Validity of a self-administered food frequency questionnaire (FFQ) and its generalizability to estimate dietary folate in Japan: Japan Public Health Center-based prospective (JPHC) FFQ Validation Study

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ABSTRACT

Background: In epidemiological studies, it is essential to test validity of food frequency questionnaire (FFQ) for its ability to estimate dietary intake. The objectives of our study was to 1) to validate a FFQ for estimating folate intake, and to identify the foods that contribute to inter-individual variation of folate intake in Japanese population; and 2) to evaluate the generalizability of the results in an independent Japanese population.

Methods: Validity of a FFQ was evaluated using 28-day weighed dietary records (DRs) as a goldstandard in the two groups independently. In the group which the FFQ was developed for, validity was evaluated by Spearman's correlation coefficients (CCs), and linear regression analysis was used to identify foods with large inter-individual variation. The cumulative mean intake of those foods was compared with total intake estimated by the DR. The external validity of the FFQ and intake from foods on the same list were evaluated in the other group to verify generalizability. Subjects were the subsample of the Japan Public Health Center-based prospective Study who volunteered to participate the validation study of the FFQ.

Results: CCs for the internal validity of the FFQ were 0.49 for men and 0.29 and women, whereas CCs for external validity were 0.33 for men and 0.42 for women. CCs for cumulative folate intake from 33 foods selected by regression analysis were also applicable to an external population.

Conclusion: Our FFQ was valid and generalizable for estimating folate intake. Foods identified as predictors of inter-individual variation in folate intake was also generalizable in Japanese populations.

Key words: folate, FFQ, internal validity, external validity, inter-individual variation

Running head: Internal and external validity for folate intake

INTRODUCTION

In epidemiological studies, dietary intake is often assessed by a means of a food frequency questionnaire (FFQ), because it is easy to administer and imposes little burden on the subject [1]. The limitation of FFQ, however, is that serious errors can occur if foods govern inter-individual differences in intake of certain nutrients are omitted from the list. Such errors can easily occur with respect to folate, because folate is derived from a variety of foods from animal and plant sources all of which cannot be included in the FFQ. The foods that contribute to inter-individual differences may fail to be included on food lists, and that makes it difficult to estimate folate intake by FFQ.

Another implication of investigating the inter-individual variation in the intake of folate or any other nutrient is that they may be the causes underlying associations between food intake and disease. The preventive effect of some foods on diseases is usually an effect of a certain nutrient contained in the food. The association is more likely to be detected when the inter-individual differences in nutrient intake from the food between individuals in the population are larger. On the other hand, even if a food contains a great amount of a nutrient, association is rather weak if many of individuals consume it in the same way. Therefore, identifying the foods that contribute to the inter-individual variation in nutrient intake in the population is important for identifying the nutrients responsible for associations between food intake and disease.

According to the National Nutrition Examination Survey of the U.S. population [2] and the National Nutrition Survey in Japan [3], the folate intake of middle-aged and older age groups are similar in both countries. However, the folate intake by younger generation is much lower in Japan, whereas it is about the same throughout all the age groups in the U.S. population. This trend is presumably due to the differences in the foods that contribute to folate intake. Folate-fortified food and supplements largely contribute to the folate intake for individuals in some Western countries, and questionnaires especially designed to assess folate intake include those items [4, 5]. Because no folate-fortified foods and very few supplements are consumed in Japan, however, folate intake is almost exclusively from natural sources. Nevertheless, little is known about the foods that are the main sources of folate intake among Japanese.

A FFQ was developed and validated for estimation of dietary intake for the JPHC study. When a biomarker was used as a reference, Spearman's correlation coefficients (CCs) between serum folate and folate intake estimated by this FFQ was 0.26 in men [6]. In this report, we used dietary records (DRs) for a gold standard to evaluate the validity of the FFQ in the subgroup of the population for which the FFQ was originally developed. We then attempted to identify foods that contributed to folate intake and foods responsible for the differences in intake between individuals. We subsequently repeated the analyses in another subgroup that was independent of the population for which the FFQ was originally developed, i. e., an external population to assess its generalizability in Japan. The objectives of this study were: 1) to validate a self-administered FFQ as a means of estimating folate intake, and to identify the foods that contributed to individual intake and inter-individual variation in folate intake in the population for which the FFQ was developed; and 2) to evaluate the generalizability of the validity of the FFQ and the foods identified as predictors of inter-individual variation in the external population.

