

Original**Development of the Revised Food Frequency Questionnaire for Cambodian School-aged Children**Yoko Horiuchi^{1*}, Kaoru Kusama², and Eri Kai³¹*Department of Health and Nutrition, Faculty of Psychological and Physical Science, Aichi Gakuin University, Nisshin, Aichi 320-0195, Japan*²*Department of Food and Health Sciences, Faculty of Health and Human Development, The University of Nagano, 8-49-7 Miwa, Nagano 380-8525, Japan*³*Foundation for International Development/Relief (FIDR); No. 82F, St. 210 Sangkat Teuk La-ak III Khan Toul Kork, Phnom Penh 12158, Cambodia*

ABSTRACT: *Background and purpose.* This study aimed to describe the process of revising the Food Frequency Questionnaire (FFQ) developed in 2016 for school-aged children in Cambodia (FFQ-CSC). *Methods.* First, we updated the food composition database using the updated version of the ASEAN Food Composition Table; we also added specific values used in the SMILING food composition tables for Cambodia and Thailand and in the food composition tables for Singapore, Thailand, and Japan. The previous portion sizes were modified based on the current reference amounts. Second, we re-examined the photographs in a picture book and adjusted them according to the revised portion sizes. *Result.* The revised FFQ-CSC was created with a new data entry form in Excel, which allows users to input data more accurately. The new picture book comprises 64 pages for 53 food items and provides respondents with more comprehensive information about various portion sizes. We also created a manual explaining how to use the FFQ-CSC. *Conclusion.* The revised FFQ-CSC with the updated food pictures can be used to assess the dietary intake of Cambodian children. With the newly developed manual, we expect this questionnaire to be used widely and more frequently. It is important to update and revise this tool regularly. Furthermore, the revised FFQ-CSC must be validated and its reliability must be assessed.

Key Words: Cambodia, school-aged children, food frequency questionnaire, revised version, development

INTRODUCTION

The Food Frequency Questionnaire (FFQ) is one of the most commonly employed dietary assessment tools in large epidemiological studies (1). It generally comprises a list of commonly consumed foods with some possible options regarding the frequency of their consumption (2) and can assess habitual food intake over a set time period (3). Several versions of the FFQ have been developed over the last few years (4,5); a validated FFQ can provide information on food intake during a certain period (6,7).

In Cambodia, however, before we developed the FFQ for Cambodian school-aged children (FFQ-CSC) in 2016 to assess their intake of macronutrients and calcium, there was no FFQ to measure their dietary intake. The original FFQ-CSC was validated through a comparison with the 24-hour dietary recall method (hereafter 24-h) developed by the Foundation for International Development/Relief (FIDR) in 2017 (8). Nutritionists usually recommend using or modifying an existing questionnaire in epidemiological surveys (9). Communities should use FFQs that were developed with considerations for how ethnicity, culture, and economic status may affect food intake and dietary habits (10,11). Assigning valid nutritional values to the food items on the quantitative FFQ requires the use of an appropriate dietary database (12) and replacement of the food composition table (FCT) used to calculate nutrient intake, by making appropriate changes to the

portion sizes and updating the program code for nutrient calculation (13,14).

Hence, we aimed to modify the FFQ-CSC by using the updated Association of Southeast Asian Nations (hereafter ASEAN) FCT and other food composition data as nutritional data. We also assessed and revised the food items, their frequencies and portion sizes, and the program code to calculate the nutritional values, and provided a picture book that allows children to visualize portion sizes more precisely. In this paper, we describe the process of revising the FFQ-CSC to match the recent dietary trends in Cambodia.

METHODS

Based on the results of our validation study and the current dietary trends, we modified the previous version of the FFQ-CSC (8) as described below.

Data collection

The nutritional data were updated primarily using the 2014 ASEAN FCT (15). The original FFQ-CSC adopted the 2000 ASEAN FCT (16) which was then revised in 2014 (15) and SMILING FCT: Cambodia (17) as its nutrition database. To address the missing data in the ASEAN FCT, we also incorporated other data from Smile FCT: Cambodia (17) and Thailand (18) and FCTs from Singapore (19), Thailand (20), and Japan (21). The nutritional data used in the FFQ-CSC were energy (calories) and nutrients (protein, fat, carbohydrate, and calcium).

Food Items/Frequency/Portion Sizes

Improvements to the FFQ-CSC made in a previous study (8), the current portion sizes in the market were assessed to identify any limitations.

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Program Code for the Nutrient Calculation

We re-created the input sheet on Microsoft Excel 2016 for the revised questionnaire by updating the food items. In addition, a pull-down input was adopted for the frequency and portion size choices.

