Original Article

Item non-responses in mailed food frequency questionnaires in a Korean male cancer cohort study

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Item non-responses are frequently encountered in mailed food frequency questionnaires (FFQs) in epidemiological studies. The effects of item non-responses in a FFQ on presumed nutrient intake and subject classifications were examined in this study of a male cancer cohort in Korea. A semi-quantitative FFQ was developed and mailed to adult males aged between 40 and 59 in Seoul. Among the 14,533 cohort participants, 7,647 subjects who fully completed the FFQ initially and 216 subjects who completed the frequency missing items at resurvey were compared. When item non-responses were treated as not eaten, the average nutrient intakes of this group were significantly lower than both the average intake of subjects who fully completed at the initial survey and the average intake of those who completed at the resurvey. Increases in nutrient intakes during resurvey were substantively proportional to the number of items originally omitted. Cross classifications of item non-response subjects by nutrient intake after the initial survey and after resurvey showed misclassification towards lower quantile. Moreover, distribution of 'never or seldom' answer of resurvey group was similar to initial complete group. These results indicate that treating item non-responses as not eaten introduces bias when estimating nutrient intakes or when classifying subjects on the basis of nutrient intakes. More study is required to determine how best to treat non-response items in FFQ.

Key Words: cross classification, food frequency questionnaire (FFQ), item non-response, cancer cohort study, Korea

Introduction

In epidemiological studies on diet and disease relationships, food frequency questionnaires (FFQs) are preferred, not only because of the cost, but also because the average long-term dietary intake of participants can be obtained easily by an administration. However, mailed self-administered FFQs are prone to problems associated with low response rates and item non-responses.[1,2] Willett[3] speculated that participants left items unanswered because of inattention or carelessness or because participants did not believe that the food items were of relevance. In studies involving FFQs, researchers have often excluded records with item non-responses.[4-7] Willett *et al.*,[4] excluded subjects with 10 or more item non-responses from a food frequency questionnaire containing 60 items in a Nurses' Health Study, but in a later Health Professional Follow-Up Study, all subjects with less than 70 item non-responses from a questionnaire containing 131 food items were included.[5] Riboli *et al.*,[6] excluded subjects with more than seven items missing, from a food frequency questionnaire developed at the U.S. National Cancer Institute, which contained 97 food items. However, the exclusion of such subjects does not only inevitably decrease the sample size, but it can also introduce bias in the final sample. When they excluded the records with item non-responses, the exclusion criteria have largely been dependent on the judgment of researchers. The others have treated the item non-responses as 'null consumption'.[8-10] Caan *et al.*,[8] reported that when subjects submitting item non-responses were followed-up, items were generally left blank because the food items were not consumed. However, when they compared the nutrient intakes of subjects with item non-responses before and after follow-up, nutrient intake levels were found to have increased. Nevertheless, they concluded that item non-responses do not affect the rankings of subjects unduly, especially when only a few items are missing.

The present study was undertaken to analyze the possible errors caused by item non-responses when they were treated as not consumed in a mailed FFQ in a Korean male cancer cohort. Subjects were initially surveyed by using a mailed FFQ. Subsequently, questionnaires with item non-responses were re-mailed, and participants were requested to complete those items left blank at the initial survey. The results from the participants who had item non-responses at the initial survey but who successfully completed the questionnaire at the resurvey were

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used to estimate the errors associated with the treatment of item non-responses as not eaten.

Methods

Study population

As an integral part of the 1992 Seoul Cancer Cohort study[11], a FFQ containing 84 food items, frequently consumed by Korean adults was mailed to 29,918 Korean males in the 40-59 age group. Of the 29,918 subjects mailed, 14,533 responded (48.6%) and 7,660 fully completed the food frequency questionnaire at the initial survey. After excluding 13 records, because all of the answers were 'never or seldom', 7,647 subjects were deemed as having completed the questionnaire satisfactorily at the initial survey and defined as the CI group. Participants with item non-responses on the initial food frequency questionnaire were followed-up by mail within 3 months, and requested to complete the items that were unanswered at the initial survey. Of the 6,873 subjects who had item non-responses in consumption frequency or portion size contacted, 2,651(38.6%) responded. Among those, we selected 216 subjects who had fully completed the FFQ during the resurvey and defined as the CR group. This work has been done in accordance with international accepted ethical standards.[12]