MATERIALS AND METHODS

Study Subjects

Two validation studies of the FFQ were conducted in the subsample of participants in the JPHC Study, which was a large-scale prospective follow-up study in population-based and health-checkup cohorts. The target population of the JPHC Study consisted of two cohorts, one started in 1990 (Cohort I), and the other started in 1993 (Cohort II). The aim of the cohort study is to investigate the association between various lifestyles such as diet and chronic diseases. For a small island, diet of Japanese varies considerably depending on the location. Therefore the study sites were selected with wide-ranged location. Cohort I was mainly northeast part, and Cohort II was southwest part of Japan (Figure 1). The study design and participants in the entire cohort have been described previously [7].

We carried out the FFQ validation study in a subsample of Cohort I and Cohort II. The purpose of the Cohort I study was to validate the FFQ because it was originally developed based on the data from 3-day weighed DRs in a random sample from Cohort I [8], and the Cohort II study was to evaluate the generalizability of the FFQ. The study in Cohort I was initiated in February 1994 to evaluate the validity of the FFQ that was going to be used in the 5-year follow-up survey [9]. A total of 247 volunteers were recruited from the Ninohe, Yokote, Saku and Chubu (previously named Ishikawa) public health center areas. The validation study in Cohort II was initiated in May 1996 to evaluate the validity of the FFQ in an external population independent of the original population for which the FFQ was originally developed [10]. A total of 392 volunteers were recruited from Mito, Kashiwazaki, Chuo-higashi, Kamigoto, Miyako and Suita. For this report, we analyzed the data of 215 and 350 subjects in Cohort I and II, respectively who had complete data of 28-day DRs and the FFQ.

Data Collection

The data collection has been described in detail elsewhere [9, 10]. In brief, each subject completed two FFQs and 28-day DRs (Figure 2). The first FFQ was administered to provide data to compare with the second FFQ as means of evaluating reproducibility, and the second FFQ was administered to obtain data to compare with the DRs to evaluate its validity. Only data from the second FFQ for validity has been used in this paper.

DRs were collected in 7 consecutive days in each of the 4 seasons, except in Chubu (2 seasons). Local dietitians instructed the subjects to weigh all foods and beverages with scales and measuring utensils provided, and to record them in a specially designed booklet. The subjects in Cohort I, however, were instructed to use standardized portion sizes for some foods that were difficult to weigh (semi-weighed DRs). The subjects described each food, method of preparation, and names of the dishes in detail. The subjects also reported all dietary supplements they used, if any. At the end of each season, the DRs were reviewed in a standardized manner, and each food was coded by local dietitians.

The self-administrative semi-quantitative FFQ consisted of 138 food items and 14 supplementary questions such as about the use of dietary supplements and about dietary habits. The validity of the questionnaire in regard to intake of energy, other nutrients and foods, as well as use of dietary supplements is described elsewhere [10-13].

Dietary intake of folate according to both the DRs and the FFQ was calculated using the Standardized Tables of Food Composition, 5th ed. [14]. The mean daily intake of folate for the 28 days (14 days in Chubu) was calculated based on the DRs of each subject. Dietary supplements were not included in the calculation, because none of the subjects used supplements containing folic acid.

Statistical analysis

The means and standard deviation of folate intakes from DRs and FFQ were calculated by sex for Cohort I and Cohort II. Spearman's rank CCs were calculated for crude intake and energy-adjusted intake by the residual method, and were corrected for the attenuating effect of random intra-individual error (deattenuation) in Cohort I subjects to evaluate the internal validity in the population for which the FFQ was developed. The same analysis was performed in regard to the Cohort II subjects to evaluate the external validity

The percentage contribution of each food to total intake was computed based on the DRs of Cohort I subjects. The 20 foods contributing most to the total folate intake were listed based on their percentage contribution. Percentage contributions of the same 20 foods on the DRs of Cohort II were calculated and the actual rank of percentage contributions of those 20 foods in Cohort II was indicated.

A linear regression analysis with stepwise selection was used to identify the foods that contribute to inter-individual variation, with folate intake from each food item according to the FFQ of Cohort I used as the explanatory variable, and total folate intake according to the DRs as the response variable. A model (partial) R-square value for the food items selected was computed. Cumulative mean intake from each food item on the list was calculated, and compared to total intake according to the DRs by Spearman's CCs to evaluate the validity. Cumulative intake from the same food items by the Cohort II subjects and their CCs with the DR data were calculated to evaluate the external validity.

