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Food Ingestion Factors of the Korean Exposure Factors Handbook

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The purpose of this study was to establish food ingestion factors needed to assess exposure to contaminants through food ingestion. The study reclassified the raw data of the Korean National Health and Nutrition Examination Survey in 2001 into 12 subcategories including grain products, meat products, fish and shellfish, and vegetables for international comparability of exposure evaluation. The criteria for food intake calculation were unified according to the characteristics of food groups, and recommended values for food ingestion factors were calculated through moisture correction and recategorization of cooked, processed, and mixed foods for each group. The average intake rate for grain and grain products was 6.25 g/kg-d per capita and the men's intake rate was approximately 8% higher than that of the women. The average intake rate of meat and meat products was 1.62 g/kg-d per capita and the men's intake rate was 30% higher than that of the women, on average. The average intake rate of fish and shellfish was 1.53 g/kg-d per capita, and the age groups of 1 to 2 and 3 to 6 recorded higher capita intake rates than other age groups, 2.62 g/kg-d and 2.25 g/kg-d, respectively. The average intake rate of vegetables was 6.47 g/kg-d per capita, with the age group of 1 to 2 recording the highest per capita intake rate of 9.79 g/kg-d and that of 13 to 19 recording the lowest mean. The study also offers recommended values for food ingestion factors of other food groups by gender, age, and region. The food ingestion exposure factors will need future updates in consideration of ongoing changes in food consumption behavior.

Key words: Risk assessment, Food, Exposure factors

INTRODUCTION

The intake of grain, meat, fish and shellfish, vegetables, fruits, and dairy products is a major path of exposure to environmental contaminants, which makes it an important factor for an exposure assessment [1]. Agricultural products, including grains, vegetables, and fruits, can be contaminated by the absorption or accumulation of polluted air, or contact with chemicals in rain or agricultural water, and the absorption of chemicals in soil and underground water from their roots. Pesticide application, soil covering, and fertilizer use can also cause the contamination of agricultural products [2]. Meat, eggs, and dairy products derived from livestock exposed to contaminated soil, water, or feed and contaminated fish and shellfish are also potential exposure paths to toxic chemicals.

The purpose of the food ingestion factor development is to calculate food intake according to the food groups and individual food and to use the result for the identification of the paths to contaminants, exposure dose assessment and others.

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There should be reliable data on the intake of grain, meat, fish and shellfish, vegetables, fruits, and dairy products for the exposure assessment of contaminants through the ingestion of food. It is also necessary to consider variables of eating habits in conjunction with the parameters of region, climate, seasonal variation, race, and the parts of foods preferred for cooking in order to evaluate the possibility of exposure to contaminants through ingestion [3].

Although there are many surveys on food intake in many countries around the world, most of them aim to provide nutritional status. The researches from the US and Canada have rarely involved the reanalysis and investigation of data on food intake for exposure assessment. The US Environmental Protection Agency (EPA) reanalyzed the data on food intake with the Continuing Survey of Food Intake by Individuals of 1989 to 1991 by the US Department of Agriculture and the Nationwide Food Consumption Survey [4]. Canada provides intake data on major foods for exposure assessment and offers scenario simulation in a virtual environment to estimate the actual exposure dose with the Human Health Risk Assessment for Priority Substances [5].

The Korean Government conducts the Korean National Health and Nutrition Examination Survey (KNHANES), which was launched in 1998, every three years in accordance with the National Health Promotion Act [6]. The survey, which is comparable to the US National Health and Nutrition Examination Survey, measures and evaluates the entire nation's food intake according to the population ratios of gender, region, and age [7]. It surveys the intake of cooked foods to estimate nutritional intake. Even though the same materials are used for cooking, it calculates or adds each food type in case of changes in moisture content or form through cooking or processing. The survey itself thus cannot provide essential information to evaluate the intake of food ingredients necessary to evaluate the intake of contaminants.

However, the KNHANES has a high level of representativeness when it comes to the food intake of the entire nation and provides detailed results as a scientific investigation regularly carried out under the responsibility of the government. Therefore, this study used its raw data, unified the calculation criteria of food intake according to the goals of exposure assessment, and identified exposure factors through food ingestion by recategorizing, reprocessing, and reanalyzing the food groups. Although the results of this survey may have discrepancies from the current intake of food in Korea, the study aimed to present the food ingestion factors of grains, meat, fish and shellfish, vegetables, and other categories, and presented the process of food ingestion exposure factor calculation from the Korean Exposure Factors Handbook developed in 2007.

