

음식 중심의 식품섭취빈도 조사지 개발을 위한 상용 음식 추출 시 성별에 따른 차이 분석

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Gender Analysis of Food Items Selection for Food Frequency Questionnaire Development

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Background: The aims of this study were 1) to compare foods between men and women with high contributions to absolute intake and the variability in energy and nutrient intakes, which are common criteria of selecting foods for food frequency questionnaire (FFQ), 2) to analyze possible inaccuracies due to not taking gender into consideration.

Methods: The study used 1-day 24 hour recall data of 7,952 participants (n=3,250 men, n=4,702 women) aged 19-64 years who participated in the 2013-2014 Korea National Health and Nutrition Examination Survey. Foods which have high possibility of being included in FFQ items, called candidate foods, were selected by analyzing their contribution to absolute intake and variability in the intakes of energy and 15 nutrients in total participants, men and women.

Results: The number of candidate foods selected was 133 for total participants, 126 for men, and 153 for women. Intakes of candidate foods for total participants were significantly higher in energy and six nutrients out of selected 16 nutrients than those of candidate foods for men only. On the contrary, all nutrient intakes of candidate foods for total participants were significantly lower than those of candidate foods for women only.

Conclusions: Differences were revealed between men and women not only in the total numbers, but also in the selected food items from the candidate foods for FFQ. Thus, developing FFQs without considering gender may produce systematic errors in dietary assessment, possibly in different directions for men and women.

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Introduction

The selection of an appropriate food list during the development of food frequency questionnaires (FFQs) is essential for adequate assessment of the dietary intake of study populations.^{1,2)} Such a list should include not only foods that are major sources of nutrients, but also those that are important with respect to between-person variance in intake

of energy and nutrients.²⁻⁴⁾

Individual dietary intakes from dietary survey can be influenced by many factors such as sex, day of the week, and environmental factors including economic status and cultural characteristics.⁵⁻⁸⁾ However, among many factors studied, Beaton et al.⁵⁾, found sex was a major contributing factor in variance of nutrient intakes, but not nutrient density.

We previously reported that only 21 of 196 FFQs reported in the literature considered gender, while during development only 5 (2.6%) took into consideration differences in preferences between men and women.⁹⁾ In this study, when intake levels obtained using an FFQ were compared with reference amounts for energy and seven nutrients, 'non-gender-specific FFQ' overestimated the intake of energy and several nutrients in women, but not in men, whereas a 'gender-specific FFQ' underestimated the intake of some nutrients similarly in both sexes.⁹⁾ Several FFQs have been developed in Korea, but none of them reported considering gender during the development process. Using a gender-inappropriate food list would likely yield erroneous results; however, no study has examined this exposure.

There has been no report comparing foods which have high possibility of being included in FFQ items, called candidate foods, between men and women and the con-

sequences of selecting items for use in dietary assessments without taking gender into consideration. The aims of this study were 1) to compare candidate foods between men and women that have a high contribution to total intake and the variability of intake of energy and nutrients of interest, which are the common criteria of selecting items for FFQ; 2) to analyze the possible inaccuracies in the energy and major nutrient intake data in men and women.

Methods

1. Data source

One-day 24 hour dietary recall data from 7,952 participants (men, n=3,250; women, n=4,702), aged 19-64 years and who participated in the 2013-2014 Korea National Health and Nutrition Examination Survey (KNHANES), were used in this study (Table 1). The KNHANES is a nationally representative, cross-sectional survey carried out by the Korea Centers for Disease Control and Prevention. The 2013-2014 KNHANES used a stratified, multiple sampling design. Detailed information on KNHANES is available elsewhere (<http://knhanes.cdc.go.kr>).¹⁰⁾ KNHANES was approved by the Korea Centers for Disease Control Prevention

Table 1. Descriptions of 6th (2013-2014) Korea National Health and Nutrition Examination Survey whose dietary intake data were included in the present study

