RESEARCH COMMUNICATION

Reproducibility of a Food Frequency Questionnaire in Koreans

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Abstract

Objective : The present study was conducted to report upon the reproducibility of a 98-item food frequency questionnaire among Koreans.

Subjects : The study subjects were recruited from among those who visited for a regular health check-up at the health centers from Samsung Hospital and Hallym University Hospital.

Setting : The FFQ was administered first in April to June of 2002 to 145 Korean adults aged 40 and over residing in Seoul and its vicinity and was then re-administered to 126 three months later between July and September of 2002 (FFQ 1 and FFQ 2).

Methods : Reproducibility was evaluated using the Pearson correlation coefficients of log-e and the calorie-adjusted nutrient score. Weighted kappa (k) statistics with 95% confidence limits were calculated to assess the chance adjusted level of agreement between the FFQ 1 and the FFQ 2. The proportions of correctly categorized subjects in the same or adjacent quintiles were calculated.

Results : The average intake in FFQ 1 was no more than 12 percent different from the average intake in FFQ 2. Correlations varied between 0.47 for sodium and 0.72 for vitamin C. All k values exceeded 0.5 except that of fiber. The average k for all nutrients was 0.67. The percentage agreement varied from 62% for energy and potassium to 82% for vitamin B_2 and cholesterol. The average of the agreement was 72%.

Conclusion : The results of this study verify that it is possible to use tailored, relatively simple, but comprehensive, self-administered food frequency questionnaires to study nutrient consumption in large-scale epidemiological studies.

Key Words: reproducibility - food frequency questionnaire - Koreans - nutrients

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Introduction

Of the commonly accepted tools for assessing habitual dietary intake in epidemiological studies, the one that is most often used in population surveys is the food frequency questionnaire (FFQ) (Briefel et al., 1992; Kushi, 1994). When using the FFQ, the results generally represent usual intakes over an extended period and are easier to collect and process. The FFQ is then used to study associations between dietary habits (both past and present) and various forms of disease. Additional uses of the FFQ include; its ability to classify individuals by rank, identify groups at extremes of intake, and to monitor trends in dietary patterns (Zulkifli & Yu, 1992). The FFQ needs to have a guaranteed reproducibility (also termed as repeatability) as well as validity, in order to make the appropriate interpretation of dietary data, which are central to the assessment of dietary habits (Hankin & Wilkens, 1994).

Some reports of FFQs used in epidemiological studies of Koreans are available. These include reports on middle-aged men, women, or the elderly (Kim et al., 1996; Kim & Yang, 1998; Oh & Hong, 2000). However, no FFQ for large-

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scale epidemiological research in Koreans aged 40 and older has been tested for both validity (Kim et al., 2003c) and reproducibility. An FFQ developed by us, has been recently validated (Kim et al., 2003c). It was developed for use in Koreans, and was based on three-day dietary records and involves analysis by contribution and multiple regression analyses (Kim et al., 2003b; Kim et al., 2003c). The objective of the present study was to report upon the reproducibility of this 98–item FFQ among Koreans.

Subjects and Methods

The performance of an FFQ depends on how accurately it is able to reflect the dietary patterns of the study subjects living in a particular geographical area. Also, omitting or consolidating food items may lead to the misinterpretation of questions and, therefore, to the over- or under-estimation of the related nutrients. During the process of implementation the simplicity, specificity and clarity of an FFQ must be considered to assure optimal communication between the study subjects and the interviewers. Hence, this study was performed using a face-to-face interview method instead of self-administration.

To test the reproducibility of the FFQ, the study subjects were recruited from among those who visited for a regular health check-up at the health centers from Samsung Hospital and Hallym University Hospital. The FFQ of concern is composed of 98 food items with nine categories of frequency and three categories of portion size. Participants were presented with two dimensional food pictures of actual size on a computer by one interviewer through both FFQs in order minimize interviewer bias.