DEVELOPMENT PROCESS

Data

The raw data of the 2001 KNHANES on nutrition by the Ministry of Health and Welfare were used in the study to investigate food intake [6]. The survey investigated the foods consumed by 9968 participants from 4015 households across the nation, as well as the intake by food groups and individual foods per capita per day. The study had to use the data of the 2001 survey since the raw data of the 2004 survey were not released yet and the data of the 2001 survey were the latest available raw data.

Recategorization of food groups and individual foods

There were 17 food groups in the 2001 KNHANES [6]. Although the categorization of food groups had a rationale from the perspective of nutrition, it did not take into account the perspective of assessment of exposure to environmental contaminants. For this reason, this study recategorized the food groups according to the criteria of the US EPA for international comparability. Accordingly, potatoes and starch, beans and their products, and mushrooms were grouped as vegetables. Furthermore, the food ingestion factors for them were individually calculated for the utilization of the subgroup category. In case of seasonings, they were regrouped as vegetables or fats and oils groups according to their ingredients, and their intake was included in the same groups of food when it became more rational.

Unification of food intake criteria

The KNHANES 2001 investigated the individual intake according to the type of food, and it became difficult to calculate the food intake according to ingredient. By taking the problem into consideration, the present study achieved the unification based on a single ingredient or food according to the characteristics of each food group in order to calculate intake. The intake of meat and its products, fish and shellfish, vegetables, fruits, sugars, and oilseeds, which were found to be a high percentage of the raw materials in the KNHANES, was calculated with raw materials. The intakes of fats and oils and milk and

dairy products were calculated with the intake of the state of food when consumed. The intake of grain and its products, however, was calculated in both ingredient and food type based calculation, because the body weight variations are huge according to cooking methods and the forms of consumption are varied. The intake of seaweeds was calculated for both wet and dry forms since they are consumed in various forms in the typical Korean diet and widely vary in moisture content. The intake data obtained both in the form of food and raw materials were unified through a correction equation based on the moisture content to be explained later. Table 1 presents the re-categorization of food groups, the major foods of each category, and the criteria for intake calculation.

Correction for moisture

There are the foods consumed with various levels of moisture content such as squid, which is eaten fresh or dried. Since the KNHANES offers the intake of such foods individually, it poses a risk of under- or over-evaluation of intake in case of the simple addition of food disregarding moisture correction. In an attempt to resolve the problem, the study devised and applied an equation to convert the moisture content of a food consumed into its body weight at various states of dryness and vice versa (Figure 1). The equation was developed on the basis of the moisture correction equation of the US EPA [8]. It was used to unify the intake criteria of foods that were derived from the same ingredient but took different forms such as fresh and dried squid, jerked beef and beef rump, fresh and dried fruits, and fresh and dried vegetables. It was also used to convert the intake of ingredients and foods if necessary. The ingredients table of the Rural Development Administration was consulted for the average moisture content of food and cooked food [9].

Recategorization of cooked and processed mixed foods

In the study, the cooked or processed foods that were difficult to classify into a certain category due to the mixture of ingredients were re-categorized by applying the recipes actually

$$IW_r = IW_d \times (100\text{-}M_d)/(100\text{-}M_r)$$

$$IW_d = Iw_r \times (100\text{-}M_r)/(100\text{-}M_d)$$

Where:

IW_r= intake weight of raw material

IW_d = intake weight of dried food

M_d (%)= percent moisture content of dried food

M_r (%)= percent moisture content of raw material

Figure 1. Formula for moisture rate correction of dried food.

Table 1. Reclassified main foods by food groups and criteria for intake calculation