Food Frequency Questionnaire (FFQ)

The semi-quantitative FFQ used was developed from a pilot dietary survey of adult male subjects living in Seoul, and was based upon the 24-hour recall method. This FFQ consisted of 84 frequently consumed food items, which were presented as a list and grouped on the basis of nutrient contribution and relationship with cancer. Eight answers were possible for consumption frequency, ranging from 'never or seldom' to 'twice a day or more'. The portion size of each food item was provided as small, medium and large. The development and validation of the FFQ has been previously described.[13]

Nutrient intake was calculated based on the Korean Nutrient Database compiled by The Korean Nutrition Society.[14] Daily nutrient intake levels of subjects were calculated from the daily average consumption frequencies and the daily average portion sizes. Responses to the FFQs were classified as complete, only if the consumption frequency and portion size of every item had been completed. For questionnaires with item non-responses, nutrient intakes were calculated by treating item non-responses as not eaten.

Data analysis

Differences of the mean nutrient intakes of the CI group and the two states of the CR (N = 216) group, i.e., before and after completing initial non-responses were compared. Nutrient intake levels were presented as mean (± SEM) and multiple comparisons of mean were test by Scheffé method of GLM procedure. Mean differences of nutrient intakes assumed before and after resurvey of CR group by the number of item non-responses in consumption frequency. Classification errors were estimated after quantile classifications of total 7,863 responders (i.e the CI + CR group). Total responders including the individuals of CR group before and after the resurvey were classified into four levels. CR group were extracted from total responders and cross-classified by quantile levels of total responders. The agreement rates were used to test for classification errors due to item non-responses. The SAS version 8.02 was used for statistical analyses (SAS Institute Inc, Cary, NC, USA).

Results

The distribution of CR group subjects by the number of food items with item non-response in consumption frequency at the initial survey is shown in Table 1. The least number of non-response items was 1, and the greatest was 84. The most common number of item non-responses was 1. Among the 216 subjects in CR group, more than half of subjects had had less than 2 non-response items and 158 (73.1%) had less than 8 non-response items (less than 10% of the total items). However, a considerable proportion of subjects, 18 (8.33%), had more than 40 items non-responded to at the initial survey.

Table 1. Distribution of subjects by the number of non-response food items in the CR[1] group.

Number of food items non-responded at the initial survey	Number of subjects	Cumulative number of subjects	%	Cumulative %
1	101	101	46.76	46.76
2	27	128	12.50	59.26
3	7	135	3.24	62.50
4	4	139	1.85	64.35
5	8	147	3.70	68.06
6	6	153	2.78	70.83
7	5	158	2.31	73.15
8 ~ 10	6	164	2.78	75.93
11 ~ 20	15	179	6.94	82.87
21 ~ 30	8	187	3.70	86.57
31 ~ 40	11	198	5.09	91.67
41 ~ 84	18	216	8.33	100.00

[1]CR: Subjects who had completed the questionnaire at the resurvey.

Mean values of energy, carbohydrate, phosphorus, β-carotene, and niacin intakes of the CR group at the initial survey were significantly lower than those of the CI group (Table 2). However, after filling out the item non-responses nutrient intakes of CR group became statistically the same. This increase ranged from 5% in vitamin C to 13.6% in carbohydrate intake which was almost proportional to the number of non-response items (Table 3). For those subjects with less than 4 original item non-responses, out of a total of 84 items, energy intake increased by 605 kJ (144 kcal) after resurvey, protein intake by 2.9g and fat intake by 2.0g. For those with 13-20 item non-responses, energy intake increased by 2822 kJ (672 kcal), protein 22.63g and fat by 9.4g.

