dietary reality makes it very difficult for subjects not involved in cooking daily to answer a questionnaire regarding their daily food frequency and intake weight of each of such single food items as mentioned above. Besides, since the standard tables of food composition in Japan show the nutrient values of edible raw portions of food per 100g, the subjects are asked in the FFQ about their usual intake of raw food. And as a means of estimating their intake, they can consult food models and photo books of food items in their raw and uncooked condition. But it is even more difficult for them to estimate the possible intake of single ingredients in the meals before they were cooked,

because they did not prepare nor cook their own meals themselves. In order to enable the subjects to answer a questionnaire more accurately, a new FFQ was developed. The new method includes, among questions, both individual food items and mixed dishes. Another feature of the new FFQ is that the subjects are allowed to estimate the intake quantity, not by the weight but by the portion size (volume).

DEVELOPMENT OF A NEW FFQ

In order to develop a food list, multiple 24-hr recalls were collected in Shiso County, Hyogo Prefecture in 1991 and 1992. Eight hundred and five residents, aged 40-69 years, were selected randomly from the census table. All reported food items were first ranked according to Block's method³⁾, that is, on the basis of the percentages of nutrients that each food item contributed to the total nutrient intake. The nutrients we were concerned with were total energy, total protein, total fat, vitamin A, and sodium. The percentages were calculated by dividing the nutrients of each food item by the total nutrient amount.

Individual food items were then consolidated into mutually-exclusive food types, according to their form and type of preparation, nutrient density, and logical association. In constructing the composite food groupings, the first food placed on each rank-order list was designated as food prototype I. All the foods contributing at least 0.1% to the total nutrient intakes were combined to form mutually-exclusive food types.

At first, there were 977 foods and recipes in the 805 recalls. After the grouping of foods and recipes which had different names but similar contents, 444 foods and recipes remained. All the food items contributing at least 0.1% to the total energy, total protein, total fat or sodium, and 0.2% to vitamin A were combined into 216 foods and recipes. Then the foods and recipes were consolidated into food types, according to their form and type of preparation, nutrient density, and logical association. Through this procedure, 133 food types were obtained. After the food types which fewer than 10 subjects had eaten were eliminated, 118 food types remained. Furthermore, 4 extra fruit items were added, because the recalls were not collected in their harvest season. As a result, 122 food types were adopted as a food list shown in Table 1. The final 122 foods and recipes in the questionnaire provided over 95% of all nutrient supply.

As to the frequency of each food consumption, the response format was not multiple-choice but open-ended. For example, when a subject answered "three times a week" as to a particular food item, its weekly frequency was converted into a daily one by multiplying it by 3/7.

To estimate the individual's usual portion size of each food, two dimensional food model pictures developed by the University of Texas-Houston School of Public Health⁴⁾ were used. Also, there were added to the food model pictures those of regular rice bowls, soup bowls and green tea cups used in Japan.

Table1. Food list of the Food Frequency Questionnaires(Complete)

