

Original Research



Development of a food frequency questionnaire for dietary intake of preschool children

Minji Kang ^{1,2} and Jae Eun Shim ^{3,4§}

¹Center for Gendered Innovations in Science and Technology Researches (GISTeR), Korea Federation of Women's Science & Technology Associations, Seoul 06130, Korea

²Cancer Epidemiology Program, University of Hawaii Cancer Center, Honolulu, Hawaii 96813, USA

³Department of Food and Nutrition, Daejeon University, Daejeon 34520, Korea

⁴Daejeon Dong-gu Center for Children's Food Service Management, Daejeon University, Daejeon 34520, Korea

OPEN ACCESS

Received: Jul 24, 2019

Revised: Oct 8, 2019

Accepted: Mar 11, 2020

§Corresponding Author:

Jae Eun Shim

Department of Food and Nutrition and Daejeon Dong-gu Center for Children's Food Service Management, Daejeon University, 62 Daehak-ro, Dong-gu, Daejeon 34520, Korea.
Tel. +82-42-280-2469
E-mail. jshim@dju.kr

©2020 The Korean Nutrition Society and the Korean Society of Community Nutrition
This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ORCID iDs

Minji Kang 

<https://orcid.org/0000-0003-2930-4780>

Jae Eun Shim 

<https://orcid.org/0000-0001-8458-9112>

Funding

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (Ministry of Science and ICT; MSIT) (grant No. 2016R1D1A1B03931820).

Conflict of Interest

The authors declare no potential conflicts of interests.

<https://e-nrp.org>

ABSTRACT

BACKGROUNDS/OBJECTIVES: To describe the data-based development of a food frequency questionnaire (FFQ) for dietary evaluation of Korean preschool children.

SUBJECTS/METHODS: Development of the FFQ was based on the data from 2,766 preschool children aged 1–5 years, who had completed 24-hour dietary recalls in the 2009–2013 Korea National Health and Nutrition Examination Survey. We selected the food list based on the results of nutritional contribution and between-person variability for energy and 13 nutrients. We selected 88 foods with over 80% of total contribution to each nutrient and with over 80% of accumulated r^2 for each nutrient. A dish containing any of the 88 foods in the recipe was listed, and a total of 903 dishes were extracted. Among the 903 dishes, we selected 438 dishes contributing more than 1% of total consumption.

RESULTS: FFQ included 116 dish items combined from 438 dishes based on nutrient profile and recipe. Quantities of dietary intake were assessed by nine categories of frequency and portion size option. In addition, when comparing the food portions of children with the reference portion size, subjects would be asked to select one of three response categories (less, similar, and more) and then to record the amount as a percentage for the reference portion. Percentages of coverage for energy, protein, fat, and carbohydrate were 89.2%, 88.4%, 88.2%, and 89.4%, respectively.

CONCLUSIONS: The dietary intake of Korean preschool children can be assessed by this new data-based FFQ. In addition, the new instrument can be used to identify nutritional needs of target groups for planning nutrition education and strategies to improve diet. Further studies are warranted to evaluate the performance of the instrument.

Keywords: Methodological study; nutrition assessment; questionnaire design; preschool children

INTRODUCTION

During early childhood, eating behaviors are established and can have long-term effects on growth and health [1,2]. Being underweight or stunted are both associated with an increased mortality, morbidity, and impaired development of children [3]. In contrast, being

Author Contributions

Conceptualization: Shim JE, Kang M; Formal analysis: Kang M; Funding acquisition: Shim JE; Methodology: Shim JE, Kang M; Project administration: Shim JE; Supervision: Shim JE; Visualization: Kang M; Writing - original draft: Kang M; Writing - review & editing: Kang M, Shim JE.

overweight or obese has immediate physical and mental health implications for a child, and both are risk factors for cardiovascular disease and diabetes in adults [3]. Diet is an important factor of growth and development during childhood. Therefore, it is important to accurately assess the dietary intake among preschool children.

Early childhood is a life phase where the assessment of dietary intake is particularly challenging because of many unique respondent and observer considerations [4,5]. For this age group, one must consider low literacy skills, limited attention span, limited memory, limited knowledge of food and food preparation, rapidly changing food habits, and dietary reporting by surrogate respondents [4,6]. As a consequence of these challenges, studies developing dietary measurement tools for preschool children are very limited.

A food frequency questionnaire (FFQ) is commonly used as an assessment tool for collecting usual dietary intake. It generally consists of a list of food items, frequencies of consumption, and portion sizes as either single or multiple categories [7,8]. One of the most frequently used methods to develop a new FFQ is by applying a data-based approach, which selects not only the food list, but also the quantitation, which includes the nutrient content and the portion size for most of the foods and nutrients consumed by the target population [9]. FFQs developed for preschool children are very few compared to those for the adult population. However, several FFQs have been developed targeting preschool age children [5,10-13].