Food group	Main foods	Criteria for intake calculation
Grain products	Boiled rice, boiled barley, boiled sticky rice, boiled brown rice, other boiled multigrain rice, rice cake, noodles, bread, cake, hamburger bun/sandwich bread, snacks, corn, cereal, ground grain	Ingredient or cooked/processed foods
Meat products	Pork, beef, chicken, other meat, processed meat, by-products	Ingredient
Fish and shellfish	Bonito, hairtail, mackerel, mackerel pike, pollock, anchovy, loach, croaker, filefish, squid, octopus, long-legged octopus, shrimp, crab, oyster, manila clam, mussel, other fishes and shellfishes	Ingredient
Seaweeds	Dried laver, kelp, sea mustard, green laver, other seaweeds	Dried or fresh seaweeds
Vegetables	Eggplant, red pepper, perilla leaf, carrot, garlic, white radish, water parsley, Chinese cabbage, chives, lettuce, ginger, spinach, cucumber, cabbage, onion, bean sprouts, green onion, tomato, pumpkin, potato, sweat potato, kidney bean, mung bean, black-eyed pea, soybean, pea, adzuki bean, mushroom, other vegetables	Ingredient
Fruits	Persimmon, tangerine, jujube, strawberry, banana, pear, peach, apple, watermelon, orange, oriental melon, grapes, other fruits	Ingredient
Nut and seed products	Sesame, wild sesame, peanut, chestnut, almond, ginkgo nut, pine nut, other nuts and seeds	Ingredient
Dairy products	Milk, powdered milk, cheese, yogurt, ice cream, ices/sherbet, baby food, other dairy products	Cooked/processed foods
Eggs	Chicken eggs, and other eggs	Ingredient
Oils and fats	Mayonnaise, margarine, butter, sesame oil, corn oil, perilla oil, creamer/powdered creamer, other oils and fats	Cooked/processed foods
Seasonings	Red pepper paste, soybean paste, mixed soybean paste, salt. Vinegar, soy sauce, black pepper, ground sesame mixed with salt, other seasonings	Cooked/processed foods
Sugars and sweeteners	Sugar, honey, Korean taffy (yeot), chocolate, candy, treacle/syrup, other sugars and sweeteners	Cooked/processed foods

used by the respondents that had the mixed products of the same kind in the KNHANES 2001 and the mixing ratio reported in the market research. Supplemental Table 1 presents the examples of mixing ratios according to the food groups.

Methods for Providing Recommended Values

The food intake was calculated according to the food groups of grain and its products, meat and its products, fish and shellfish, seaweeds, vegetables, fruits, oilseeds and their products, milk and dairy products, eggs, fats and oils, seasonings, and sugar and its products. The total intakes were presented in such statistical values as means and percentiles according to gender, age, and geographical area. Age groups were categorized into 2 and under, 3 to 6, 7 to 12, 13 to 19, 20 to 39, 40 to 69, and 70 or older for easy comparison with the US EPA data.

For the analysis of food intake per unit body weight, the study used the body weight data in the nutrition part of the KNHANES 2001. Because there were no data reflecting certain groups totaling 1542 (15.5%) participants in the survey, the average body weight by gender and age were calculated based on the 5th Body Measurements Survey by the Ministry of Commerce, Industry and Energy.

The average intake of the population and individuals per unit body weight (g/kg-d) was also presented in the Korean Exposure Factors Handbook to expand the scope of applicability of the data. The daily average intake (g/d) was added for fish and shellfish for comparison with foreign data. The present study only introduced the statistical values of the intakes of major food groups according to gender, age, and geographical area due to limited space.

RECOMMENDED VALUES OF FOOD FACTORS

Table 2 shows the total intake of grain and its products per capita. The intake of grain and its products in the form of ingredients averaged 6.25 g/kg-d for the entire nation, 6.51 g/kg-d for men, and 6.01 g/kg-d for women. Children recorded greater intakes per body weight than adults. The inhabitants of small or medium-sized cities, and rural area recorded a little bit more intake than those of metropolitan cities.

Table 3 shows the total intake of meat and its products per capita. The average intake of meat and its products per capita was 1.62 g/kg-d, and the 95th percentile was 6.18 g/kg-d. While men recorded an average of 1.84 g/kg-d, women recorded an average of 1.42 g/kg-d. The inhabitants of small- or medium-sized cities recorded 1.77 g/kg-d, which was a little bit higher than those of metropolitan cities. Those of rural area recorded an average of 1.27 g/kg-d, which was considerably lower than the other areas.