RESULTS

Daily folate intake assessed by DRs and FFQ and their Spearman's rank CCs by cohort group and sex were shown in Table 1. Mean daily intake of folate based on FFQ in Cohort I was overestimated compared to the DR data. The Spearman's CCs of the crude intakes was higher in the males (0.49) than in the female (0.29), however, after energy-adjustment, CC decreased in the male (0.40) and increased in the female (0.35). When CCs were deattenuated for intra-individual variability, they increased in both sexes (0.57 in the male and 047 in the female). Mean daily folate intake based on the FFQ in Cohort II was underestimated in the males and slightly overestimated in the females. In Cohort II, the CCs were higher in the females (0.42) than in the males (0.33). CCs were higher for energy-adjusted values for both males (0.50) and females (0.48) in Cohort II. When CCs were deattenuated for intra-individual variability, the CCs increased in both sexes (0.63 in both sexes).

The list of 20 foods that made the greatest contribution to total folate according to the DR in Cohort I is shown in Table 2. The list consisted of various foods mainly from plant sources such as vegetables. Spinach was the food that made the highest contribution followed by rice, green tea, cabbage eggs and beer. The 20 foods contributed to 55.2% of total intake by the males, and 52.9% by the females. The contribution of the same 20 foods to the folate intake of the Cohort II subjects was 44.9% for the males and 43.2% for the females. The food item which made the second highest contribution in Cohort II, but did not in Cohort I was gyokuro (high-grade green tea) which appeared simply by difference in coding of the food item in DR. Among the other 20 food items with the highest contribution in Cohort II, but not in Cohort I were kamairi-cha (pan-fried green tea), bread, tomatoes, and pumpkins in both sexes, purple laver in males, and sweet potatoes and komatsuna (a green leafy vegetable) in females, however those foods accounted for only 4.6 % of the total intake in males and 6.2 % in females, when both kinds of green tea were not taken account.

The foods that best predicted inter-individual variation in dietary folate, and the validity (correlation coefficients) of folate intake based on those foods are shown in Table 3. A total of 33 foods are listed with the cumulative R-square value of 0.59. The food that best predicted in variation of folate intake was green tea, which contributed 12-15% of total folate intake. There was no other food which was predictive for variation of folate and contributed more than 1% of total folate intake. The cumulated folate intake from the 33 foods contributed approximately 30% of the total intake in both males and females. The CC of intake from the 33 foods in internal population (Cohort I) was 0.46 in the males and 0.28 in the females (indicated as “internal” in Table 3), and they had approximately the same level of validity as the data from the full 138-food FFQ.

When the same 33 food list was used to compute intake in external population (Cohort II), the cumulative folate intake from the 33 foods also contributed 30% (indicated as “external” in Table 3). The CC was 0.30 in the males and 0.35 in the females, and they had approximately the same level of validity as in the internal population.

DISCUSSION

In this study, we evaluated the validity of a FFQ as a means of estimating dietary folate intake in the population for which the FFQ was originally developed. It also attempted to identify the foods that discriminate between individuals' folate intake by stepwise regression, and tested the validity of assessing folate intake based on those foods. The results were also cross-validated in an independent population to evaluate the generalizability.

The validity of the FFQ in estimating folate intake was moderate in both the internal and the external populations. The validity of questionnaires in estimating energy-adjusted dietary folate intake in previous studies varied from 0.2 to 0.6, depending on the study population [15-21]. In the studies that reported intake from the diet and from dietary supplements separately, the CC was 6-21% higher for folate intake that included supplements than for the diet alone. Although none of the subjects used supplements that contained folic acid because they had just become available at the time of the study, the validity of our FFQ was relatively high for estimating folate from the diet, probably because the dietary folate intake of our subjects was as high as that of supplement users in some of the previously-cited studies.

Although the largest proportion of folate intake was from vegetables, they did not necessarily explain the differences in intake between individuals. For example, spinach, which is very rich in folate and was one of the highest contributors to mean folate intake, was not selected as a food that explained the inter-individual variation, because it was consumed by almost every subject. Green tea contributed greatly to individual intake, and also to inter-individual variation, probably because consumption of green tea largely depended on the individuals' preferences. Although the analysis provided us with information about the foods that predicted inter-individual variation in folate intake, some foods which had a moderate partial R-square value contributed less than 0.1% to the total folate intake, such as luncheon meat, ham, and so on. They may have been selected by chance alone. In this kind of analysis, even unimportant contributors to the cumulative R-square value may be statistically significant, but could be ignored [1]. However it was noteworthy to learn that individuals could be ranked by folate intake based on only 33 foods with the same level of validity as with the long FFQ.