In the Korea National Health and Nutrition Examination Survey (KNHANES), a daily dietary intake assessed by 24-hour dietary recall (24HDR) is conducted for the population of one year of age or older. However, only the age group of 19 to 64 years is surveyed for the usual dietary intake by FFQ [14]. In other words, there is no comprehensive dietary assessment tool for estimating the usual dietary intake of preschool children in Korea. Therefore, the primary goal of this study was to design a food frequency questionnaire for a comprehensive assessment of dietary intake in Korean preschool children using the data-based approach.

SUBJECTS AND METHODS

Data source

We developed the FFQ based on the data from 2,766 preschool children aged between 1 and 5 years who had completed 24HDR in the 2009–2013 Korea National Health and Nutrition Examination Survey. The KNHANES is a nationally representative, cross-sectional survey and consists of the following three surveys: a health interview, a health examination, and a nutrition survey. Detailed information on the method and data of KNHANES is available [14]. The Korea Centers of Disease Control and Prevention Institutional Review Board approved the survey protocol (approval No. 2009-01CON-03-2C, 2010-02CON-21-C, 2011-02CON-06-C, 2012-01EXP-01-2C, and 2013-07CON-03-4C), and all guardians of the participants provided written informed consent.

Food list

The process of selecting dish items for the FFQ consisted of four steps as shown in **Fig. 1** [7,9]. First, we tried to identify foods most predictive of between-person variability using cumulative r^2 and nutritional contribution to total consumption for energy and 13 nutrients (protein, fat, carbohydrate, calcium, phosphorous, iron, sodium, potassium, vitamin A, thiamin, riboflavin, niacin, and vitamin C) [15]. We calculated the nutritional contribution

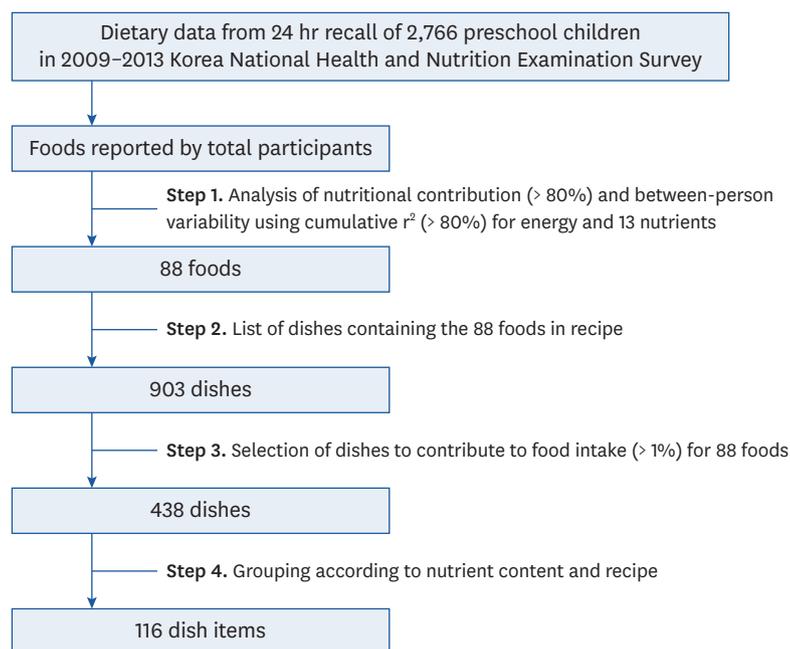


Fig. 1. Selection of dish items.

based on the percent contribution of each food (“y1”) as

$$y1 = \frac{\text{Nutrient Intake Provided by Specific Food}}{\text{Total Nutrient Intake}} \times 100$$

We excluded foods that accounted for less than 0.5% of total consumption in order to exclude foods consumed in large quantities by only a few participants [16]. To assess the between-person variation in nutrient intake, we carried out stepwise multiple regressions, and included the total nutrient intake from all foods as a dependent variable, and included nutrient intakes provided by each food as independent variables. We thus selected 88 foods that made over 80% of the total contribution to each nutrient and over 80% of accumulated r^2 for each nutrient.

Second, we listed dishes containing any of 88 foods in the recipe and identified a total of 903 dishes. Third, we identified the percent contribution of each of the 903 dishes to the consumption of 88 foods. In this analysis, we selected 438 dishes contributing more than 1% of total consumption from the 903 dishes. Percent contributions of each dish (“y2”) in intake of each food were calculated as,

$$y2 = \frac{\text{Specific Food Intake Provided by Specific Dish (g)}}{\text{Total Consumption of Specific Food (g)}} \times 100$$

Finally, some of these 438 dishes were combined based on the nutrient profile and recipe into 116 items for the food list in the newly developed FFQ.