Table 4 shows the total intake of fish and shellfish per capita. The average intake of fish and shellfish per capita was 1.53 g/kg-d, and the 95th percentile was 5.40 g/kg-d. Men recorded

Table 2. Total daily average intake of grain products (ingredient) per capita (g/kg-d)

Demographic group	n	Mean (SD)	5th	25th	50th	75th	90th	95th	99th
Gender									
Male	4751	6.51 (4.11)	2.33	4.02	5.50	7.72	11.29	14.13	22.44
Female	5192	6.01 (4.03)	2.10	3.68	5.17	7.1	10.22	12.72	20.36
Age									
1-2	238	9.51 (8.14)	0.19	4.18	7.90	13.35	19.19	21.77	28.00
3-6	684	11.96 (6.69)	4.39	7.61	10.66	14.51	19.93	23.76	33.84
7-12	1088	8.84 (4.77)	3.49	5.78	7.78	10.89	14.74	17.82	25.54
13-19	968	6.05 (3.04)	2.30	4.05	5.46	7.34	9.85	11.55	16.70
20-39	3057	5.31 (2.61)	2.03	3.59	4.85	6.46	8.41	10.11	14.00
40-69	3360	5.11 (2.46)	2.10	3.56	4.76	6.19	7.91	9.35	12.65
≥70	548	5.17 (2.51)	2.07	3.57	4.82	6.24	8.18	9.55	14.52
Region									
Metropolitan city	4575	6.12 (3.75)	2.15	3.83	5.22	7.25	10.55	13.45	20.65
Small or medium-sized city	3278	6.42 (4.67)	2.16	3.75	5.35	7.59	11.07	14.05	24.18
Rural area	2090	6.27 (3.72)	2.45	4.03	5.49	7.33	10.39	13.16	19.39
Total	9943	6.25 (4.08)	2.20	3.85	5.32	7.39	10.66	13.64	21.34

SD, standard deviation.

Table 3. Total daily average intake of meat products per capita (g/kg-d)

Demographic group	n	Mean (SD)	5th	25th	50th	75th	90th	95th	99th
Gender									
Male	3617	1.84 (2.62)	0	0.10	0.95	2.47	4.81	6.64	12.19
Female	3515	1.42 (2.4)	0	0	0.60	1.81	3.86	5.54	11.04
Age									
1-2	138	1.67 (3.0)	0	0	0.25	2.11	4.76	6.94	18.01
3-6	548	2.93 (4.01)	0	0.25	1.36	4.12	7.92	11.12	18.76
7-12	943	2.47 (3.01)	0	0.54	1.57	3.33	5.95	7.78	14.29
13-19	788	1.8 (2.38)	0	0.26	1.08	2.5	4.31	6.09	10.53
20-39	2374	1.63 (2.38)	0	0.14	0.84	2.13	4.23	5.94	10.65
40-69	2113	1.18 (1.96)	0	0	0.46	1.59	3.42	4.77	8.58
≥70	228	0.63 (1.35)	0	0	0	0.77	1.94	3.45	5.80
Region									
Metropolitan city	3404	1.67 (2.57)	0	0	0.84	2.24	4.32	6.18	12.08
Small or medium-sized city	2484	1.77 (2.61)	0	0.09	0.89	2.32	4.64	6.38	12.00
Rural area	1244	1.27 (2.2)	0	0	0.40	1.65	3.72	5.57	10.19
Total	7132	1.62 (2.51)	0	0	0.76	2.13	4.33	6.18	11.71

SD, standard deviation.

Table 4. Total daily average intake of fishes and shellfishes per capita (g/kg-d)

Demographic group	n	Mean (SD)	5th	25th	50th	75th	90th	95th	99th
Gender									
Male	3960	1.58 (2.52)	0	0.17	0.85	2.02	3.95	5.60	11.24
Female	4264	1.48 (3.17)	0	0.13	0.67	1.86	3.58	5.20	10.79
Age									
1-2	144	2.61 (10.72)	0	0	0.27	1.98	5.31	9.3	51.78
3-6	547	2.25 (3.86)	0	0.15	0.95	2.71	5.87	8.25	19.45
7-12	891	1.53 (2.11)	0	0.13	0.74	2.07	3.93	5.86	9.68
13-19	775	1.09 (1.65)	0	0.08	0.55	1.50	2.84	3.85	8.41
20-39	2629	1.53 (2.38)	0	0.20	0.88	2.00	3.67	5.29	9.98
40-69	2869	1.5 (2.18)	0	0.19	0.81	2.01	3.78	5.17	10.28
≥70	369	1.01 (1.83)	0	0	0.28	1.31	2.7	4.24	9.88
Region									
Metropolitan city	3859	1.51 (3.02)	0	0.18	0.79	1.92	3.68	5.24	10.56
Small or medium-sized city	2725	1.66 (3.07)	0	0.14	0.80	2.10	4.09	5.74	11.62
Rural area	1640	1.34 (2.15)	0	0.08	0.65	1.77	3.32	5.10	9.96
Total	8224	1.53 (2.88)	0	0.15	0.76	1.95	3.76	5.40	10.93

SD, standard deviation.

an average of 1.58 g/kg-d, whereas women had an average of 1.48 g/kg-d. The age groups of 1 to 2 and 3 to 6 recorded higher intakes at 2.62 g/kg-d and 2.25 g/kg-d, respectively, compared with the other age groups.