When investigating the effect of folate intake on diseases, it is also necessary to investigate the effect of some food items which contributed to total intake and inter-individual variation of folate. It is also of great research interest to determine whether the association between food intake and diseases is the result of folate intake. For example, we might hypothesize that folate was one of the factors that has the protective effect of green tea intake against gastric cancer in the recent report of the JPHC Study [22]. The mechanism of carcinogenesis through DNA instability and methylation abnormalities as a result of folate deficiency had been studied in animal and in vitro studies [23-25], and an association between folate and gastric cancer had been reported in a number of case-control studies [26-29]. However the results from other prospective studies have been inconsistent. We speculated that variation in the food intake that contributed to folate intake other than green tea which may conceal the effects of green tea.

One of the strengths of our study is the precision of the reference data. The ratio of intra- to inter-individual variation in our data was somewhat higher (1.9-4.8) than in some of the prior studies in Western countries [30, 31]. When intra-individual variation is larger, more dietary assessment days are required to be used a s a valid gold standard. Although the intra-individual variation among our subjects was high, the number of days that DRs need to be collected to estimate true intake within 20% of the true mean with our data was about 17 to 19 days, and we ensured a sufficient numbers of days (28 days) of data to represent the true intake of the individuals. On the contrary, the greatest number of days of dietary assessment used as a gold standard was 14 days in previous studies [32].

In addition, our analysis is unique because we used regression analysis to identify the foods most predictive for inter-individual variation in dietary folate, and then evaluated both the internal and external validity of the intake of those foods. It is important to test the external validity, because explanatory variables selected by regression analysis were not assured to be valid in an external population [1]. To our knowledge, this is the first study to attempt to identify foods that contribute to the inter-individual variation of folate intake in Japan, where folate intake is almost exclusively from natural sources. We developed a list of foods that contribute to inter-individual variation in folate intake in the population for which FFQ was originally developed, and tested the generalizability of the results in the external population. Both populations covered various geographic areas throughout Japan. Our result implies the possibility of development of a shorter questionnaire that specifically targets folate intake in Japanese population.

One of the limitations of our study was that because the subjects needed to be highly motivated people to complete 28-day DRs, they were not a randomly selected sample. Mean folate intake based on DRs was slightly higher than in the entire cohort, probably because the validation study subjects may be more health conscious and consumed more vegetables. If all of them had consumed similar amount of certain foods, the inter-individual variation of the food could have been falsely low. The generalizability of the results needs to be carefully done.

CONCLUSIONS

Our FFQ is valid for estimating folate intake and generalizable to the Japanese population. Although some foods such as spinach, rice and cabbage contributed more to total intake of folate, they did not necessarily contribute to the inter-individual variation. The validity of estimation of folate intake based on intake of the 33 foods that contributed to the most to inter-individual variation was about the same as based on the original 138-food FFQ. Although folate is contained in a variety of foods, 33 foods in the FFQ were determinants of explaining the inter-individual variation of intake and ranking individuals' intake in Japan.

COMPETING INTERESTS

None

LIST OF ABBREVIATIONS

FFQ: food frequency questionnaire

DR: dietary record

CC: correlation coefficients

JPHC Study: Japan Public Health Center-based prospective Study

AUTHORS' CONTRIBUTIONS

JI performed data analysis and drafted the manuscript

SY participated in design of study, coordinated study and helped the analysis and preparation of the manuscript

HI helped the analysis and preparation of the manuscript

MI helped the analysis and preparation of the manuscript

ST participated in design of study and helped to draft the manuscript. Principal investigator of the JPHC Study

All authors read and approved the final manuscript.

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Table 1. Folate intake (µg/day) assessed by the DR and FFQ, and their correlation coefficients.

	DR[1]					FFQ[2]					% difference	Spearman correlation		
	Mean	±	SD	Median	Range	Mean	±	SD	Median	Range	of mean	Crude	Energy-adjusted[3]	Deattenuated
Cohort I														
Males (n=102)	425	±	103	427	210-735	473	±	231	444	119-1807	11	0.49	0.40	0.57
Females (n=113)	389	±	106	380	153-667	476	±	287	419	146-1978	22	0.29	0.35	0.47
Cohort II														
Males (n=174)	467	±	156	443	197-1280	421	±	190	370	85-1178	-10	0.33	0.50	0.63
Females (n=176)	426	±	112	417	198-980	454	±	237	397	4-1498	7	0.42	0.48	0.63

[1] DR, dietary records

[2] FFQ, food frequency questionnaire.