Characteristic	Total (n=7,952)	Men (n=3,250)	Women (n=4,702)	P ^a
Age, y	43.4±12.4	43.3±12.5	43.5±12.3	0.3736
Age group				
19-29 years	1,237 (15.6)	523 (16.1)	714 (15.2)	0.4030
30-49 years	3,830 (48.2)	1,571 (48.3)	2,259 (48.0)	
50-64 years	2,885 (36.3)	1,156 (35.6)	1,729 (36.8)	
Residential area ^b				
Rural	1,385 (17.4)	616 (19.0)	769 (16.4)	0.0005
City	2,980 (37.5)	1,244 (38.3)	1,736 (36.9)	
Metropolitan	3,587 (45.1)	1,390 (42.8)	2,197 (46.7)	
Household income, monthly, won				
≤2,000,000	1,939 (24.5)	717 (22.2)	1,222 (26.1)	0.0009
2,000,000-3,500,000	2,227 (28.1)	944 (29.2)	1,283 (27.4)	
3,500,000-5,000,000	1,762 (22.3)	733 (22.6)	1,029 (22.0)	
>5,000,000	1,988 (25.1)	843 (26.0)	1,145 (24.5)	
Education				
Middle school or less	1,445 (21.1)	461 (17.2)	984 (23.6)	<0.0001
High school	2,722 (39.7)	1,081 (40.2)	1,641 (39.4)	
College or more	2,685 (39.2)	1,144 (42.6)	1,541 (37.0)	

Values are mean±standard deviation or number (%).

^aDifferences between men and women were analyzed by *t*-test for continuous variable and by χ^2 test for categorical variables.

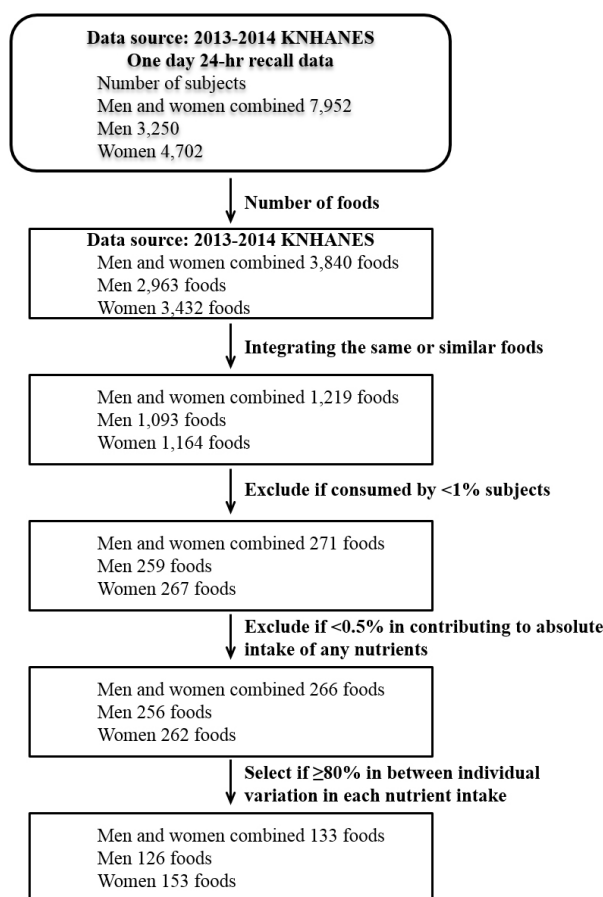
^bResidential area was categorized as rural area (Eup-Myeon area of the administrative district in Korea), city (Dong area in non-metropolitan cities, such as Gyeonggi-do), and metropolitan area (Dong area in metropolitan cities such as Seoul).

Institutional Review Board, and informed written consent was provided by all participants.

2. Selection of candidate foods for FFQ

Candidate foods for the FFQ were selected from reported intakes of cooked foods and beverages. The number of food items consumed by participants was 3,840 for total participants, 2,963 for men, and 3,432 for women. The process of selecting candidate foods followed the database approach used in previous studies (Figure 1).^{3,11-13)} Based on the results from the 2013-2014 KNHANES, intakes of total daily energy and 15 nutrients: protein, fat, saturated fatty acid, polyunsaturated fatty acid, carbohydrate, calcium, phosphorous,

Figure 1. Selection of candidate foods for the food frequency questionnaire (FFQ).^a



Abbreviation: KNHANES, Korea National Health and Nutrition Examination Survey.

^aCandidate foods: foods which have high possibility of being included in FFQ items, which were identified as foods with high contribution to total energy and major nutrient intakes as well as foods of major sources of between-person variation in energy and nutrient intakes.

iron, sodium, potassium, vitamin A, thiamin, riboflavin, niacin, and vitamin C from each food were calculated for the total participants and for each gender separately. Candidate foods were identified as foods with high contribution to total energy and major nutrient intakes, as well as foods of major sources of between-person variation in energy and nutrient intakes among total participants, men, and women.