To assess the quantities of oil and sugar used in the food items, we enabled a system that automatically adds the amount of oil and sugar in proportion to the energy value, instead of requiring respondents to provide these quantities.

Picture Book

We provided a picture book containing the updated representative portion sizes of the food items to help children select their portion sizes easily. The sizes of the dishes and spoons in the photographs were consistent so that respondents could imagine more accurate portion sizes.

RESULTS

Nutritional Data

Table 1 shows the updated nutritional data on the final list of food items.

Food Items/Frequency/Portion Sizes

Table 2 shows the modifications to the nutritional data. Two items (mung bean cake and salt for food) were deleted, one item was modified (salt for young fruits), and portion sizes of all except 17 items (e.g., rice noodles) were revised. The frequency of each item was unified.

Program Code to Calculate the Nutritional Values

We generated a new input worksheet on Microsoft Excel 2016 with pull-down lists for frequencies and portion sizes to enable easy input. The input numbers corresponding to the frequencies and portion sizes were converted into the quantities used to calculate the nutritional values. In addition, automatically calculated amounts of sugar and oil in the food items were included in the program code (Table 2). Based on the following formula, the amounts of oil and sugar per 1000 kcal were calculated to be 21.1 g and 83.9 g, respectively.

Formula: Adding sugar amount (g) per 1000 kcal = (Average carbohydrate intake only from "sugar"/Average energy intake)/S; S is carbohydrate per 100g of sugar (=99.4). Adding oil amount (g) per 1000 kcal = (Average fat intake only from "oil"/Average energy intake)/O; O is fat per 100g of oil (=90.8).

Picture Book

A 64-page picture book was created to supplement the food items listed in the FFQ-CSC. To ensure that the photographs were as realistic as possible, the bowl or plate containing the food was photographed against a background of vertical and horizontal coordinates calibrated in units of length (scale with 2.5 cm × 2.5 cm), and the images were color-printed.

DISCUSSION

We updated the FFQ-CSC based on the results of a previous validation study (8) and the current dietary trends. First, we referred to various FCTs (15, 17-21) to modify the nutritional values of the FFQ-CSC. This method had also been employed for the previously developed FFQs (22-25). In Croatia, the FFQ was developed using a combination of different food databases to analyze the meals because their national food composition database is outdated and impractical to use (25).

Second, regarding the modified food items and portion sizes, in a previous study, 33 food items were added to and 5 food items and beverages were excluded from the FFQ to account for regional and generational dietary changes (14). Another study used altered portion sizes to improve the accuracy of the participants' dietary intakes (13).

Third, the weak correlation between the fat levels in the FFQ-CSC and 24-h (8) was considered. Concerning fat intake, because our survey inquired about respondents' consumption of stir-fried or deep-fried dishes to measure oil intake, it may have been difficult for children to answer these questions (8). A study conducted in Tehran (26) showed that the weak correlation between liquid oil and solid fat might be due to respondents' lack of culinary knowledge. In addition, people use various types of volume measures, such as teaspoons, tablespoons, and cups, for liquid oils and solid fats in food preparations. Therefore, estimating the actual amount of lipids is a challenge. Further, measuring the nutritional values of ingredients in mixed dishes when assessing dietary intake is always a taxing process, and there is a risk of potential loss of dietary information (27). Thus, there was a need to address the question about "oil intake." Similarly, a question about "sugar consumption" in the previous FFQ-CSC used teaspoons as the measuring unit, which may have made it difficult for school-aged children to estimate their sugar intake.

To address these limitations, we developed a new system in which oil and sugar quantities were automatically added per each individual's calorie intake. In addition, we considered that a picture book would help the respondents visualize the food items, making it easier to estimate their portion sizes. An accurate estimation of food portion size remains an important challenge in the collection of dietary data. In China, a food atlas with adequate visual references was developed to improve the accuracy of dietary surveys (28). We should also continue to enhance the food pictures to help respondents accurately determine their portion sizes.

Finally, we emphasize that our next step is to validate the revised FFQ-CSC to ensure its feasibility and reproducibility.

Over the past decade, dietary assessment methods have increasingly made use of online technologies, with the traditional paper-based questionnaires getting replaced (29). An online self-administered FFQ has been validated (30). Digital solutions may minimize some of the errors associated with paper-based questionnaires, and the problem of missing values can be eliminated through automated pop-up reminders and mandatory questions. These in turn may ease respondents' cognitive burden when choosing the right portion size and potentially reduce errors from inaccurate estimations of portion sizes (30). Therefore, we aim to develop an online version of the FFQ-CSC after evaluating the modified FFQ-CSC.