Frequency response section

Frequency questionnaire was designed to obtain the consumption frequency of each dish item for a month. Frequency response choices for dish items were categorized into nine

groups with more allocation for more frequent intake: one non-consumption response, two monthly base responses, three weekly bases responses, and three daily bases responses.

Portion sizes

Reference portion size for each dish item was based on typical serving size as reflected in the distribution from the one-day 24HDR of 2,766 preschool children in the 2009–2013 KNHANES. For countable items such as strawberry, gram weight derived from the distribution was compared with the gram weight in the book [17,18]. For mixed dishes, gram weight and volume were confirmed after cooking according to the derived recipe.

Development of a nutrient database

We developed the nutrient database for FFQ for preschool children according to the data-based approach [9,11,19]. Nutrient content per 100 g of the 116 items in the FFQ was derived from the one-day 24HDR of the 2,766 preschool children aged between 1 and 5 years in the 2009–2013 KNHANES. We calculated the energy and nutrient intakes of KNHANES data based on the 8th edition of the Standard Food Composition Table from the Rural Development Administration by the KNHANES survey team [14]. Energy, macronutrients (protein, fat, and carbohydrate), five minerals (calcium, phosphorous, iron, sodium, and potassium), and five vitamins (vitamin A, thiamin, riboflavin, niacin, and vitamin C) content were contained in the nutrient database.

In order to examine how the developed FFQ assessed the dietary intake of preschool children, we calculated the percentage coverage of energy and 13 nutrients that can be assessed by the FFQ based on the nutrient database for preschool children FFQ. The percentage coverage of each nutrient (“y3”) was calculated as

$$y3 = \frac{\text{Nutrient Intake Calculated from 116 Items in FFQ for Korean Preschool Children}}{\text{Total Nutrient Intake}} \times 100$$

Data were analyzed using SAS 9.4 (SAS Institute, Inc., Cary, NC, USA).

RESULTS

Food list

Fig. 2 shows the example of FFQ for the dietary evaluation of Korean preschool children. This FFQ examines the intake frequency and portion size for 116 items to assess the dietary intake of Korean preschool children. For calibration purpose, we added a question for the number of meals (i.e., Korean staple dishes such as rice or noodles) a day. Participants (i.e., primary caregivers) would be asked how often their children had consumed each dish item for the past month. Finally, 116 dish items were presented as shown in **Table 1**. Dish items of questionnaire consisted of 15 Korean staple dishes, including cooked rice and noodles, 14 soups and stews, 53 side dishes including cooked and seasoned vegetables, kimchi, grilled and boiled fish or meat foods, 8 breads and baked products, 13 dairy products and beverages, and 13 fruits.

Frequency response section and portion sizes

Frequency response choices for dish items were “never or hardly ever,” “once a month,” “2 to 3 times a month,” “once a week,” “2 to 4 times a week,” “5 to 6 times a week,” “once a day,” “2

Food Frequency Questionnaire for Korean preschool children

How many meals (i.e. Rice or Noodles) a day does your child eat?

① One ② Two ③ Three ④ Four or more

For each dish item, fill a box that best describes HOW OFTEN your child ate those item during the past month.

Then fill a box that best describes USUAL PORTION SIZE.

Dishes	How many times had the dishes during the past month in average?									Reference portion size	Usual portion size (compared with reference portion size)			% reference portion
	Never or hardly ever	per month		per week			per day				less than	similar to	more than	
		1	2~3	1	2~4	5~6	1	2	3					
Cooked Rice														
White Rice										1/2 bowl				
Multi-grain Rice										1/2 bowl				
Gimbap										1/2 roll				
Fried Rice										1 bowl				
Bibimbap										1 bowl				
Curry and Rice										1 bowl				
Rice Ball										1 piece				

Fig. 2. Example of the food frequency questionnaire for Korean preschool children: dish items of cooked rice group.

Table 1. Number of items selected for the food frequency questionnaire for Korean preschool children