[3] Energy was adjusted by a residual model for intake.

For n=102, r>0.20 = p<0.05. For n=113, r>0.19 = p<0.05. For n=174, r>0.15=p<0.05. For n=176, r>0.15=p<0.05.

Table 2. Foods that contribute to folate intake, and their cumulative percentage of contribution to total intake.

Males	Cohort I		Cohort II		Females	Cohort I		Cohort II	
Food items	Rank[1]	%	Rank[2]	%	Food items	Rank[1]	%	Rank[2]	%
Spinach, leaves	1	6.5	3	5.4	Spinach, leaves	1	7.1	3	5.6
Well-milled rice	2	6.4	4	5.0	Green tea, sencha, infusion	2	6.1	1	10.1
Green tea, sencha, infusion	3	5.6	1	9.1	Cabbage, head	3	4.7	5	3.4
Cabbage, head	4	4.9	5	3.6	Well-milled rice	4	4.5	4	3.6
Chicken eggs, whole	5	3.8	6	3.6	Chicken eggs, whole	5	3.5	6	3.1
Beer	6	3.3	7	3.0	Aspargus, shoots	6	2.8	36	0.7
Radish, root with skin	7	2.6	8	2.5	Chiken offals, liver	7	2.5	15	1.2
Pork offals, liver	8	2.4	35	0.7	Radish, root with skin	8	2.5	7	2.4
Aspargus, shoots	9	2.3	34	0.7	Bracken, young shoots	9	1.9	72	0.3
Natto, itohiki-natto (whole fermented using Bacillus natto)	10	2.0	13	1.4	Natto, Itohiki-natto (Whole fermented using Bacillus natto)	10	1.9	10	1.7
Miso, rice- koji miso, dark yellow type	11	1.9	46	0.5	Broccoli, florets	11	1.8	8	2.0
Chiken offals, liver	12	1.8	12	1.4	Miso, rice- koji miso, dark yellow type	12	1.8	55	0.4
Chinese cabbage, head	13	1.8	11	1.7	Chinese cabbage, head	13	1.7	11	1.6
Bracken, young shoots	14	1.6	67	0.3	Ordinary liquid milk	14	1.5	20	1.1
Broccoli, florets	15	1.6	9	1.8	Shoyu: soy sauce, Koikuchi-shoyu (Common type)	15	1.5	23	1.0
Shoyu: soy sauce, Koikuchi-shoyu (Common type)	16	1.6	17	1.1	Head letucce, crisp type, head	16	1.5	22	1.1
Carrots, European type, root with skin	17	1.4	16	1.1	Purple laver, toasted	17	1.5	18	1.1
Potatoes, tuber	18	1.3	23	0.9	Pork offals, liver	18	1.4	34	0.7
Head letucce, crisp type, head	19	1.3	22	1.0	Carrots, European type, root with skin	19	1.4	17	1.1
Leaf mustard, leaves	20	1.2	75	0.2	Potatoes, tuber	20	1.3	26	0.9
Total		55.2		44.9			52.9		43.1

[1] Food items are listed in order of % contribution to total folate intake based on dietary records of Cohort I (by rank in Cohort I).

[2] Rank of % contribution to total folate intake determined on the basis of the dietary records of Cohort II.

Table 3. Foods most predictive of inter-individual variation in dietary folate, and their correlation coefficients with intake from DR.