Before analysis, cooked foods were grouped based on the similarity of their main ingredients, resulting in 1,219 foods for total participants, 1,093 foods for men, and 1,164 foods for women. The similarity of the cooking methods was assessed based on the methods used to establish the Han-sik database.¹⁴⁾ For example, foods such as “soybean paste soup with radish”, “soybean paste soup with spinach”, “soybean paste soup with fried tofu”, “soybean paste soup with clams”, “soybean paste soup with soybean sprouts”, “soybean paste soup with seafood”, “soybean paste soup with pumpkin” were reclassified as “soybean paste soup.”

For the analysis, foods consumed by less than 1% of subjects in each group were excluded from the analysis of that group, leaving 271 foods for total participants, 259 foods for men, and 267 foods for women.

The major food sources of absolute nutrient intake were evaluated based on the contribution of each food to total intake (contribution analysis). The percent contributions of each food (“y”) were calculated as follows:

$$y = \frac{\text{Nutrient intake provided by specific food}}{\text{Total nutrient intake provided by all food}} \times 100$$

Foods making a contribution of less than 0.5% percent to energy or nutrient intake were excluded from the subsequent variance analysis of the contribution to the between-person variation in intake of energy or a specific nutrient.^{12,13)} For the variance analysis, stepwise multiple regressions were performed; the total nutrient intake from all foods was included as a dependent variable and the nutrient intake from each of food was included as an independent variable. Cumulative R^2 was used to assess the contribution to variability in nutrient intake of each food. Foods that contributed more than 80% of the between-person variation in intake of each nutrient were included separately for total participants, men, and women.^{12,13)}

The candidate foods for the FFQ were classified into 25 categories based on the KNHANES classification of cooked dishes,¹⁰⁾ as follows: “cooked rice”, “breads and baked prod-

ucts", "noodles and dumplings", "porridges", "soups", "stews", "steamed food", "grilled food", "pan-fried food", "stir-fried food", "braised food", "fried food", "cooked and seasoned vegetables", "seasoned fresh vegetables of other food", "Kimchi", "pickled or preserved food", "seasoning", "milk and milk products", "beverages and tea", "alcoholic beverages", "fruits", "grain, starch and grain products", "legumes, nuts and seeds", "vegetables and seaweeds", "meat, poultry and fish".

3. Evaluation of candidate foods selected for each gender

To evaluate the suitability of candidate foods selected for total participants for assessing the dietary intake of each gender, energy and nutrient intakes from these candidate foods were compared to those of the foods selected for each gender. Therefore, the suitability of candidate foods for men was calculated by comparing the energy and nutrient intakes calculated from candidate foods for total participants to the intakes calculated from the candidate foods for men. The same calculation was done for women. The ratios between the energy and nutrients intakes estimated from the candidate foods for total participants to the intakes estimated from the candidate foods for each gender were calculated. Among the study population, participants who did not consume any of the candidate foods (men, $n=1$; women, $n=3$) were excluded from the nutrient intake comparison; the foods consumed by the three women were included among the candidate foods for dietary data of women but were not among the candidate foods for dietary data of total participants. The ratio was calculated as follows:

$$\text{Ratio} = \frac{\text{estimated nutrient intake of a candidate food for all subjects}}{\text{estimated nutrient intake of a candidate food for each gender}}$$

4. Statistical analysis

Data are presented as n (%) for categorical variables and as $\text{mean} \pm \text{standard deviation}$ for continuous variables. Nutrient intakes from candidate foods selected for total participants were compared with intakes from candidate foods selected for each gender, and the significance of differences was determined by paired t -test. The ratios of nutrient intakes from candidate foods selected for total participants to intakes from candidate foods selected for men only and

women only were calculated. Differences were assessed for significance by t -test. Differences were considered significant if $P < 0.05$. Data were analyzed using SAS software (ver. 9.4; SAS Institute, Inc., Cary, NC, USA).

Results

Out of the total 7,952 participants included in this analysis, 59.1% were women (Table 1). Mean age was similar in men (43.3 years) and women (43.5 years). Men were more likely to be educated and had higher household income than women ($P < 0.05$).