Item groups	Items	No. of items
Cooked rice	“white rice”, “multi-grain rice”, “gimbap”, “fried rice”, “bibimbap”, “curry and rice”, “rice ball”	7
Noodles and dumplings	“banquet noodles, spicy mixed noodle with vegetable”, “buckwheat noodle, chilled buckwheat noodle soup, udon noodle, hand-made noodles in broth, sliced rice cake soup”, “spaghetti”, “instant noodle”, “black bean paste noodle, rice with black bean sauce”, “dumpling”, “porridge (rice porridge with vegetables, pumpkin porridge, rice porridge with sesame, rice porridge with peanut, rice with assorted grains porridge)”, “porridge (rice porridge with chicken, rice porridge with beef, rice porridge with abalone, rice porridge with canned tuna)”	8
Soups	“potato soup”, “egg soup”, “soybean paste soup”, “radish soup”, “seaweed soup”, “dried Alaska pollack soup”, “beef leg bone soup, thick beef bone soup”, “chicken and ginseng soup”, “beef soup”, “fish paste soup”, “beef soup with seasoned red pepper sauce, chicken soup with seasoned red pepper sauce”, “bean sprout soup”	11
Stews	“kimchi stew”, “soybean paste stew, fermented soybean paste stew”, “spicy soft tofu stew”	3
Cooked and seasoned vegetables	“stir-fried shredded potato, braised potato”, “grilled laver”, “perilla leaves (seasoned perilla leaves, steamed perilla leaves, perilla leaf kimchi, perilla leaves)”, “stir-fried mushroom”, “seasoned radish, cooked”, “seasoned radish”, “stir-fried sea mustard stem”, “seasoned spinach, cooked”, “braised lotus root, braised burdock”, “seasoned cucumber”, “stir fried noodles with vegetables”, “vegetable salad”, “seasoned soybean sprouts, cooked”, “braised bean”, “seasoned young pumpkin, cooked”	15
Eggs and tofu	“steamed egg”, “pan-fried egg, rolled omelette, scrambled eggs”, “boiled egg, braised egg”, “tofu (steamed, pan-fried, braised)”	4
Pan-fried food	“Kimchi pancake, chive pancake, welsh onion pancake”, “pan-fried meat rolls, pan-fried fishcake, pan-fried shrimp cake”, “pan-fried young pumpkin”	3
Kimchi	“Kimchi”, “Radish root and leaves kimchi”, “Pickled radish”	3
Grilled and boiled fish or meat foods	“chicken (spicy grilled, braised, steamed, grilled)”, “Grilled duck”, “grilled pork (grilled pork ribs, grilled pork belly)”, “pork (stir-fried, braised, braised pork seasoned with soy sauce)”, “Beef (bulgogi, stir-fried, steamed, soy sauce braised)”, “grilled beef (grilled beef ribs, steak)”, “grilled short rib patties, hambak steak”, “grilled ham, pan-fried ham, stir-fried sausage”, “grilled yellow croaker, grilled salt-dried croaker”, “mackerel (grilled, braised)”, “squid (stir-fried, seasoned, boiled)”, “dried squid (stir-fried, seasoned, braised)”, “stir-fried fish paste, braised fish paste, boiled fish paste”, “stir-fried anchovy, braised anchovy”, “canned tuna”	15
Fried food	“french fries”, “fried laver”, “fried chicken, fried chicken with sweet and spicy sauce, fried boneless chicken with sweet and spicy sauce”, “pork cutlet”, “fried squid, fried shrimp”, “sweet and sour fried pork”	5
Breads and baked products	“doughnut”, “red beans bread, cream bun”, “sandwich”, “bread, streusel bread, morning roll, Castella, mocha bread”, “cake”, “pizza”, “hotdog, sausage bread, hamburger”, “Stir-fried rice cake”	8
Grain, starch, and grain products	“potato (steamed, baked)”, “sweet potato (steamed, baked)”, “corn (steamed, baked)”, “rice cake (steamed white rice cake, a stick of rounded rice cake, rice cake stuffed with syrup, half-moon-shaped rice cake, steamed rice cake with red beans, glutinous rice cake with bean flour, pounded rice cake, glutinous rice cake)”	6
Snack	“snack, rice snack, Korean traditional rice cookies”, “cookie, cracker”	2
Ice cream	“sherbet”, “ice cream”	2
Dairy products and beverages	“powdered formula”, “drinking yogurt”, “yogurt”, “milk”, “cheese”, “soy milk”, “Parched barley powder drink”, “sports drink”, “orange juice”, “vegetable juice”, “sugar sweetened beverage”	11
Fruits	“persimmon”, “mandarin”, “strawberry”, “banana”, “pear”, “peach”, “apple”, “watermelon”, “orange”, “oriental melon”, “kiwi”, “tomato”, “grape”	13
Total		116

times a day,” and “3 times a day.” Reference portion size for each item was provided. For dish items such as “powdered formula”, “yogurt”, “milk”, “soy milk”, and “juice”, the reference portion size was determined as median value of consumed gram amount among preschool children aged 1–2 years. For other items, the reference portion size was determined as median value of preschool children aged 3–5 years. Countable items such as strawberry were given in natural units (e.g., 1, 2, and 3). Portion sizes of mixed dishes were given in specific amounts (e.g., 1 spoon, 1/3 cup, and 1 cup, etc.). In addition, we designed response choices for portion size as “less than”, “similar to”, or “more than” the reference portion size. If either “less” or “more” was selected, participants would be asked to record a percentage for the reference portion.