Foods selected by regression analysis[1]	Male and female		Male						Female					
			Cohort I (internal)			Cohort II (external)			Cohort I (internal)			Cohort II (external)		
	Partial R-Square[1]	Cumulative R-Square[1]	Cumulative mean intake µg/day	(%)[2]	Spearman[3] correlation	Cumulative mean intake µg/day	(%)[2]	Spearman[3] correlation	Cumulative mean intake µg/day	(%)[2]	Spearman[3] correlation	Cumulative mean intake µg/day	(%)[2]	Spearman[3] correlation
Green tea (sencha)	0.096	0.096	72	(15.3)	0.31	55	(13.0)	0.28	55	(11.6)	0.17	66	(14.6)	0.25
Dried small fish	0.070	0.166	73	(15.4)	0.33	55	(13.1)	0.27	56	(11.7)	0.19	67	(14.7)	0.26
Horse mackerel, sardine	0.039	0.204	74	(15.7)	0.37	57	(13.5)	0.27	57	(12.0)	0.20	68	(15.0)	0.24
Cake	0.031	0.236	74	(15.7)	0.37	57	(13.6)	0.27	58	(12.1)	0.19	69	(15.1)	0.24
Miso-soup	0.030	0.266	84	(17.8)	0.37	62	(14.8)	0.28	66	(13.8)	0.24	73	(16.1)	0.27
Luncheon Meat	0.032	0.298	84	(17.8)	0.38	62	(14.8)	0.28	66	(13.8)	0.24	73	(16.1)	0.27
Ham, loin	0.022	0.320	84	(17.8)	0.38	62	(14.8)	0.29	66	(13.8)	0.24	73	(16.1)	0.27
Cream for coffee	0.014	0.335	85	(17.9)	0.37	63	(14.9)	0.28	66	(13.9)	0.24	74	(16.2)	0.27
Stewed pork, Western style	0.012	0.346	85	(17.9)	0.37	63	(15.0)	0.28	66	(14.0)	0.24	74	(16.2)	0.27
Mayonnaise	0.011	0.357	85	(17.9)	0.37	63	(15.0)	0.28	66	(14.0)	0.24	74	(16.2)	0.27
Worcester sauce	0.013	0.370	85	(17.9)	0.37	63	(15.0)	0.28	66	(14.0)	0.24	74	(16.2)	0.27
Kamaboko (fish paste product)	0.014	0.384	85	(18.0)	0.37	63	(15.0)	0.28	67	(14.0)	0.24	74	(16.3)	0.27
Lettuce	0.011	0.395	86	(18.3)	0.37	64	(15.3)	0.30	68	(14.3)	0.25	75	(16.5)	0.27
Bean sprouts	0.015	0.410	88	(18.7)	0.37	66	(15.7)	0.29	71	(14.9)	0.23	77	(16.9)	0.26
Peaches	0.017	0.427	89	(18.7)	0.38	66	(15.8)	0.29	71	(14.9)	0.23	77	(17.0)	0.26
Sausage, Wieners	0.011	0.437	89	(18.7)	0.38	66	(15.8)	0.29	71	(14.9)	0.23	77	(17.0)	0.26
Chocolate	0.009	0.446	89	(18.8)	0.38	67	(15.9)	0.29	71	(15.0)	0.23	78	(17.1)	0.26
Octopus	0.008	0.455	89	(18.8)	0.38	67	(15.9)	0.29	71	(15.0)	0.23	78	(17.1)	0.26
Salted fish	0.008	0.463	90	(19.1)	0.38	68	(16.0)	0.30	73	(15.2)	0.23	78	(17.2)	0.26
Apples	0.010	0.473	92	(19.5)	0.38	69	(16.3)	0.31	75	(15.8)	0.24	80	(17.6)	0.26
Sweet pepper	0.012	0.485	94	(19.8)	0.39	70	(16.6)	0.31	77	(16.1)	0.26	81	(17.9)	0.27
Udon	0.011	0.496	95	(20.0)	0.39	71	(17.0)	0.30	78	(16.3)	0.25	82	(18.1)	0.27
Grilled chicken	0.014	0.510	95	(20.1)	0.39	72	(17.1)	0.30	78	(16.4)	0.25	83	(18.2)	0.27
Pickled plums	0.009	0.519	95	(20.1)	0.39	72	(17.1)	0.30	78	(16.4)	0.25	83	(18.2)	0.27
Papaya	0.009	0.528	96	(20.2)	0.39	73	(17.3)	0.29	79	(16.5)	0.25	83	(18.4)	0.27
Black tea	0.007	0.536	96	(20.4)	0.39	73	(17.4)	0.30	79	(16.7)	0.24	84	(18.5)	0.28
Green tea (bancha, genmaicha)	0.007	0.542	105	(22.1)	0.42	83	(19.8)	0.33	88	(18.6)	0.25	95	(21.0)	0.35
Chicken liver	0.007	0.550	122	(25.8)	0.45	98	(23.2)	0.32	101	(21.2)	0.28	107	(23.6)	0.34
Bananas	0.008	0.557	126	(26.6)	0.46	101	(24.1)	0.32	104	(21.9)	0.27	111	(24.3)	0.34
Rice mixed with other grains	0.005	0.562	128	(27.1)	0.45	103	(24.5)	0.33	107	(22.5)	0.27	112	(24.8)	0.34
Well-milled rice	0.011	0.573	152	(32.2)	0.49	124	(29.5)	0.30	125	(26.2)	0.29	128	(28.3)	0.34
Yushi-dofu	0.006	0.579	153	(32.3)	0.49	125	(29.6)	0.30	125	(26.3)	0.29	129	(28.4)	0.34
Bitter gourds	0.011	0.590	158	(33.3)	0.46	128	(30.5)	0.30	130	(27.2)	0.28	132	(29.1)	0.35

[1] Foods were selected by stepwise regression analysis using data from the food frequency questionnaire of the Cohort I male and female. Partial and cumulative R-Square values were calculated in the process of performing the regression analysis.