There were 133 candidate foods items for total participants, 126 for men, and 153 for women (Table 2). The list of 133 candidate foods selected for total participants did not include 15 foods (11.9%) selected for men only and 30 foods (19.6%) selected for women only. When the selected foods were examined by food group, the number and type of foods in only two food groups – grilled dishes and fried dishes – were identical among all three study groups. For other food groups, there were differences in the number and type of foods selected by study group. For example, in the cooked rice food group, 13 types of rice ("dried seaweed rolls", "rice with barley", "fried rice", "fried rice with Kimchi", "cooked rice with assorted vegetables and meat", "raw fish on rice", "cooked rice", "rice with assorted grains", "rice with glutinous rice", "rice with beans", "rice with assorted grain and beans", "rice with black rice", and "rice with brown rice") were selected for total participants. In contrast, 11 (exclusion of "raw fish on rice" and "rice with glutinous rice") and 14 (addition of "rice with glutinous millet") types of rice were selected for men and women, respectively.

Table 3 shows the mean intakes of each nutrient for men and women, calculated from the candidate foods selected for total participants and those selected for each gender. Intakes of energy, fat, polyunsaturated fatty acid, carbohydrate, calcium, iron, and vitamin A calculated from candidate foods selected for total participants were significantly higher than those calculated from candidate foods selected for men ($P < 0.05$). On the contrary, intakes of energy and all nutrients calculated from candidate foods selected for total participants were significantly lower than those calculated from candidate foods selected for women ($P < 0.05$).

The ratios of nutrient intakes between candidate foods selected for total participants and those selected by gender

Table 2. Number of candidate foods selected among total participants, men, and women in the 2013-2014 Korea National Health and Nutrition Examination Survey^a

Group	Total participants (n=7,952)	Men (n=3,250)	Women (n=4,702)
Cooked rice	13	11	14
Breads and baked products	7	9	11
Noodles and dumplings	9	7	11
Porridges	1	1	2
Soups	4	4	6
Stews	6	6	7
Steamed food	3	3	3
Grilled food	10	10	10
Pan-fried food	3	3	3
Stir-fried food	5	6	8
Braised food	4	3	2
Fried food	4	4	4
Cooked and seasoned vegetables	4	4	5
Seasoned fresh vegetables of other food	4	5	4
Kimchi	5	5	8
Pickled or preserved food	4	3	4
Seasoning	4	7	3
Milk and milk products	5	4	5
Beverages and tea	10	8	12
Alcoholic beverages	3	3	2
Fruits	11	11	11
Grain, starch and grain products	7	2	9
Legumes, nuts, and seeds	3	2	4
Vegetables and seaweeds	3	3	3
Meat, poultry, and fish	1	2	2
Total	133	126	153

^aCandidate foods: foods which have high possibility of being included in food frequency questionnaire items, which were identified as foods with high contribution to total energy and major nutrient intakes as well as foods of major sources of between-person variation in energy and nutrient intakes.

Table 3. Energy and nutrient intakes from the selected candidate foods^{a,b}

Nutrient	Men (n=3,249)		Women (n=4,699)	
	From candidate foods of total participants ^c	From candidate foods of men ^d	From candidate foods of total participants ^e	From candidate foods of women ^f
Macro nutrients				
Energy, kcal	1934.4±929.9	1915.6±921.6 ^g	1343.5±649.7	1399.4±660.4 ^g
Protein, g	59.4±40.7	59.4±41.3	42.3±27.6	44.2±28.1 ^g
Fat, g	39.2±37.3	38.8±36.8 ^h	28.0±26.9	29.8±27.5 ^g
Saturated fatty acid, g	12.2±12.7	12.0±12.4	8.6±9.4	9.1±9.6 ^g
Polyunsaturated fatty acid, g	9.2±9.3	9.0±9.1 ^g	6.8±7.4	7.1±7.4 ^g
Carbohydrate, g	284.7±124.7	280.6±122.3 ^g	219.8±105.6	228.4±107.2 ^g
Minerals				
Calcium, mg	392.7±276.7	389.3±275.1 ^g	322.4±253.1	332.4±247.4 ^g
Phosphorous, mg	918.7±499.6	917.8±503.1	703.8±426	730.0±429.8 ^g
Iron, mg	14.1±63.5	13.7±63.5 ^g	10.0±6.6	11.0±7.1 ^g
Sodium, mg	3240.2±2757.3	3303.2±2742.2 ^g	2187.6±1915	2329.4±1950.5 ^g
Potassium, mg	2520.1±1421.7	2521.3±1405.3	2120.2±1360.4	2186.7±1380.1 ^g
Vitamins				
Vitamin A, µgRE	550.2±642.2	526.1±598.2 ^g	457.8±565.8	479.2±579.2 ^g
Thiamin, mg	1.9±1.1	1.9±1.1	1.4±0.8	1.4±0.8 ^g
Riboflavin, mg	1.2±0.8	1.2±0.8	0.9±0.6	0.9±0.6 ^g
Niacin, mg	13.6±8.8	13.5±9.1	10.2±6.5	10.7±6.6 ^g
Vitamin C, mg	68.2±97.5	71.3±99.6 ^g	79.9±122.3	81.1±122.6 ^g