In conclusion, the revised FFQ-CSC with updated food pictures can now be used to assess the dietary intake of Cambodian children. We expect this tool to be used widely and more frequently in Cambodia. However, the validity and reliability of the revised FFQ-CSC must be assessed. Furthermore, we believe that FFQ-CSC should be updated and revised in the future with changing environmental conditions.

Table 1. Question numbers and composition of nutritional data in the previous and updated versions of the questionnaire

Food group	Name of food item	Previous version			Updated version						
		Q. No.	ASEAN FCT 2000	SMILING FCT Cambodia 2013	Q. No.	ASEAN FCT 2014	SMILING FCT Cambodia 2013	SMILING FCT Thailand 2013	Singapore FCT 2003	Thailand FCT 2015	Japan FCT 2020
I. Cereal and cereal products	Boiled rice, rice noodle, sandwich bread, wheat noodle with flavor, corn, sweet potato	Q1-6	6	0	Q1-6	2	4	0	0	0	0
	Morning glory, amaranth, spinach, cucumber, bean sprout	Q7-11	5	0	Q7-11	1	4	0	0	0	0
III. Fruits	Yellow banana, green banana, coconut cream, guava, green mango, ripe papaya, Spanish plum, rambutan	Q12-19	8	0	Q12-19	7	1	0	0	0	0
	Fermented soybean, soybean milk, boiled mung bean, roasted peanut, snake head fish, clam, snail, shrimp, crab, canned fish, dried shrimp, duck egg, beef, pork, beef meat ball, chicken, pork blood	Q20-36	16	1	Q20-36	7	9	0	0	1	0
V. Milk and milk products	Fresh milk, yogurt, yogurt drink, cheese, milk powder, ice cream, condensed milk	Q37-43	7	0	Q37-43	6	0	0	0	0	1
	Rice cake, snack made from potato or corn, (mung bean cake), Milo powder, Ovaltine powder, soft drink juice, soft drink tea	Q44-50	7	0	Q44-49	4	0	1	1	0	0
VII. Condiments	(Soybean oil), (sugar for food and drink), fish paste in the dish, fish sauce, (salt for food), salt for young fruits*, fermented fish	Q51-58	8	0	Q50-53	0	2	1	0	1	0
	All	Q1-Q58	57	1	Q1-Q53	27	20	2	1	2	1

Note: FCT: Food Composition Table; (Foods enclosed in brackets have been removed in the updated version); * Modified in the updated version

Table 2. Frequency of food consumption in the past three months

Item	Changes made in the updated version
Mung bean cake	Removed in the updated version because every participant selected "0" for the frequency question.
Salt	Removed in the updated version due to the difficulty faced by children in answering the question. Moreover, sodium is not a targeted nutrient in the updated FFQ-CSC.
Salt for young fruits	Modified in the updated version to reflect its real use in Cambodian cuisine. It refers to the mixed dipping salt used for eating young fruits, such as mangoes. The nutritional data for "Salt for young fruit" is not available in the FCT. Therefore, it has been modified using nutritional information provided by food companies.
Rice noodle	Portion sizes of rice noodles were adjusted according to a commonly recognized unit of measurement used in the local market or store.
Frequency	In the previous version, for boiled rice, the choice of frequency was set as once a day, 2-3 times, 4-5 times, or 6 times or more per day. However, when revising the questionnaire, we considered potential respondents who never eat boiled rice. Therefore, we set the frequency choice as that for the other items, with ten response categories: never, once a month, 2-3 times a month, 1-2 times a week, 3-4 times a week, 5-6 times a week, once a day, 2-3 times a day, 4-5 times a day, or 6 times or more per day.
Oil	To improve the FFQ-CSC to assess omission of oil, we implemented a system that automatically adds the amount of oil in proportion to energy value, instead of asking about the intake of "oil." The amount is calculated based on the values from a 24-hour dietary recall questionnaire, which was administered in the validation study of the FFQ-CSC [8] by using the following formula: Adding oil amount (g) per 1000 kcal = (Average fat intake only from "oil"/Average energy intake) × O; O is fat per 100g of oil (=90.8).
Sugar	To improve the FFQ-CSC to assess omission of sugar, we implemented a system that automatically adds the amount of sugar in proportion to energy value, instead of asking about the intake of "sugar for food" and "sugar for drink." The amount was calculated based on the values from a 24-hour dietary recall questionnaire, which was administered in the validation study of the FFQ-CSC [8] by using the following formula: Adding sugar amount (g) per 1000 kcal = (Average carbohydrate intake only from "sugar"/Average energy intake) × S; S is carbohydrate per 100g of sugar (=99.4).

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