Although the influence of item non-responses on the perceived nutrient intake levels of the subjects presumably

Table 2. Nutrient intake levels of study subjects who completed the food frequency questionnaire either at the initial survey or at the resurvey

Nutrients	Subjects with item non-response at the initial but completed at resurvey (CR group) (N = 216)			Subjects who completed at initial survey (CI group) (N = 7647)	P
	Initial survey[1)]	Re- survey	Difference (%)[2)]		
Energy (kJ)	8001 ± 296[b]	9016 ± 293[a]	11.3	8884 ± 19.8[a]	0.0117
(kcal)	1905 ± 69.8	2146 ± 70.7		2115 ± 11.9	
Protein (g)	75.8 ± 3.43[a]	82.7 ± 3.44[a]	8.4	77.4 ± 0.50[a]	0.1895
Fat (g)	54.5 ± 3.20[a]	59.1 ± 3.17[a]	7.7	58.3 ± 0.54[a]	0.4947
Carbohydrate (g)	264 ± 9.94[b]	305 ± 9.62[a]	13.6	303.8 ± 1.75[a]	0.0006
Ca (mg)	758 ± 39.5[a]	812 ± 40.5[a]	6.7	741.3 ± 5.58[a]	0.105
P (mg)	1069 ± 45.2[b]	1184 ± 45.5[a]	9.6	1119 ± 6.76[ab]	0.134
Fe (mg)	15.6 ± 0.72[a]	16.8 ± 0.73[a]	7.1	15.1 ± 0.12[a]	0.177
Vitamin A (RE)	645 ± 37.3[a]	692 ± 37.7[a]	6.8	603.0 ± 6.53[a]	0.050
Retinol (RE)	31.1 ± 2.57[a]	33.2 ± 2.64[a]	6.4	30.8 ± 0.40[a]	0.666
β -carotene (μ g)	786 ± 85.6[b]	829 ± 86.0[a]	5.2	631.9 ± 10.3[a]	0.001
Thiamin (mg)	1.18 ± 0.06[a]	1.30 ± 0.06[a]	8.5	1.18 ± 0.009[a]	0.117
Riboflavin (mg)	1.20 ± 0.06[a]	1.31 ± 0.06[a]	8.4	1.20 ± 0.009[a]	0.112
Niacin (mg)	16.8 ± 0.77[b]	18.4 ± 0.77[a]	8.8	16.97 ± 0.1117[a]	0.118
VitaminC (mg)	98 ± 5.06[a]	104 ± 5.05[a]	5.0	96.2 ± 0.80[a]	0.339

1) Nutrient intake levels were calculated by treating item non-responses as not eaten. Real value (resurvey)-Treating as not eaten (initial survey) ; 2) Difference(%) = - × 100 Real value (resurvey); 3) Multiple comparisons of mean were test by Scheffé method of GLM procedure. D.f (2, 8076); CI: Subjects who had completed the questionnaire satisfactorily at the initial survey; CR: Subjects who had completed the questionnaire at the resurvey.

depend on the nutrient contents of the omitted items, our results indicate that the number of item non-responses on the questionnaire could be used to estimate the uncounted nutrient intake. Usually, most nutrients showed sharp increases at the number of 9~12 food items missed. Among those subjects with 21 or more non-response items, the increases in nutrient intake upon re-survey were not as proportional as for those with less than 20 non-response items (data not shown).

In epidemiological studies on diet and disease relationships, subjects are often classified into several groups according to their intake levels of the nutrients of interest. The misclassification of subjects, rather than of dietary intake levels, imposes a severe bias on the data analysis. The extent of error in the quantile classification of subjects with item non-responses was estimated by joint classification of CR group before and after resurvey among the quantile levels of total responders (CI + CR group). The initial quantile classification was determined using nutrient intake levels calculated on the basis of treating item non-responses as not eaten. The quantiles of the total responders were again determined after resurvey. In the lowest quantile of initial survey, overall 77% of subjects were classified into same quantile after resurvey and 15% were into neighboring quantile. In the highest quantile of initial survey, over 99% of subjects were classified into the same quantile after resurvey. It showed that the majority classification errors in the CR group occurred in subjects in the lower quantile of nutrient intakes at the initial survey (Table 4).