Values are mean±standard deviation or number (%).

^aCandidate foods: foods which have high possibility of being included in food frequency questionnaire items, which were identified as foods with high contribution to total energy and major nutrient intakes as well as foods of major sources of between-person variation in energy and nutrient intakes.

^bAmong the participants (men, n=3,250; women, n=4,702), those who did not consume the candidate foods (men, n=1; women, n=3) were excluded from the nutrient intake comparison.

^cNutrient intakes among men calculated from candidate foods of total participants.

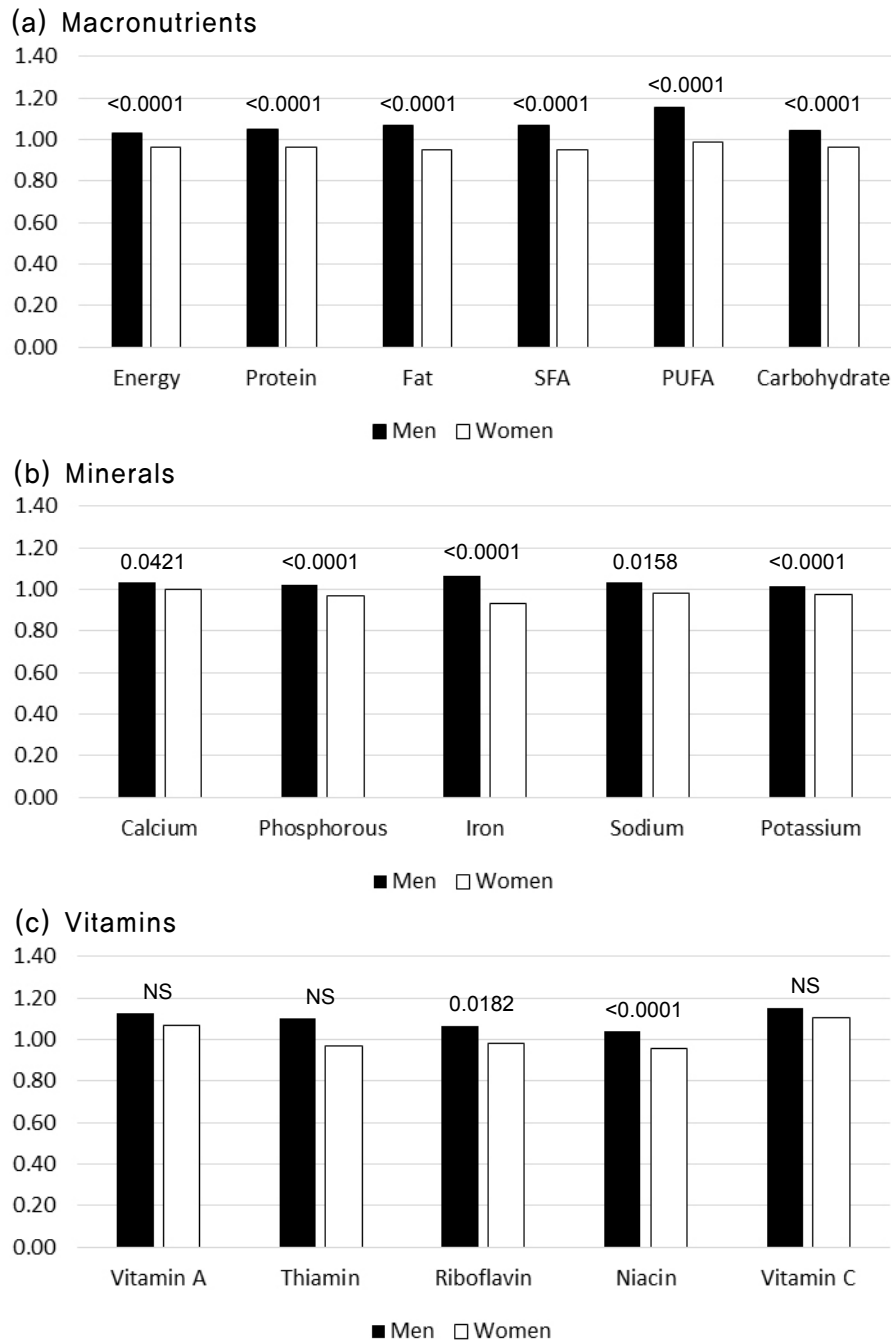
^dNutrient intakes among men calculated from candidate foods of only men.