Nutrient database

Nutrient contents per 100 g were produced as a weighted mean value, multiplied by the intake proportion of the individual foods for each dish item. **Table 2** presents examples of nutrient database. For example, energy content per 100 g of six individual foods belonging to “chicken (spicy grilled, braised, steamed, grilled)” item ranged from 111.7 kcal (“spicy braised chicken”) to 189 kcal (“grilled chicken drumsticks”). After adjusting the frequency weight of each individual food, energy content per 100 g of “chicken (braised, grilled)” item was 124.3 kcal.

Performance of questionnaire

Percentage coverage of energy from the selected 116 items was 89.2%; the percentage coverage of protein, fat, and carbohydrates was 88.4%, 88.2%, and 89.4%, respectively (**Table 3**). The percentage coverage for sodium (82.9%) was lowest, whereas those for calcium (91.4%) were highest of the minerals. In vitamins, the percentage coverage was lowest for vitamin A (87.6%) and highest for riboflavin (91.7%). The percentage coverage of the target nutrients was more than 80% in both age groups.

DISCUSSION

Dietary intake during childhood is important for growth and health, but studies on dietary measurement tools for preschool children are limited. Our study developed an FFQ for Korean preschool children using a data-based approach. We identified dish items and portion sizes for each item of this newly developed FFQ by using the data from 2,766 preschool children aged between 1 and 5 years in the 2009–2013 KNHANES. We selected a total of 116 dish items and created nine frequency categories and three portion size response choices for each item. We compiled a nutrient composition database per 100 g for each dish item using the recipes from the 2,766 preschool children.

In order to develop a new FFQ for a group study, it is necessary to select a food list that reflects the diet of the target population. For example, in a previous study, to estimate habitual dietary intake among Japanese children, an FFQ was developed with 75 food items [11]. The food items were selected using a contribution analysis to include items that contribute greatly to energy and nutrient intake and used a multiple regressions analysis to consider the between-person variance in the nutrient intake based on the data from 586 children's dietary data [11]. In our study, we selected a list of foods using data-based method, and selected 116 items based on the dishes that contain foods resulting from the contribution analysis and variation analysis for energy and 13 nutrients using the target population dietary data. The FFQ can identify the food source that contributes to the specific nutrient intake and can also provide information on what type of dish is being consumed, including the

Food frequency questionnaire for preschool children

Table 2. Examples of nutrient database of food frequency questionnaire for preschool children: content of energy and macronutrients with composition of each item