Some researchers have argued that subjects leave items blank because the items are not consumed. This idea was tested by comparing the percentages of 'never or seldom' answers in the consumption frequency of the CI and CR groups (Table 5). Among the 84 food items, 76 items were answered 'never or seldom' higher proportion in the CR group, and 8 items in CI group. For 25 food items, the difference in the proportion of 'never or seldom' answers in the CI and CR group was statistically significant. Among them the following 24 items (jam/honey/syrup, sushi, dog meat, fresh/frozen/dried fish, mayonnaise, fish stew, soybeans, tofu, mungbean pancake, apple, peach, plum, pear, strawberry, grape, kiwi, orange juice, tomato juice, yogurt, cheese, coffee, black

Table 3. Mean differences of nutrient intakes before and after resurvey in the CR group according to the number of item non-responses in the initial survey

No. of Item non-responses in consumption frequency	1~4 (*N* =139)	5~8 (*N* = 20)	9~12 (*N* = 11)	13~20 (*N* = 9)	*P*
Energy (kJ)	605.2[b] ± 99.3[b]	798.4[b] ± 454	2126[ab] ± 1246	2822[a] ± 1050	0.0002
(kcal)	144.1 ± 0.53	190.1 ± 108	506.2 ± 296.7	671.9 ± 250.1	
Protein (g)	2.9[b] ± 6.3	4.2[b] ± 2.8	14.1[ab] ± 6.9	22.3[a] ± 8.7	< 0.0001
Fat (g)	2.0[b] ± 0.19	2.5[b] ± 1.2	7.0[a] ± 2.2	9.4[a] ± 3.3	< 0.0001
Carbohydrate (g)	27.4[b] ± 5.0	35.7[b] ± 20.2	92.1[ab] ± 60.5	117.4[a] ± 45.5	0.0019
Ca (mg)	25.3[b] ± 4.8	16.3[b] ± 3.8	62.0[b] ± 21.2	196.2[a] ± 110.4	< 0.0001
P (mg)	57.5[b] ± 8.2	69.3[b] ± 38.6	220.3[ab] ± 112.1	325.8[a] ± 123.3	< 0.0001
Fe (mg)	0.4[b] ± 0.07	0.5[b] ± 0.2	2.4[a] ± 0.9	3.6[a] ± 1.7	< 0.0001
Vitamin A (R.E.)	5.9[b] ± 2.4	5.0[b] ± 3.2	36.2[a] ± 20.0	57.4[a] ± 31.1	< 0.0001
Retinol (R.E)	0.68[a] ± 0.42	0.02[a] ± 0.02	7.3[a] ± 4.6	2.3[a] ± 1.3	0.0034
β-carotene (ug)	16.2[b] ± 13.5	2.87[b] ± 2.28	98.6[a] ± 68.6	189.3[ab] ± 171.7	0.0303
Thiamin (mg)	0.05[b] ± 0.009	0.08[b] ± 0.06	0.24[ab] ± 0.15	0.30[a] ± 0.11	< 0.0001
Riboflavin (mg)	0.06[b] ± 0.007	0.05[b] ± 0.02	0.16[ab] ± 0.07	0.28[a] ± 0.12	< 0.0001
Niacin (mg)	0.7[b] ± 0.13	1.0[b] ± 0.6	3.19[a] ± 1.64	4.38[a] ± 1.44	< 0.0001
Vitamin C (mg)	0.8[b] ± 0.23	1.0[b] ± 0.67	9.25[a] ± 4.53	13.1[a] ± 9.07	< 0.0001

[1]Nutrient intake of initial survey was calculated by treating item non-responses as not consumed.