^eNutrient intakes among women calculated from candidate foods of total participants.

^fNutrient intakes among women calculated from candidate foods of only women.

^gNutrient intakes from candidate foods selected for total participants, and for each gender, were compared by paired *t*-test (<0.001).

^hNutrient intakes from candidate foods selected for total participants, and for each gender, were compared by paired *t*-test (<0.05).

Figure 2. Ratios of energy and nutrient intakes for the selected candidate foods.^{a-c}

Abbreviations: SFA, saturated fatty acid; PUFA, polyunsaturated fatty acid; NS, not significant; FFQ, food frequency questionnaire.

^aCandidate foods: foods which have high possibility of being included in FFQ items, which were identified as foods with high contribution to total energy and major nutrient intakes as well as foods of major sources of between-person variation in energy and nutrient intakes.

^bRatios of energy and nutrients intakes of candidate foods between total participants and men, and between total participants and women.

^cDifferences in ratios between men and women were compared by *t*-test.

ranged from 1.01 to 1.16 for men and from 0.93 to 1.11 for women (Figure 2). Differences in the intake ratios between men and women were significant for all nutrients, with the exception of vitamin A, thiamin, and vitamin C.

Discussion

We identified the possible differences between men and women in dietary assessment based on the candidate foods

for FFQ. Candidate foods selected from the dietary data of the total participants, men only, and women only differed not only in the total numbers but also in the selected food items. Nutrient intakes from candidate foods for total participants were higher than those from candidate foods for men, and were lower than those from candidate foods for women.

FFQs are the most widely used dietary assessment tools in nutritional epidemiology studies, and development of appropriate food lists for these instruments is crucial.¹⁵⁾ Food lists should include foods that either make considerable contributions to absolute intake or differentiate intake levels between individuals.^{2-4,15)} For instance, a previous study used stepwise regression analysis of dietary data from a target population to differentiate intake levels between individuals.¹⁵⁾ This is a frequently used method for selecting items for FFQ that meets research objectives and reflects the characteristics of the target population.

Several studies have reported the importance of considering gender when developing FFQs.^{6,11,16)} In a Danish study of FFQ development, all relevant analyses were performed for the study group as a whole, and for men and women separately, to include the foods important for single sex/gender but not for the group as a whole.¹¹⁾ However, the number of different foods that were included to reflect gender differences was not stated. When Block et al.¹⁶⁾ developed a short-form dietary questionnaire, age, sex, and race-specific analyses were performed to determine whether any foods important to particular demographic groups had been omitted. However, how the number and type of foods were modified to reflect differences by gender is unknown.

We investigated the possible effects of ignoring differences between men and women when selecting foods for inclusion in FFQs. Candidate foods selected for total participants, and for men and women separately, differed not only in total number but also by food group. The characteristics of the target population are important in determining the length and items of FFQs.¹⁵⁾ Greater numbers of candidate foods for women implies greater diversity in sources of energy and nutrients. In several studies, women were reported to consume a greater variety of foods than men.^{17,18)}