[2] Percent of total folate according to the food frequency questionnaire.

[3] Spearman's correlation coefficients between cumulative intake and total intake base on dietary records

Figure legend

Figure 1. Study sites of the JPHC Study.

Figure 2. Sequence of data collection for the JPHC FFQ Validation Study

Figure 1. Study sites of the JPHC Study

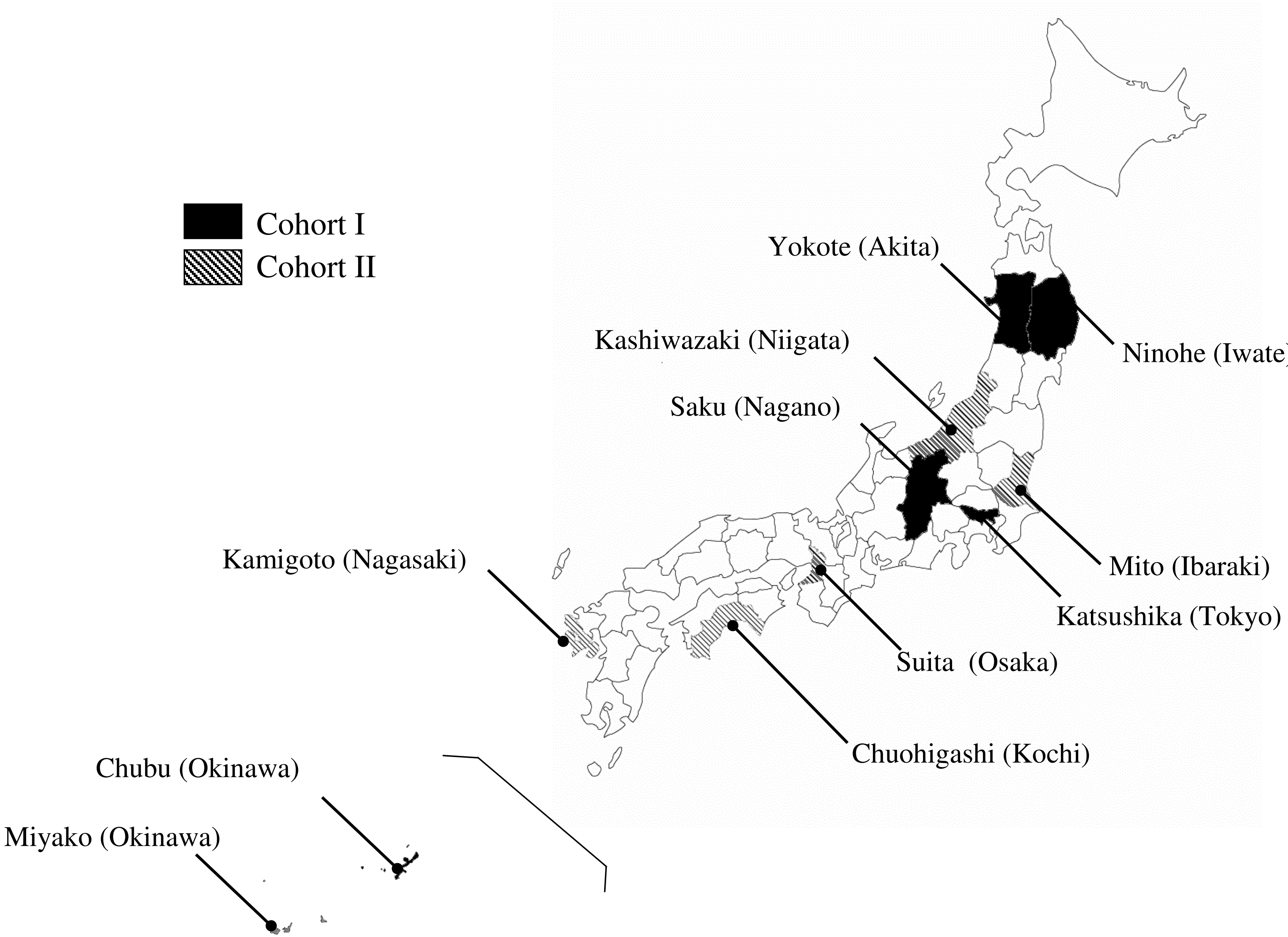

Figure 1

Figure2. Sequence of data collection for the JPHC FFQ Validation Study.