Medium was defined as the portion sizes shown, small as about one-half the medium portion size, and large as about one-and-a-half times the medium portion size. The FFQ was administered first in April to June of 2002 to 145 Korean adults aged 40 and over residing in Seoul and its vicinity and was then re-administered to 126 three months later between July and September of 2002 (FFQ 1 and FFQ 2). The respondents were asked how often and how much they had eaten on average over the past year at both sessions. Thirteen percent of the study subjects who were interviewed initially refused to participate in the re-survey.

Nutrient intakes were computed using a database and a computerized software program (Kim et al., 2003b; Kim et al., 200c). Descriptive statistics, such as means and standard deviation, and testing for normality were calculated using SPSS-11.0 (SPSS Inc., 2002). Reproducibility was evaluated using the Pearson correlation coefficients of log-e and the calorie-adjusted nutrient score. Adjustment for total energy intake was made by using the residual method of Willett (Willett, 1998). Residuals were computed from regression models, with total energy as the independent variable and nutrient intake as the dependent variable.

Table 1. Means and Standard Deviations of Daily Energy and Nutrient intakes Based on FFQ 1 and FFQ 2 (N = 126)

	FFQ1				FFQ2			
	male		female		male		female	
	mean	SD	mean	SD	mean	SD	mean	SD
Energy (kcal)	2051.70	683.33	1723.53	534.63	2141.78	713.34	1853.18	558.11
Protein (g)	85.37	42.00	70.10	29.67	88.92	43.75	75.21	30.90
Total fat (g)	50.17	31.20	41.77	23.93	54.87	34.13	47.05	26.18
Carbohydrate (g)	306.20	92.47	270.77	82.27	311.74	94.14	283.94	83.76
Calcium (mg)	555.80	308.77	470.53	233.80	574.46	319.13	500.92	241.65
Phosphorus (mg)	1147.23	544.83	968.63	385.80	1186.55	563.50	1031.88	399.02
Iron (mg)	14.57	6.73	12.40	5.10	15.61	7.21	13.68	5.46
Potassium (mg)	2829.03	1217.60	2371.63	900.27	2995.45	1289.22	2586.48	953.22
Vitamin A (IU)	790.97	1357.90	559.30	527.97	827.21	1420.12	602.48	552.16
Sodium (mg)	4629.77	2183.67	3779.87	1852.10	4880.70	2302.02	4104.28	1952.48
Vitamin B1 (mg)	1.43	0.97	1.10	0.53	1.53	1.03	1.21	0.57
Vitamin B2 (mg)	1.23	0.73	0.97	0.50	1.30	0.77	1.05	0.53
Niacin (mg)	20.20	10.93	16.20	7.57	21.59	11.69	17.84	8.09
Vitamin C (mg)	100.83	71.03	76.33	49.17	97.36	68.58	75.91	47.47
Zinc (mg)	10.33	4.70	8.60	3.57	11.27	5.13	9.66	3.89
Vitamin B6 (mg)	24.30	10.40	19.83	9.50	25.89	11.08	21.77	10.12
Folate (mg)	228.70	115.33	212.80	166.83	234.64	118.33	224.88	171.17
Retinol (mg)	143.30	292.63	94.20	91.77	157.44	321.51	106.60	100.82
Carotene (mg)	2889.20	2114.03	2575.93	3012.13	2627.52	1922.56	2412.91	2739.32
Fiber (g)	6.63	3.00	5.37	2.40	7.27	3.29	6.05	2.63
Vitamin E (mg)	13.03	8.90	11.90	8.90	13.50	9.22	12.69	9.22
Cholesterol (mg)	337.77	278.90	287.10	233.87	364.52	300.99	319.14	252.39

Weighted kappa (k) statistics with 95% confidence limits were calculated to assess the chance adjusted level of agreement between the FFQ 1 and the FFQ 2 categorized as quintiles. The proportions of correctly categorized subjects in the same or adjacent quintiles were calculated.