Table 4. Agreement rates of CR group subjects in terms of the quantile classifications of the nutrient intake level of the total responders

Initial quantile[1]	Lowest			Highest		
Actual quantile of nutrient intake after resurvey						
Nutrient	1st	2nd	4th	1st	2nd	4th
Energy	61.84	23.68	526	0	0	100
Protein	73.97	16.44	2.74	0	0	94.12
Fat	82.09	11.94	2.99	0	0	100
Carbohydrate	63.41	17.07	6.1	0	0	100
Ca	86.15	10.77	1.54	0	0	100
P	74.07	16.05	2.47	0	0	100
Fe	80.6	13.43	2.99	0	0	100
Vitamin A	81.97	11.48	4.92	0	0	100
Retinol	89.83	6.78	0	0	0	98.08
β-carotene	77.42	19.35	1.61	0	0	100
Thiamin	75.76	15.15	4.55	0	0	100
Riboflavin	72.73	20.78	13	0	0	100
Niacin	75	16.67	2.78	0	0	100
Vitamin C	84.91	11.32	0	0	0	100
Mean	77.125	15.065	2.80	0	0	99.44

[1]Nutrient intakes before resurvey were calculated by treating the item non-responses are not eaten; [2]Multiple comparisons of mean were test by Scheffé method of GLM procedure. Df (2, 175)

Table 5. The comparison of proportion of those who answered 'never or seldom' at the initial survey and who left blank at the initial survey but completed the item at resurvey for consumption frequency

Food items	Proportion of 'never or seldom' intake (%)		Food items	Proportion of 'never or seldom' intake (%)	
	CI group (*N* = 7647)	CR group (*N* = 216)		CI group (*N* = 7647)	CR group (*N* = 216)
White breads/toast	56.9	58.3	Kimchi stew	5.9	12.5
Donuts	84.4	86.8	Soybean paste stew	2.9	9.1
Other breads	54.8	61.7	Fish stew[1]	11.5	43.8
Butter (with breads)	83.2	90.7	Seaweeds	13.1	23.5
Margarine (with breads)	87.6	93.2	Laver	12.5	17.6
Jam/Honey/Syrup (with breads) [1]	66.1	84.1	Eggs	21.5	36.8
Cooked rice	4.6	3.2	Soybeans[1]	29	54.2
Cooked rice, brown	80.9	78.9	Tofu[1]	8	25
Mixed rice	43.8	34.2	Mungbean pancake[1]	64.4	89.3
Fried rice	68.2	74.4	Tomato	25.9	31.6
Rice cake	46.5	54.5	Mandarin orange	9.8	12.5
Sushi[1]	59.9	82.5	Grapefruit/Orange	75.7	77.8
Dumpling	57.6	66.7	Apple[1]	4.6	25
Noodles	20.8	30	Peach[1]	24.4	55.6
Buckwheat noodle	52.7	41.5	Plum[1]	58.9	80
Ramyon	38.8	34.4	Banana	47.7	59.1
Pizza	89.9	93.6	Pear[1]	17.7	50
Boiled potatoes	43.6	52.8	Melon	24.8	33.3
Fried potato	66.1	69	Watermelon	16.3	28.6
Beef	6.5	10.5	Strawberry[1]	19.9	40
Thick beef soup	15.5	26.1	Grape[1]	21.2	43.8
Pork	20.3	28.6	Kiwi[1]	83	97.1
Pork belly/Bacon	34.9	34.6	Orange juice[1]	33.2	62.5
Chicken/Turkey/Duck	37.3	39.1	Tomato juice[1]	60.9	78.8
Dog meat[1]	59.7	77.8	Vegetable juice	67.4	76.7
Liver	84.3	85.3	Other juice	44.6	58.3
Sausage	74.2	82.9	Ice-cream	60.5	77.3
Raw fish	33.2	40.9	Yogurt[1]	58.9	81
Salted fish	24.5	33.3	Cake/Chocolate/Candy	52	60.9
Fresh/Frozen/Dried fish[1]	30.6	50	Nuts	39.2	33.3
Processed fish	58.6	72.7	Milk	28	46.7
Squids	23.9	27.3	Soymilk	68.9	82.8
Shrimp/Shell fish/Oyster	34.6	51.9	Cheese[1]	82.6	96.6
Salt fermented seafood	51	64.9	Coffee[1]	16.5	71.4
Kimchi/Kkakduki	1.9	11.1	Black tea[1]	75.1	100
White Kimchi[1]	45.5	33.3	Green tea	53.3	58.3
Green vegetables	11.1	15.4	Carbonated beverage[1]	37.7	75
Native lettuce	6.2	9.1	Garlic	18.4	30.8
Lettuce	47	58.1	Onion	25.9	38.1
Green yellow vegetables	21.6	38.1	Ginseng	45.9	62.5
Boiled vegetables	7.7	16.7	Stirred starch vermicelli with vegetables	52.3	69.6
Mayonnaise[1]	57.3	77.8	Pickles[1]	46.8	73.7