Table 5 shows the total intakes of vegetables per capita. The average intakes of vegetables per capita were 6.47 g/kg-d, and the 95th percentile was 14.24 g/kg-d. Men recorded an average of 6.54 g/kg-d, and women, an average of 6.39 g/kg-d. The age group of 1 to 2 recorded the highest intake, at 9.79 g/kg-d, whereas the age group of 13 to 19 recorded the lowest. Supplemental Table 2 contains the intakes of seaweeds, fruits, oilseeds and their products, milk and dairy products, eggs, fats and oils, seasonings, and sugar and its products.

Table 5. Total daily average intake of vegetables per capita (g/kg-d)

Demographic group	n	Mean (SD)	5th	25th	50th	75th	90th	95th	99th
Gender									
Male	4719	6.54 (5.22)	1.48	3.67	5.59	8.15	11.35	13.94	22.46
Female	5170	6.39 (4.7)	1.32	3.39	5.47	8.09	11.62	14.55	23.42
Age									
1-2	218	9.79 (15.74)	0	0.65	4.42	11.36	24.74	34.87	84.02
3-6	670	7.15 (6.16)	0.67	3.05	5.63	9.56	14.66	17.58	28.59
7-12	1085	6.45 (4.67)	0.62	1.33	1.88	3.35	5.47	8.37	11.98
13-19	962	4.97 (3.52)	1.04	2.70	4.26	6.40	9.07	10.88	16.63
20-39	3051	6.38 (4.11)	1.81	3.74	5.52	7.99	10.94	13.52	21.05
40-69	3360	6.67 (3.96)	1.88	4.02	5.97	8.41	11.29	13.59	20.97
≥70	543	6.02 (4.48)	1.04	3.02	5.13	7.70	11.57	14.57	24.39
Region									
Metropolitan city	4552	6.38 (4.83)	1.36	3.46	5.41	8.11	11.52	14.00	22.90
Small or medium-sized city	3256	6.53 (5.34)	1.40	3.6	5.54	8.05	11.55	14.54	24.69
Rural area	2081	6.55 (4.56)	1.41	3.6	5.73	8.28	11.39	14.34	22.52
Total	9889	6.47 (4.95)	1.38	3.54	5.52	8.12	11.48	14.24	23.27

SD, standard deviation.

CONCLUSION

The average intake of grain and its products among the Korean people was 14.0 g/kg-d per unit body weight (Supplemental Table 3), which was three times higher than that of American people at 4.1 g/kg-d [8]. The average Korean intake of meat and its products was 1.62 g/kg-d per body weight, which was lower than the American intake of 2.1 g/kg-d. However, the 95th percentile was 6.18 g/kg-d, which was higher than that of the American people, at 5.1 g/kg-d. Japan simply provided a daily intake of meat without considering body weight; Japanese men and women recorded 98.9 g/d and 72.3 g/d, respectively [10]. When considering the Korean data based on average body weight, Korean men and women recorded about 99.9 g/d and 65.8 g/d, respectively. In comparing the Koreans and Japanese, the intakes of the men were similar, whereas the intake of Japanese women was greater than that of Korean women.

The Koreans' intake of fish and shellfish was 79.6 g/d, which was about four times higher than that of the American people, at 20.1 g/d [8]. Considering the habitats of fish and shellfish, the intake of deep-sea fishing species was 14.1 g/d, which was more than two times higher than that of fresh or costal water fishing species at 6.0 g/d in the US. On the other hand, in Korea, the intake of fresh or costal water fishing species was 52.4 g/d, which was considerably higher than that of deep-sea fishery at 19.8 g/d. Japan announced recommended level for man and woman, 107.3 g/d and 85.4 g/d, respectively, and they were rather higher than those of Koreans [10].