Results

The mean ages for men and women were 53.2 (40 – 71) and 51.7 (41 – 72) years, respectively. The mean BMIs of the men and women were 23.4 and 23.2 (kg/m^2). Table 1 shows the results of the two FFQs for daily consumption of calories and 21 nutrients. The mean intakes of most nutrients were higher when estimated using the second questionnaire (FFQ 2) than the first (FFQ 1), except for vitamin C by males and for carotene by both genders. However, the values for the nutrient intakes were similar. The average intake in FFQ 1 was no more than 12 percent different from the average intake in FFQ 2. Log transformation was taken for all nutrient values to reduce skewness.

Table 2 shows the result of Pearson's correlation coefficients of nutrient intakes adjusted for total energy intake. The correlations of all nutrients were above 0.50, except for sodium. Correlations varied between 0.47 for sodium and 0.72 for vitamin C. The ranges of correlations for vitamins (0.52 – 0.72) were higher than those for minerals (0.47 – 0.65) and calorigenic nutrients (0.52 – 0.61).

Reproducibility was also evaluated using kappa (k) values as shown in Table 3. For example, the quadratic weighted k valued for energy was 0.69 and that for phosphorus was 0.84. All k values exceeded 0.5 except that of fiber. The average k for all nutrients was 0.67.

Table 2. Pearson's Correlation Coefficients of Nutrient intakes, Adjusted for total Energy intake (N = 126)

Nutrient	Coefficient
Energy	0.53
Protein	0.61
Total fat	0.52
Carbohydrate	0.53
Calcium	0.65
Phosphorus	0.56
Iron	0.51
Potassium	0.63
Vitamin A	0.59
Sodium	0.47
Vitamin B1	0.54
Vitamin B2	0.72
Niacin	0.59
Vitamin C	0.71
Zinc	0.52
Vitamin B6	0.55
Folate	0.64
Retinol	0.70
Carotene	0.52
Fiber	0.59
Vitamin E	0.60
Cholesterol	0.55

Table 3. Quadratic Weighted *k* and Approximate 95% Confidence Limits (CL) for Quintile Ranks from Repeated Food Frequency Questionnaires (N = 126)

	K	Lower 95% CL	Upper 95% CL
Energy	0.68	0.54	0.79
Protein	0.68	0.53	0.80
Total fat	0.71	0.61	0.81
Carbohydrate	0.66	0.47	0.80
Calcium	0.65	0.51	0.77
Phosphorus	0.84	0.73	0.91
Iron	0.61	0.46	0.73
Potassium	0.73	0.61	0.82
Vitamin A	0.66	0.52	0.79
Sodium	0.72	0.55	0.85
Vitamin B1	0.50	0.26	0.80
Vitamin B2	0.72	0.59	0.82
Niacin	0.74	0.59	0.84
Vitamin C	0.72	0.60	0.84
Zinc	0.66	0.48	0.79
Vitamin B6	0.67	0.48	0.80
Folate	0.72	0.57	0.82
Retinol	0.61	0.54	0.75
Carotene	0.57	0.38	0.73
Fiber	0.48	0.25	0.66
Vitamin E	0.70	0.67	0.81
Cholesterol	0.59	0.42	0.64

The degree of misclassification across categories between FFQ 1 and FFQ 2 was examined by dividing nutrient intakes into quintiles (Table 4). The proportions of correctly categorized subjects in the same or adjacent quintiles were calculated. The cross-classification between the lowest quintile on FFQ 1 and lowest quintile on FFQ 2 ranged from 21% for niacin to 62% for vitamin C and carotene. The greatest misclassifications in the lowest quintile on FFQ 1 and in the highest quintile on FFQ 2 were found for vitamin B_1 at 17%. On average, 4% of nutrients were grossly misclassified into extreme quintiles. Overall, the percentage agreement varied from 62% for energy and potassium to 82% for vitamin B_2 and cholesterol. The average of the agreement was 72%.