Item groups	Items	Nutrient content ¹⁾				Composition of item ²⁾					
		Energy (kcal/100 g)	Protein (g/100 g)	Fat (g/100 g)	Carbohydrate (g/100 g)	Individual foods	Frequency	Energy (kcal/100 g)	Protein (g/100 g)	Fat (g/100 g)	Carbohydrate (g/100 g)
Cooked rice	White rice	369.8	6.4	0.5	81.3	White rice	2,463	369.8	6.4	0.5	81.3
Noodles and dumplings	Banquet noodles, spicy mixed noodle with vegetable	212.1	6.7	2	40.4	Noodles	102	222	7	1.3	43.2
						Spicy mixed noodle with vegetable	129	216.4	7	3.2	39.2
						Banquet noodles	1,394	207.9	6.5	2	39.7
Soups	Potato soup	59.9	4.2	0.8	10	Potato soup	414	59.9	4.2	0.8	10
Stews	Kimchi stew	77.4	6.7	4.6	3.6	Kimchi stew	699	80.8	6.5	5.2	3.4
						Kimchi stew with canned tuna	369	69	7	3.5	3.8
						Kimchi stew with pork	271	82.7	6.5	4.6	3.8
Cooked and seasoned vegetables	Stir-fried shredded potato, braised potato	81.6	2.5	1.9	14.4	Stir-fried shredded potato	561	84.9	2.6	2.3	14.4
						Stir-fried shredded potato with vegetables	333	71.2	2.4	1.5	13
						Stir-fried potato	157	73.6	2.4	1.5	13.4
						Braised potato	751	86.4	2.7	1.7	16
Eggs and tofu	Steamed egg	120.2	9.9	7	3.5	Steamed egg	1,076	120.2	9.9	7	3.5
Pan-fried food	Kimchi pancake, chive pancake, welsh onion pancake	189.6	8.8	7.2	23.8	Kimchi pancake	544	185.1	7.3	8.2	21.7
						Chive pancake	302	186.6	9.3	6.1	25.4
						Vegetable pancake	240	184.8	7.1	8.5	20
						Welsh onion pancake with sea food	95	203.6	11.6	7	25.6
						Vegetable pancake with zucchini	57	192.6	7.8	7.8	26.3
Kimchi	Kimchi	19.2	1.9	0.4	4	Kimchi	1,983	19.2	1.9	0.4	4
Grilled and boiled fish or meat foods	Chicken (spicy grilled, braised, steamed, grilled)	124.3	15.9	3.6	6.9	Braised chicken	391	114.9	13	3.5	7.9
						Chicken brochette	12	129.7	26.6	1.6	2.1
						Grilled chicken	75	134.9	26.2	1.9	2.6
						Grilled chicken drumsticks	17	189	16.9	11.4	3.2
						Spicy grilled chicken	670	117.2	12	3.8	9.3
Fried food	French fries	101.4	1.8	5	12.6	Spicy braised chicken	492	111.7	12.9	2.9	8.6
						French fries	92	101.4	1.8	5	12.6
Breads and baked products	Doughnut	365.7	6.9	13.8	53.1	Twisted bread stick	120	355.6	7.9	11	54.6
						Doughnut	26	357.4	6.4	20	38.8
						Ring-shaped doughnut	19	367.3	6.4	22.9	35.8
						Sweet rice doughnut	53	390.3	5.9	7.6	74.1
Grain, starch, and grain products	Potato (steamed, baked)	65.7	2.8	0	14.5	potato (steamed, baked)	49	65.7	2.8	0	14.5
Snack	Snack, rice snack, Korean traditional rice cookies	481.8	5.9	21.8	65.4	Snack	697	495.6	6.6	23.1	65
						Rice snack	71	452.7	3.3	15.2	77.5
						Wafer	40	505.4	4.4	25.4	66.2
						Chips	47	418.2	4.8	20.9	54
						Korean traditional rice cookies	18	380.3	5.2	5.1	78.9
						Honey cookie	15	462.2	4.1	14.5	78
Ice cream	Sherbet	130.1	1.6	1.2	28.5	Frozen desserts	119	127.1	0.9	1.1	28.5
						Sherbet	50	127.9	0.9	1.1	28.7
						Milkshake	9	182.3	13.7	2.1	27.4
Dairy products and beverages	Powdered formula	375.5	15	17.5	40.7	Powdered formula	404	375.5	15	17.5	40.7
Fruits	Persimmon	80.4	0.8	0	22.1	Persimmon	145	80.4	0.8	0	22.1

¹⁾Resulted from the nutrient composition and frequency weight of individual foods included in each item.

²⁾Frequencies and nutrient contents of individual food were obtained from dietary intake data of 2,766 preschool children aged between 1 and 5 years in the 2009–2013 Korea National Health and Nutrition Examination Survey.

food source, since we selected the dish items in two stages (food list selection, and dish item choices including the selected foods). For example, major food sources of iron intake among

Table 3. Percentage coverage of energy and 13 nutrients from the selected 116 items in FFQ for Korean preschool children

Nutrients	Coverage (%) ¹⁾		
	All	1–2 years	3–5 years
Energy	89.2	90.6	88.4
Protein	88.4	89.8	87.6
Fat	88.2	90.4	87.0
Carbohydrate	89.4	90.6	88.7
Calcium	91.4	92.9	90.3
Phosphorus	90.4	91.7	89.6
Iron	85.0	86.9	83.9
Sodium	82.9	85.3	81.7
Potassium	89.1	90.8	88.2
Vitamin A	87.6	89.6	86.3
Thiamin	90.4	91.6	89.8
Riboflavin	91.7	93.3	90.7
Niacin	88.4	89.8	87.7
Vitamin C	91.4	92.8	90.6

FFQ, food frequency questionnaire.

¹⁾Percentage coverage of each nutrient was calculated as: (Nutrient Intake Calculated from 116 Items in FFQ for Korean Preschool Children)/(Total Nutrient Intake)*100.

1-5 years Korean preschool children were “white rice” and “egg.” “White rice” was mainly consumed as “cooked rice and multi-grain rice” and “egg” was mainly consumed as “fried egg, boiled egg, rolled omelet, steamed egg, and gimbap.” From this separate process of food list selection and dish item choices, extra coverage was accomplished, resulting in measuring intake of more than 87% of total consumption for most nutrients other than sodium.