The average intake of vegetables among adults in Korea was 6.5 g/kg-d, which was about 1.5 times higher than the 4.3 g/kg-d of the US [9]. Like the other food groups, Japan provided a daily average intake (g/d) of vegetables. It was 293.8 g/d for men and 275.3 g/d for women [10]. When considering the Korean data on average body weight, Korean men and women recorded 370.3 g/d and 317.5 g/d, respectively, which suggests that the Korean people have a higher intake of vegetables than Japanese.

The average intake of fruits among the Korean people was 4.5 g/kg-d per unit body weight per day, which was rather high compared to 3.4 g/kg-d in the US [9]. Like the other food groups, Japan provided a daily average intake (g/d) of fruit. It was 103.7 g/d for men and 127.6 g/d for women, which means that the Korean people have a greater intake of fruit than do the Japanese [10].

The average intake of milk and dairy products among the Korean people was 2.73 g/kg-d per unit body weight, which was very low compared with 7.86 g/kg-d in the US [8]. Japan reported average intake of milk for men and women recorded 98.1 g/d and 101.4 g/d, respectively. When the daily intake of milk was converted for the Koreans, it was 77.6 g/d for the men and 65.8 g/d for the women, which was lower than the

intake in Japan.

The average intake of eggs among the Korean people per unit body weight was 0.47 g/kg-d, which was slightly higher than 0.34 g/kg-d in the US [8]. Japanese daily average intake level of egg was 44.7 g/d for men and 38.1 g/d for women. The daily intake of the Korean people could be converted to 24.1 g/d for men and 17.9 g/d for women and their intake of eggs turned out to be half that of Japan [10].

The average intake of fats and oils among the Korean people was 0.2 g/kg-d per unit body weight per day, which was about 2/3 of the American intake at 0.3 g/kg-d [8]. The average daily intake level of fats and oils was 18.1 g/d for men and 16.0 g/d for women, which indicates that the Japanese people had a greater intake of fats and oils than that of the Korean people [10].

The data used in the study were the national-level data derived from the actual measurement and the evaluation of the entire nation's food intake, taking into account the population ratio according to gender, geographical area, and age. However, the goal of the original survey was not exposure assessment, which means the research design had a limitation of no correction of intake according to the types of food, categories, and consumption patterns. In addition, the KNHANES survey on nutrition took place for two months in November and December, which reveals the limitation of not capturing seasonal variations such as the difference in fruit intake according to the season [6].

The present study fundamentally re-categorized and reanalyzed the raw data to compensate for those limitations. The research procedure worked to minimize the problems with the food categories and the chance of error in analysis results according to the consumption patterns and obtained exposure factors applicable to exposure assessment, which make them the best available food ingestion factors at the time of development in 2007. Even though the study used the latest available data at that time, considering the rapid changes in the trends of Korean food intake, the food ingestion factors must be updated and revised to reflect the outcomes of the latest KNHANES as soon as possible.

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CONFLICT OF INTEREST

The authors have no conflicts of interest with the material presented in this paper.

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Supplemental Table 1. Mixing ratio of the processed food groups

Food name	Food group	Mixing ratio (%)[1]
Pizza	Grain products	30
	Meat products	19
	Vegetables	35
	Fruits	1
	Dairy products	12
	Oils and fats	1
	Sugars and sweeteners	1
	Other	1
Meat dumpling	Meat products	30
	Grain products	32
	Vegetables	30
	Seasonings	6
	Oils and fats	2
Kimchi dumpling	Meat products	17
	Grain products	17
	Vegetables	62
	Seasonings	3
	Oils and fats	1
Spaghetti sauce	Meat products	22
	Vegetables	75
	Beverage	3
Dried pollock soup	Fish and shellfish	23
	Eggs	14
	Vegetables	58
	Seasonings	4
	Oils and fats	1
Curried rice	Vegetables	72
	Meat products	17
	Seasonings	11
Potato croquette	Grain products	30
	Vegetables	30
	Meat products	25
	Seasonings	1
	Other	1
	Eggs	13
Red bean soup	Grain products	33
	Sugars and sweeteners	11
	Nuts and seeds products	13
	Vegetables	42
	Seasonings	1
Pumpkin soup	Grain products	18
	Sugars and sweeteners	4
	Vegetables	78

[1]Weight (kg, g, and mg) or volume (L and mL) measured raw material composition ratio of the mixed products.