In this study, the intakes of candidate foods selected for men and women separately were significantly different from the values obtained for total participants, for both energy and all nutrients for women, and for energy and 9 nutrients out of 16 selected nutrients for men. These differences are

reflected by the opposite directions of the ratios of energy and nutrient intakes of candidate foods for total participants compared to those of men only and women only. The ratios for men were >1 , while they were <1 for women. The differences in intake ratios between men and women were significant for energy and most nutrients. This is presumably because fewer foods were selected for men than for total participants (126 vs. 133); in contrast, the number was much greater for women (153 vs. 133). Difference in the number of food items selected may be partly because differences in the preferences and intakes of foods between men and women. Previous studies of Korean adults have reported differences in food perception and consumption patterns between men and women. Women exhibited a greater preference for cereal, fruit, fast food, and sweetened foods than men.^{19,20)} Similar differences by gender have also been reported in other countries. Women tend to eat more fruits and vegetables than men in the United States and Norway,^{21,22)} and men tend to eat more eggs, sugar, and certain meat products, and drink more alcohol, in the United Kingdom.²³⁾ The median intakes of several food groups, as well as specific foods, also differ between men and women;^{24,25)} how these differences may affect dietary assessment conducted with one FFQ is difficult to speculate.

Several limitations should be taken into consideration when interpreting the findings from this study. First, we used 1-day 24 hour recall data of adults from the KNHANES. Therefore, the findings may not represent the usual intake data which are more suitable for developing FFQs. Second, the results may not be generalizable to other age groups or populations with different dietary patterns. Third, the presented study is theoretical in nature and the obtained food items list were not transferred in FFQ, nor was it validated in a group of patients. In addition, we could not assess the intakes of folate, vitamin D, or dietary fiber, which are of interest in relation to chronic diseases, because no nutrient database on Korean foods is available.

Nevertheless, this study is the first, to our knowledge, on the effects of ignoring differences in food preferences selection between men and women when selecting foods for inclusion in an FFQ. There may be systematic errors in dietary intake assessment using FFQs developed without considering gender, possibly in a different directions for men and women. More studies are required to further assess the effects of gender to foods selection in development of FFQs.

요 약

연구배경: 성별/젠더는 식품 선택 시 영향을 끼치는 중요한 요인 중 하나이나, 식품섭취빈도조사지 개발 과정 중 식품/음식 목록 선정 과정에서 거의 고려되지 않는 실정이다. 따라서, 본 연구에서는 식품섭취빈도조사지 개발을 위한 식품/음식 목록 선정 과정에서 성별/젠더에 따른 차이를 비교하고, 식품/음식 목록 선정 시 성별/젠더를 고려하지 않았을 때의 잠재적인 오류에 대하여 분석하고자 한다.

방법: 제6기(2013-2014) 국민건강영양조사 식품섭취조사에 응답한 만 19-64세 성인 7,952명의 자료를 이용하였다. 식품섭취빈도조사지 개발을 위한 상용 식품/음식 목록 추출 시 식품/음식 목록을 선정하는 주된 방법인 에너지 및 영양소의 급원 분석 및 변이 분석 방법을 적용하여 전체 대상자, 남자 대상자, 여자 대상자의 세 그룹에서 식품/음식 목록을 추출하고, 선정된 식품/음식에서 비롯한 영양소 섭취량을 비교하였다.

결과: 전체 대상자로부터 선정된 식품/음식 수는 133종, 남자 대상자로부터 선정된 식품/음식 수는 126종, 여자 대상자로부터 선정된 식품/음식 수는 153종으로 선정된 항목 수에서 차이를 보였으며, 선정된 식품/음식의 종류에도 차이를 보였다. 또한 선정된 식품/음식에서 비롯한 영양소 섭취량을 비교하였을 때, 전체 대상자 자료에서 비롯한 에너지 및 일부 미량 영양소 섭취량이 남자 대상자만의 자료에서 비롯한 섭취량보다 유의적으로 높았다. 반면, 여자 대상자에서는 전체 대상자 자료에서 비롯한 분석한 모든 영양소 섭취량이 유의적으로 낮아, 성별에 따라 다른 양상을 보였다.

결론: 남자와 여자에서 선정된 주요 식품/음식의 항목수 뿐 아니라 주요 식품/음식의 종류에서 차이가 도출되었다. 따라서, 식품섭취빈도조사지에 포함할 식품/음식의 선정에서 성별 차이를 고려하지 않으면 성별/젠더에 따른 식생활 차이를 적절히 평가하기 어려울 가능성이 있으며, 특히 차이의 방향성으로 인한 계통적 오류 발생의 가능성이 있다.

중심 단어: 젠더, 식품/음식 목록 선정, 식품섭취빈도조사지 개발, 식이 평가, 국민건강영양조사

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