CI: Subjects who had completed the questionnaire satisfactorily at the initial survey. CR: Subjects who had completed the questionnaire at the resurvey. [1]represents significantly different food items in proportion of 'never or seldom' at 95% CI.

tea, carbonated beverages, pickles) received a higher proportion of the answer 'never or seldom' in the CR group. Only one item (white kimchi) received a higher proportion of 'never or seldom' answers in CI group. Items that showed large differences in terms of the answer 'never or seldom' in the two groups and were higher in the CR group tended to be items that showed low levels of the 'never or seldom' response in the CI group. There were 12 items had more than double proportion of 'never or seldom' answer in CR group. These 12 items (kimchi/kkakduki, boiled vegetables, kimchi stew, soybean paste stew, fish stew, tofu, apple, peach, pear, strawberry, grape, coffee) tended to have lower percentage of 'never or seldom' answers in the CI group, but the percentage of 'never or seldom' in the CR group was still relatively low except 'coffee' although higher than in the CI group. They were items consumed at higher frequency by Koreans.[15] For example, 'never or seldom' answer for kimchi/kkakduki, the most favorite side dish for Koreans, was 1.9% in CI group but 11.1.% in CR group - more than five times that of the CI group but 88.9% of the CR group consumed the item at higher frequency. Although the overall percentages of the 'never or seldom' answer tended to be higher in the CR group than in the CI group, they were in the similar range (53.0% ± 25.7 vs. 41.2% ± 24.5).

Discussion

The results of our study implies that treating such item non-responses of consumption frequency on FFQ as not eaten might result in errors, both in terms of the absolute nutrient intake levels and in terms of the quantile classifications of subjects by nutrient intake levels. And according to the comparisons of the percentage of 'never or seldom' answers (Table 5), we do not believe that all subjects failing to complete at the initial survey left items blank because they did not eat them.

If indeed non-response means that the item was not consumed, nutrient intake levels of CR group would not increase after completing item non-responses at resurvey. This study showed increases of nutrient intakes after resurvey. The observed increases were almost proportional to the number of items omitted initially, and to be much higher than that reported by Caan *et al.*[8] The mean increase of energy intake among the subjects with 1-4 item non-responses at the initial survey was 46.1kcal in the study of Caan *et al.*, but 144kcal in our study. It is not clear why this difference occurred, but our questionnaire contained mainly Korean food items. Even though it would not be appropriate to try to compare the results directly, the results of both studies consistently show that increases in nutrient intake levels are almost proportional to the number of item non-responses at the initial survey. Moreover, we could make the critical numbers of item non-response we must investigate by considering the distribution of subjects by the number of item non-responses (Table 1) and nutrient increases by the number of item non-responses (Table 3). In our data, item non-responses under 8 are much room for consideration.

Many studies on diet and disease relationships have compared disease risks in subjects with different nutrient intakes. In such studies, the classification of subjects into groups is often of more interest than the absolute intake levels. When all subjects complete their questionnaires, nutrient intake levels can be calculated and subjects can be properly classified into groups on the basis of their nutrient intake levels. When items not responded to are treated as not eaten, the subjects may or may not be classified into their appropriate groups. Our study proved that treating missing item as not consumed made nutrient intakes be underestimated, and classified some of the subjects (about 23%) into lower level quantile than true. In the present study, we assumed no dietary pattern changes in the resurveyed subjects. The interval between initial survey and resurvey was about 3 months and the subjects were asked to consider their food consumptions over the previous 12 months. It would not be unreasonable to believe that the differences between the initial survey and the resurvey were mainly due to treating item non-responses as not eaten at the initial survey. Item non-responses in mailed FFQs are inevitable.