Supplemental Table 2. Intake according to the food group per capita (g/kg-d)

Food group	Gender	n	Mean (SD)	5th	25th	50th	75th	90th	95th	99th
Seaweeds	Male	2526	0.55 (2.02)	0	0	0.12	0.59	1.3	2.10	5.00
	Female	2725	0.60 (2.64)	0	0	0.10	0.61	1.36	2.22	6.37
	Total	5251	0.58 (2.36)	0	0	0.11	0.60	1.33	2.15	5.48
Fruits	Male	2693	3.86 (6.65)	0	0	1.18	5.25	11.27	16.17	32.05
	Female	3548	4.95 (6.75)	0	0	3.11	7.00	12.61	17.71	30.52
	Total	6241	4.45 (6.72)	0	0	2.14	6.30	12.00	16.93	31.21
Nut and seed products	Male	2390	0.05 (0.36)	0	0	0	0.01	0.08	0.23	0.93
	Female	2459	0.07 (0.40)	0	0	0	0.01	0.08	0.26	1.18
	Total	4849	0.06 (0.38)	0	0	0	0.01	0.08	0.24	1.02
Dairy products	Male	1698	2.97 (7.64)	0	0	0	2.96	8.83	14.63	36.87
	Female	1845	2.51 (6.12)	0	0	0	3.33	7.37	12.18	28.82
	Total	3543	2.73 (6.89)	0	0	0	3.18	8.03	13.33	33.22
Eggs	Male	2361	0.51 (0.94)	0	0	0	0.69	1.52	2.29	4.62
	Female	2400	0.44 (0.91)	0	0	0	0.56	1.29	1.92	4.45
	Total	4761	0.47 (0.92)	0	0	0	0.63	1.42	2.13	4.55
Oils and fats	Male	4215	0.20 (0.27)	0	0.04	0.14	0.28	0.46	0.61	1.07
	Female	4436	0.19 (0.27)	0	0.03	0.12	0.26	0.43	0.6	1.17
	Total	8651	0.20 (0.27)	0	0.03	0.13	0.27	0.44	0.61	1.11
Seasonings	Male	4625	0.53 (0.56)	0.02	0.18	0.39	0.71	1.13	1.52	2.45
	Female	5032	0.50 (0.67)	0.01	0.15	0.34	0.65	1.08	1.49	2.66
	Total	9657	0.52 (0.62)	0.02	0.16	0.36	0.68	1.11	1.5	2.55
Sugars and sweeteners	Male	3617	0.20 (0.38)	0	0	0.10	0.27	0.49	0.71	1.63
	Female	3813	0.21 (0.38)	0	0	0.09	0.28	0.51	0.73	1.55
	Total	7430	0.21 (0.38)	0	0	0.09	0.27	0.50	0.72	1.58

SD, standard deviation.

Supplemental Table 3. Total intake of grain products (food) per capita (g/kg-d)

Demographic group	n	Mean (SD)	5th	25th	50th	75th	90th	95th	99th
Gender									
Male	4751	14.70 (8.51)	5.29	9.27	12.76	17.79	25.1	30.49	45.7
Female	5192	13.37 (7.89)	4.69	8.35	11.71	16.19	22.54	27.75	40.48
Age									
1-2	238	19.27 (14.39)	0.19	8.03	16.37	27.88	38.89	45.52	58
3-6	684	24.73 (12.81)	9.59	16.31	22.42	30.04	40.03	47.35	75.93
7-12	1088	18.69 (9.26)	7.7	12.37	16.56	22.93	30.33	35.35	50.3
13-19	968	13.66 (6.84)	5.18	9.13	12.56	16.8	22.05	26.78	35.69
20-39	3057	12.15 (6.03)	4.5	8.04	11.05	15.14	19.71	23.08	31.74
40-69	3360	11.99 (5.6)	4.88	8.31	11.13	14.69	18.67	21.62	30.29
≥70	548	12.26 (5.81)	4.82	8.39	11.53	14.87	19.13	22.93	33.42
Region									
Metropolitan city	4575	13.68 (7.93)	4.8	8.61	11.93	16.57	23.1	28.87	41.69
Small or medium-sized city	3278	14.24 (8.91)	4.76	8.62	12.2	17.4	24.74	30.2	46.1
Rural area	2090	14.34 (7.66)	5.54	9.43	12.82	17.31	23.39	29.56	41.3
Total	9943	14.00 (8.22)	4.91	8.82	12.22	17	23.76	29.48	43.28

SD, standard deviation.