Discussion

We have developed and evaluated the performance of an FFQ for Koreans in terms of its validity (Kim et al., 2003c) and reproducibility. In other reproducibility studies, the correlation coefficients have generally varied from 0.5 to 0.7 for nutrient intakes (Willett, 1998) and the results of the present study compare well with these findings. In a study over the same time interval (Hankin et al., 1983), these correlation coefficients ranged between 0.12 and 0.41.

Table 4. Cross-classification of Nutrients by Distribution Quintiles from FFQ 1 and FFQ 2 (N = 126)

	Lowest quintile on FFQ1 (%)			Overall % of agreement
	Lowest quintile on FFQ2	Lowest 2 quintiles on FFQ2	Highest quintile on FFQ2	
Energy	39	57	0	58
Protein	30	53	4	67
Total fat	38	62	0	64
Carbohydrate	39	57	8	68
Calcium	38	62	4	73
Phosphorus	43	75	0	71
Iron	39	57	0	63
Potassium	53	66	4	57
Vitamin A	38	62	0	68
Sodium	21	53	8	64
Vitamin B1	25	61	17	68
Vitamin B2	48	71	4	79
Niacin	21	53	4	62
Vitamin C	62	80	4	72
Zinc	39	66	4	71
Vitamin B6	48	80	0	72
Folate	25	61	0	67
Retinol	39	57	4	66
Carotene	62	84	4	74
Fiber	48	80	8	70
Vitamin E	34	66	4	63
Cholesterol	53	80	4	78

When measuring the reproducibility of an FFQ, one must compare at least two independent measurements of the same situation for the same person (Willett, 1998). If the period between the two measurements is too short, the respondent might remember what he or she reported in the first interview at re-interview. Therefore, the two measurements will not be independent, and reproducibility will be overestimated. However, if this period is too long, the dietary intake of the respondent might change and reproducibility will be underestimated. For example, in a study conducted over intervals of 2.5 years, 2.0 years, and 4-5 months in Iowa, the correlations for repeated administrations were greatest over the shortest interval of 5 months (Willett et al., 1988). As mentioned in a previous study, in order to avoid the influences of memory and physical conditions on recalled dietary habits, a three-month interval may be appropriate for reproducibility assessment (Imaeda et al., 2002).

The reproducibility studies conducted by Willett et al. (1985), with FFQs administered 1 year part, resulted in Pearson's correlations with ranges of 0.52 – 0.71, which is slightly higher than our result. The potential reason is that the respondents in Willett's studies were mainly educated nurses.

The weighted k values and percent agreement found in the present study are similar to those of Hankin et al. (1990), Lazarus et al. (1995), and Pietinen (1988). These comparative studies were conducted in elderly, who have more stable patterns of food purchase, meal preparation, and eating habits, although they were expected to show poorer reproducibility due to failing memory or cognition.

From the results of this reproducibility study and the previous validation, it is highly unlikely that the FFQ has important food or nutrient omissions (Willett, 1998). Furthermore, there is little chance that the FFQ fails to represent an accurate measure of the usual nutrient intake (Goldbohm et al., 1995). These results also indicate that FFQs provide a useful means of categorizing individuals by nutrient intake levels. The FFQ was designed to assess long-term exposure to different nutrients in order to study their potential role as risk factors for chronic diseases and to enable the classification of individuals by nutrient intake. The FFQ will be used in future epidemiological studies, to assess nutritional risk factors of chronic diseases among Korean adults who live in Seoul and its metropolitan area.

The results of this study verify that it is possible to use tailored, relatively simple, but comprehensive, self-administered food frequency questionnaires to study nutrient consumption in large-scale epidemiological studies, and that reasonably high FFQ response rates can be expected. This is a very important finding which demonstrates that dietary data can be collected from Korean adults for epidemiological studies and processed at low-cost with acceptable validity (Kim et al., 2003c) and reproducibility. The present study has additional value since it is the first to demonstrate the validity and reproducibility of a single dietary assessment tool in Korean adults. Further effort should be made to develop novel approaches to test the hypotheses in edpiemiological studies dealing with the relationship of diet to chronic diseases.

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