We focused on the consumption frequency in this study. In terms of portion size, Caan *et al.*,[8] reported that omitted portion size was less of a problem than omitting frequency, because people checked 'medium' for portion size about 70% of the time. In our data, just 2.3% of subjects with item non-response in portion size answered that they did not eat the non-response items at resurvey. Therefore, imputation of medium value for portion size omitted items with consumption frequency information could be one way of treating the data.

Although Kuskowska-Wolk *et al.*,[16] reported that their follow up respondents stated that they omitted items because they were not eaten, they did not concluded that generally omitted answers mean that the food items are 'never or seldom' consumed. Participants might inadvertently omit an answer. Willett[3] also speculated that participants leave items unanswered because of inattention or carelessness. There were mostly just one item missings in Table 1. That might be caused by carelessness.

Hansson and Galanti[9] concluded that treating the item non-response as 'zero consumption' was fairly reasonable in their case-control study. They concerned the various 'true' proportions of null consumption (ranged 0-95%) by food items. They quantified the 'true proportion' of 'zero consumption' as about 50% averagely, but they did not report the proportions compared with those from source population. Our comparison table showed the similarity of the proportion of 'never or seldom' answers in complete group and resurveyed group. Hansson and Galanti[9] construed the highest 'true' proportion of zero consumption for those foods that have a low consumption frequency whereas the lowest for foods with high frequency of consumption. Their explanation was different from ours. The highest 'never or seldom' proportion items like 'butter', 'margarine', 'pizza', and 'kiwi' in CR group were hardly consumed foods in middle aged men in Korea. And 'never or seldom' proportions of those foods in CI group were also the highest.

They pointed out the limitation of their study to generalize the results for some reasons. Our study also has the same problems. This study was not based on the random sample of the study population, either, and sample size was small. Nevertheless, our results demonstrate that

researchers using mailed FFQ in epidemiological studies should manage item non-responses properly, and exercise care in the development of a suitable technique. Insufficient attention has been paid to the development of ways to treat non-response items on food frequency questionnaires, indeed. Because the deletion of records with item non-responses reduces sample size[6] and treating missing items as not-eaten may result in errors, it is important to treat item non-responses optimally to reduce result bias, and allow accurate assessment of the dietary intake and classification of subjects by nutrient intake levels. It is necessary to investigate the treating strategy of omitted answers in FFQ.

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Original Article

Item non-responses in mailed food frequency questionnaires in a Korean male cancer cohort study

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在一项韩国男性癌症队列研究中邮寄给予食物频率调查问卷存在的未应答项情况

流行病学研究采用邮寄方式给予受试者食物频率调查问卷，时常会遇到未应答项的情况。韩国一项关于男性癌症的队列研究，调查了食物频率调查问卷中未应答项对假定的营养素摄入量和病人分类的影响。一份半定量食物频率调查问卷邮寄给汉城年龄在 40 到 59 岁的男性。在 14533 位参与者中，7647 位一次性完成了食物频率调查问卷，216 位在再次调查中补充回答了原来的未应答项。当未应答项按照摄入量为零来处理时，该组人群平均营养素摄入量会显著低于一次性完成问卷和在再次调查中完成问卷的人群的平均摄入量。在再次调查中营养素摄入量的增加实质上和原先未应答项的数目成比例。原始调查和再次调查后，以营养素摄入量对未应答人群进行交叉分类，对低值区间块会出现误分类。 此外，再调查组回答为“从不或很少”的分布和一次性就完成问卷的组相似。 这些结果表明，当估计营养素摄入量或以营养素摄入量为基础将受试者分类时，将未应答项以摄入量为零计会导致偏差。如何最好地处理食物频率调查问卷中未应答项还需要更多的研究。

关键词：交叉分类，食物频率调查问卷，未应答项，邮寄。