STAPLE FOODS, SNACKS			
1 Curried rice	62 Stewed deep-fried tofu		
2 Fried rice or fried rice wrapped with egg	63 Stewed soy beans		
3 Sushi rice mixed with minced vegetables	64 Tempura (deep-fried vegetables)		
4 Other sushi, e.g. sushi rice rolled with sea weed, sushi rice wrapped with deep fried tofu, etc.	65 Croquette		
5 Rice topped with chicken and egg, or rice topped with beef and egg, etc.	66 Sauteed thin sliced budock root		
6 Rice with mixed ingredients	67 Sauteed vegetables		
7 Rice broth or, rice with green tea	68 Boiled vegetables		
8 Rice ball	69 Vegetable and potato stew		
9 Rice cake	70 Grated radish		
10 Steamed rice	71 Baked eggplant		
11 Noodle soup	72 Vegetable salad with egg		
12 Chilled noodles	73 Vegetable salad		
13 Fried noodles	74 Potato salad		
14 Instant noodle soup	75 Macaroni salad or spaghetti salad		
15 White bread	76 Salt-flavored pickled vegetables		
16 Butter roll	77 Dried and salted plums		
17 Margarine, added to food or bread	78 Soy-sauce flavored vegetable products		
18 Butter, added to food or bread	79 Soy-sauce seasoned seaweed products. or dried and salted kelp		
19 Cheese	80 Stewed seafood		
20 Confectionary bun	81 Toasted purple laver		
21 Sandwich	82 Condiment sprinkled on cooked rice		
22 Hamburger sandwich or bun with non-confectionary fillings	83 Miso soup		
23 Japanese pizza with vegetables	84 Other soup		
DISHES			
24 Fried chicken	85 Beef stew, chowder or potage		
25 Pork cutlet	86 Sukiyaki or hodgepodge dish (fish, meat, vegetables, etc.)		
26 Hamburger	87 Hodgepodge dish (fish paste, egg, tofu, etc)		
27 Beef steak or teriyaki chicken	88 Venegar-flavored seafood and vegetables		
28 Fried meat	DAIRY FOODS		
29 Broiled beef	89 Whole milk or coffee flavored milk		
30 Broiled chicken (Yaki-tori)	90 Low fat milk or Skim milk		
31 Liver-based dishes	91 Yogurt		
32 Fried sausage	92 Lactic acid bacteria beverages		
33 Ham or roasted pork	93 Ice cream or ice milk		
34 Meat-and-vegetable stew	BEVERAGES		
35 Sweet and sour pork or fried vegetables mixed with pork, seafood, etc.	94 Jananese green tea		
36 Gyoza (Chinese dishes)	95 Fruits juice or vegetable juice (fresh, frozen, or canned)		
37 Fried fish or deep fried fish	96 Carbonated beverage (with sugar)		
38 Stewed cuttle fish, prawns, or octopus	97 Coffee or canned coffee		
39 Stewed white meat fish	98 Sake (fermented alcoholic beverage)		
40 Stewed dark meat fish	99 Beer		
41 Other stewed fish	100 Shochu (distilled alcoholic beverage)		
42 Broiled white meat fish	101 Chu-hai (shochu diluted with carbonated beverage)		
43 Broiled dark meat fish	102 Whiskey		
44 Other broiled fish	103 Wine (red wine or white wine)		
45 Broiled salted and semi-dried sardines	FRUITS		
46 Raw fish or raw shellfish	104 Mandarins, Oranges, or Grapefruit		
47 Salted cod roe	105 Watermelon		
48 Semi-dried sardine fries	106 Japanese pears		
49 Fish paste	107 Bananas		
50 Soy-sauce seasoned fish products	108 Grapes		
51 Dried cuttle fish	109 Apples		
52 Salted and semi-dried seafood	110 Japanese persimmons		
53 Fried egg roll	111 Chestnuts		
54 Fried egg sunny-side up	112 Muskmelons		
55 Vegetable omelet	113 Strawberries		
56 Egg pudding	SWEETS, BAKED GOODS, NUTS		
57 Raw egg	114 Sweetend bean paste		
58 Steamed egg	115 Rice craker		
59 Fermented soy beans	116 Deep-fried wheat flour confectionery		
60 Tofu (chilled or boiled)	117 Chocolates		
61 Dried tofu-dish	118 Sponge cake		
	119 Cake (home baked or ready made)		
	120 Cookies (home baked or ready made)		
	121 Beans (parched and salted peas. or fried broad beans)		
	122 Nuts		

Table 2. Comparison of mean daily nutrient intake using diet records and food frequency questionnaire

	Diet records		The first FFQ		The second FFQ	
	Mean	SD*	Mean	SD	Mean	SD
Energy (kcal)	1415	296	1450	328	1299	348
Protein (g) animal	29.3	7.5	29.1	9.9	25.2	9.9
Protein (g) vegetable	22.1	5.0	23.8	5.9	21.6	6.8
Fat (g) animal	20.3	6.0	19.5	7.8	17.3	6.8
Fat (g) fish	2.5	1.1	2.9	1.6	2.3	1.4
Fat (g) vegetable	24.9	7.3	22.8	6.7	19.6	7.4
Carbohydrate (g)	188	44	200	45	183	49
Calcium (mg)	353	125	438	163	388	159
Sodium (mg)	3042	708	3510	1236	2975	1236
Potassium (mg)	1589	481	1767	556	1524	553
Retinol potency (IU)	1708	598	1704	778	1456	845
Retinol (µg)	242	130	257	183	214	165
Carotene (µg)	1587	663	1489	743	1302	942
Vitamin C (mg)	59	34	77	38	63	36
Vitamin E potency (mg)	3.8	1.2	3.8	1.2	3.2	1.2

* standard deviation

VALIDATION OF THE FFQ

The FFQ mentioned above was validated against consecutive 56 or 63 days' diet records. The subjects were 67 junior college students (3 males and 64 females, aged 19-26 years) taking a dietitian course.