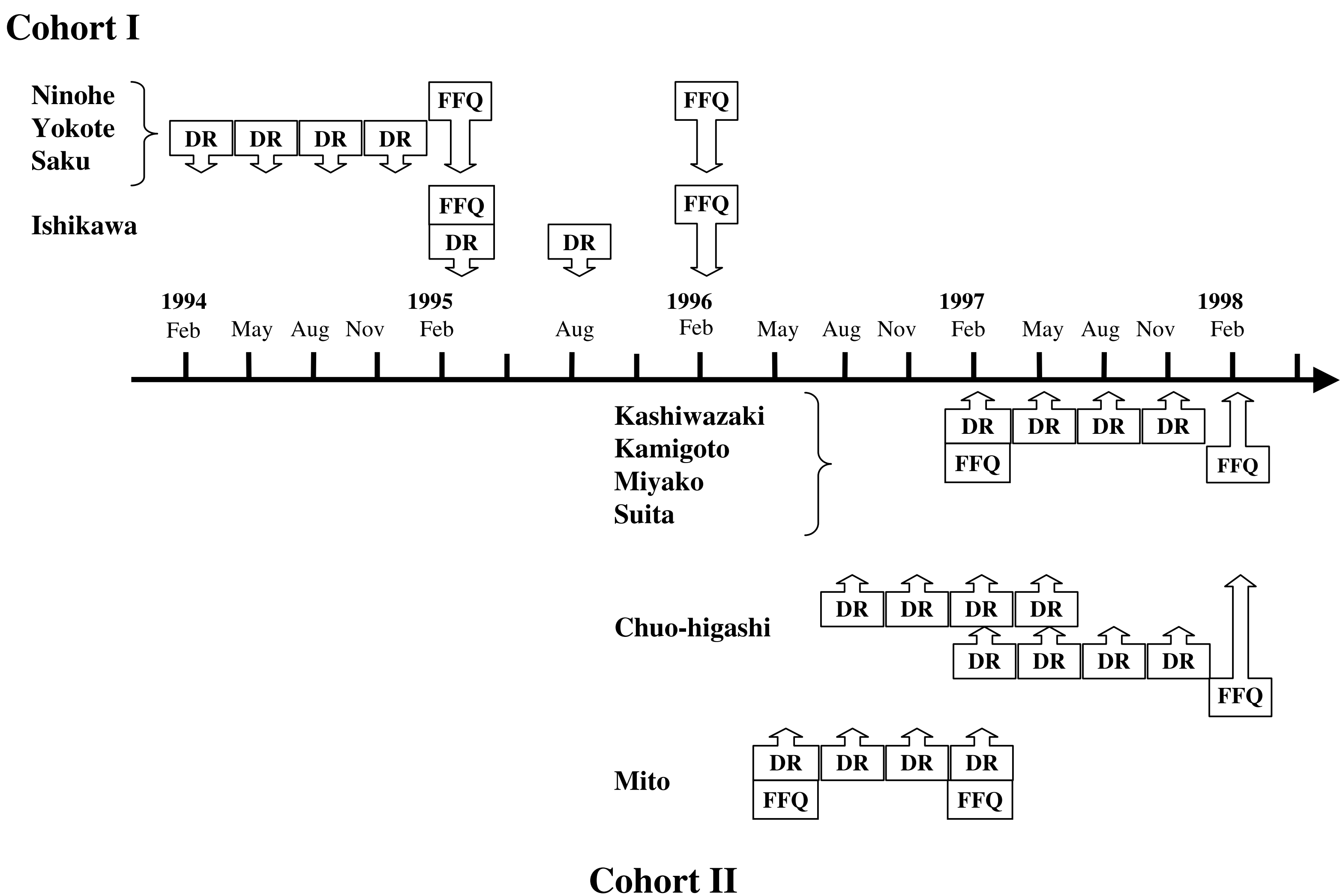

Figure 2