Portion sizes either with multiple options or as a reference portion are necessary for calculating gram weights or nutrient intakes [20]. In a systematic review evaluating 17 studies of the FFQ validation for 12- to 36-month-old children, six studies used household measures/standard portion sizes to estimate the portion sizes, and three studies used portion sizes derived from the national nutrition survey data [5]. Our study designed the portion size with three options of “less than,” “similar to,” or “more than” the reference portion size, and in turn, we set reference portion size as a typical portion size based on the consumption distribution from the national survey data. Furthermore, a percentage of intakes compared to the reference portion size was asked if either “less” or “more” was selected. The strength of this design is its capacity to measure in detail the actual intake of participants whose eating behaviors are established during early childhood. In addition, this design is also consistent with previous research reporting correlation coefficients as being highest when subjects were able to describe their own portion size as compared with no portion size specified or portion size specified on the questionnaire [21].

Assigned recall interval of FFQ ranged from the previous seven days to the previous year for the 12- to 36-month-old children, and ranged from the previous month to the previous year for children 3 to 12 years old [5,10,12,22-24]. In this study, we assigned the recall period of FFQ as the previous month. This short recall period is expected to have a good correlation with the dietary habits of the participants, but several repeated survey are needed to reflect long-term dietary habits.

To measure dietary intake using FFQs, a nutrient database is required for each food item in addition to the selected food list, portion size for each food item, and frequency of consumption for each food item. Compared with other open-ended dietary assessment

methods, such as 24HDRs or food records, FFQs already had selected food items, and each item contains a variety of foods depending on the purpose of the study. Therefore, it is important to assign a nutrient value to each item to represent a composite value for the possible variants of the items queried [25]. To do this, we developed a nutrient composition database for each item of the FFQ for Korean preschool children using recipes from the national dietary survey data for the same target-age group.

Coverage rates of energy and all nutrients based on the selected dish items in the newly developed FFQ ranged from 82.9% (sodium) to 91.7% (riboflavin). Few studies are directly comparable. However, our coverage rates were similar to those from the FFQ for Japanese children aged 3–11 years [88.6% (vitamin C) to 97.8% (alpha-carotene)] [11]. In addition, the mean percentage coverage of nutrient intake was 82.4% by FFQ with 94 food items developed for Korean adults aged 30 years and older [26] and 92.3% by FFQ with 95 dish items developed for Korean adults aged 20 years and older [27].

In conclusion, this study is the first to develop a FFQ for preschool children using national data in Korea. The dietary intake of Korean preschool children can be assessed by this new data-based FFQ. In addition, the new instrument can be used to identify the nutritional needs of target groups for planning nutrition education and strategies to improve diet. Further studies are warranted to evaluate the performance of the instrument (e.g., reliability and validity).

REFERENCES

1. Mikkilä V, Räsänen L, Raitakari OT, Pietinen P, Viikari J. Consistent dietary patterns identified from childhood to adulthood: the cardiovascular risk in Young Finns Study. *Br J Nutr* 2005;93:923-31.
[PUBMED](#) | [CROSSREF](#)
2. Lanigan J, Singhal A. Early nutrition and long-term health: a practical approach. *Proc Nutr Soc* 2009;68:422-9.
[PUBMED](#) | [CROSSREF](#)
3. World Health Organization. Guideline: Assessing and Managing Children at Primary Health-Care Facilities to Prevent Overweight and Obesity in the Context of the Double Burden of Malnutrition: Updates for the Integrated Management of Childhood Illness (IMCI). Geneva: World Health Organization; 2017.
4. Livingstone MB, Robson PJ, Wallace JM. Issues in dietary intake assessment of children and adolescents. *Br J Nutr* 2004;92 Suppl 2:S213-22.
[PUBMED](#) | [CROSSREF](#)
5. Lovell A, Bulloch R, Wall CR, Grant CC. Quality of food-frequency questionnaire validation studies in the dietary assessment of children aged 12 to 36 months: a systematic literature review. *J Nutr Sci* 2017;6:e16.
[PUBMED](#) | [CROSSREF](#)
6. Livingstone MB, Robson PJ. Measurement of dietary intake in children. *Proc Nutr Soc* 2000;59:279-93.
[PUBMED](#) | [CROSSREF](#)
7. Willett W. *Nutritional Epidemiology*. 3rd ed. Oxford: Oxford University Press; 2012.
8. Coulston AM, Boushey CJ, Ferruzzi MG, Delahanty LM. *Nutrition in the Prevention and Treatment of Disease*. 4th ed. Cambridge (MA): Elsevier Academic Press; 2017.
9. Block G, Hartman AM, Dresser CM, Carroll MD, Gannon J, Gardner L. A data-based approach to diet questionnaire design and testing. *Am J Epidemiol* 1986;124:453-69.
[PUBMED](#) | [CROSSREF](#)
10. Delisle Nyström C, Henriksson H, Alexandrou C, Bergström A, Bonn S, Bälter K, Löf M. Validation of an online food frequency questionnaire against doubly labelled water and 24 h dietary recalls in pre-school children. *Nutrients* 2017;9:E66.
[PUBMED](#) | [CROSSREF](#)