Food consumption was recorded from April through June for 56 days by 32 students in 1993, and for 63 days by 35 students in 1994. Within 1 week after the dietary record period was finished, the first FFQ was conducted; with respect to each of the

122 food items, the subjects were asked by a trained interviewer to indicate the frequency of consumption and the average amount during the above-mentioned dietary record periods in both years. A week after the first FFQ, the second one was conducted with the use of the same method. The average nutrient intake was calculated from each individual dietary record and designated as the gold standard. The validation of the FFQ was checked against correlation coefficients between the gold standard and the first FFQ. Furthermore, the reproducibility of the FFQ was examined against correlation coefficients

Table 3. Pearson correlation coefficients between nutrients estimated by the first food frequency questionnaire and the average of consecutive 56 or 63 diet records

	The first food frequency questionnaire vs. 56 or 63 diet records	
	Unadjusted	Adjusted**
Energy	0.65	-
Protein (animal)	0.70	0.60
Protein (vegetable)	0.62	0.44
Fat (animal)	0.66	0.46
Fat (vegetable)	0.47	0.54
Carbohydrate	0.65	0.58
Calcium	0.70	0.74
Sodium	0.46	0.26
Potassium	0.52	0.50
Retinol potency*	0.40	0.21
Retinol*	0.54	0.53
Carotene*	0.42	0.25
Vitamin C*	0.35	0.38
Vitamin E potency*	0.56	0.42

Data are based on responses of 67 students

* Correlation coefficient is shown as Spearman correlation coefficient

** Intakes adjusted using Willett's method

Table 4. Pearson correlation coefficients between nutrients estimated by the first and those by the second food frequency questionnaire conducted one week apart

The first food frequency questionnaire vs. the second food frequency questionnaire	
	Unadjusted
Energy	0.69
Protein (animal)	0.78
Protein (vegetable)	0.64
Fat (animal)	0.72
Fat (vegetable)	0.70
Carbohydrate	0.67
Calcium	0.78
Sodium	0.75
Potassium	0.77
Retinol potency	0.53
Retinol	0.28
Carotene	0.39
Vitamin C	0.73
Vitamin E potency	0.74

Data are based on responses of 67 students

cients between the first FFQ and the second one.

Mean nutrient intake values estimated from the first and second FFQs and the diet records are shown in Table 2. Both methods yielded almost the same intake of all the nutrients.

Pearson correlation coefficients between the nutrient intake estimated from the FFQ and the one from the diet records are shown in Table 3. Correlation coefficients are shown in two types: adjusted one for total energy intake by Willett's method⁵ and unadjusted one. Unadjusted correlation coefficients varied from 0.35 for vitamin C to 0.70 for animal protein, with most values between 0.5 and 0.7. After adjustment for total energy, most of the adjusted values were between 0.4 and 0.6. Adjustment for total energy decreased correlation coefficients for most nutrients except vegetable fat, calcium, sodium, and vitamin C.

The correlation coefficients between nutrient intake estimated from the first and the one from the second FFQ are presented in Table 4 to show the reproducibility of the FFQ. The correlation coefficients varied from 0.64 for vegetable protein to 0.78 for calcium, with most values above 0.7 except vitamin A.

These data indicate that the FFQ provides a useful estimation of intake for many nutrients over a two-month period.

REFLECTION ON THE DEVELOPED FFQ

There was, however, a problem in administrating the FFQ: An interview with one subject took as long as 1 hour.

Firstly, the problem stemmed from dealing with too many food items. In this study we used Block's approach³ to identify foods that contribute most importantly to the total absolute intake. Consequently, 122 food items were adopted as a food list. Hence the number must be reduced in the future. Since in most epidemiologic applications, ranking individual intake is

its primary objective⁵, food items to classify individuals by should be selected, because food intake varies from person to person. Willette et al.⁶ and Overvad et al.⁷ adopted stepwise multiple regression analysis to identify important foods in predicting individual nutrient intake. We will also adopt the same procedure in reducing the number of food items.

Secondly, the long interview time was also due to the estimation of the portion size by open-ended questionnaires. Our FFQ consists of a food list, a frequency response section, and a portion size section which is estimated by using food model pictures. To shorten the interview time, we have devised a picture booklet of 122 food items (foods and mixed dishes) in their actual sizes. The typical portion was made from 24 hr recalls of 805 people which we had used for the development of the food list.

Also, there were two problems with the validation study. The first problem was with the length of the study period. We examined the validity of estimating the past 2-month-nutrient intake against the FFQ, but judging from seasonal variations in dietary intake, this period proved to be too short to examine individual's usual intake over a long period of time. The other problem with this validation study has to do with the subjects: since they were students of the dietitian course, they might have been different from ordinary adults in a community to whom we would like to apply the FFQ in examining relationships between dietary intake and health status.

Therefore we have started a new one-year validation study with adults (aged over 30, males and females) in two communities in Osaka--spring, summer, autumn and winter with 7-days dietary records per session.

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