11. Kobayashi T, Tanaka S, Toji C, Shinohara H, Kamimura M, Okamoto N, Imai S, Fukui M, Date C. Development of a food frequency questionnaire to estimate habitual dietary intake in Japanese children. *Nutr J* 2010;9:17.
[PUBMED](#) | [CROSSREF](#)
12. Saravia L, González-Zapata LI, Rendo-Urteaga T, Ramos J, Collese TS, Bove I, Delgado C, Tello F, Iglesia I, Gonçalves Sousa ED, De Moraes AC, Carvalho HB, Moreno LA. Development of a food frequency questionnaire for assessing dietary intake in children and adolescents in South America. *Obesity (Silver Spring)* 2018;26 Suppl 1:S31-40.
[PUBMED](#) | [CROSSREF](#)
13. Watson EO, Heath AL, Taylor RW, Mills VC, Barris AC, Skidmore PM. Relative validity and reproducibility of an FFQ to determine nutrient intakes of New Zealand toddlers aged 12–24 months. *Public Health Nutr* 2015;18:3265-71.
[PUBMED](#) | [CROSSREF](#)
14. Korea Centers of Disease Control and Prevention. The Sixth Korea National Health and Nutrition Examination Survey (KNHANES VI). Cheongju: Korea Centers of Disease Control and Prevention; 2014.
15. Kang M, Shim JE, Kwon K, Song S. Contribution of foods to absolute nutrient intake and between-person variations of nutrient intake in Korean preschoolers. *Nutr Res Pract* 2019;13:323-32.
[PUBMED](#) | [CROSSREF](#)
16. Jung HJ, Song WO, Paik HY, Joung H. Dietary characteristics of macronutrient intake and the status of metabolic syndrome among Koreans. *Korean J Nutr* 2011;44:119-30.
[CROSSREF](#)
17. Rural Development Administration. Food Composition Database Based on One Portion Size. Paju: Gyomoon; 2013.
18. Rural Development Administration. Food Composition Database for Children. Paju: Gyomoon; 2010.
19. Park MK, Noh HY, Song NY, Paik HY, Park S, Joung H, Song WO, Kim J. Validity and reliability of a dish-based, semi-quantitative food frequency questionnaire for Korean diet and cancer research. *Asian Pac J Cancer Prev* 2012;13:545-52.
[PUBMED](#) | [CROSSREF](#)
20. Cade J, Thompson R, Burley V, Warm D. Development, validation and utilisation of food-frequency questionnaires - a review. *Public Health Nutr* 2002;5:567-87.
[PUBMED](#) | [CROSSREF](#)
21. Cade JE, Burley VJ, Warm DL, Thompson RL, Margetts BM. Food-frequency questionnaires: a review of their design, validation and utilisation. *Nutr Res Rev* 2004;17:5-22.
[PUBMED](#) | [CROSSREF](#)
22. Fatihah F, Ng BK, Hazwanie H, Norimah AK, Shanita SN, Ruzita AT, Poh BK. Development and validation of a food frequency questionnaire for dietary intake assessment among multi-ethnic primary school-aged children. *Singapore Med J* 2015;56:687-94.
[PUBMED](#) | [CROSSREF](#)
23. Kobayashi T, Kamimura M, Imai S, Toji C, Okamoto N, Fukui M, Date C. Reproducibility and validity of the food frequency questionnaire for estimating habitual dietary intake in children and adolescents. *Nutr J* 2011;10:27.
[PUBMED](#) | [CROSSREF](#)
24. Moghames P, Hammami N, Hwalla N, Yazbeck N, Shoaib H, Nasreddine L, Naja F. Validity and reliability of a food frequency questionnaire to estimate dietary intake among Lebanese children. *Nutr J* 2016;15:4.
[PUBMED](#) | [CROSSREF](#)
25. Subar AF, Midthune D, Kuhlthorff M, Brown CC, Thompson FE, Kipnis V, Schatzkin A. Evaluation of alternative approaches to assign nutrient values to food groups in food frequency questionnaires. *Am J Epidemiol* 2000;152:279-86.
[PUBMED](#) | [CROSSREF](#)
26. Kim J, Kim Y, Ahn YO, Paik HY, Ahn Y, Tokudome Y, Hamajima N, Inoue M, Tajima K. Development of a food frequency questionnaire in Koreans. *Asia Pac J Clin Nutr* 2003;12:243-50.
[PUBMED](#)
27. Kim YO, Kim MK, Lee SA, Yoon YM, Sasaki S. A study testing the usefulness of a dish-based food-frequency questionnaire developed for epidemiological studies in Korea. *Br J Nutr* 2009;101:1218-27.
[PUBMED](#) | [CROSSREF](#)