Development and Evaluation of a Brief Fruit and Vegetable Food Frequency Questionnaire for Higher-Grade Elementary School Children

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초등 고학년 아동의 과일 및 채소 섭취 수준 평가를 위한 간단한 식품 섭취 빈도 조사지의 개발과 평가

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Abstract

본 연구는 초등 고학년 아동의 과일과 채소 섭취 수준 측정을 위한 간단한 식품 섭취 빈도 조사지를 개발 및 평가하고자 실시되었다. 2001년도 국민건강영양조사에 참가한 만 9~11세 아동의 24-시간 회상 자료에 기초하여 식품섭취빈도 조사지의 항목 선정을 위한 기초 조사를 하였다. 각 과일과 채소 식품의 일일 평균 섭취량을 전체 아동 및 섭취량의 4분위 집단 별로 산출한 후, 이 자료를 바탕으로 전체 인구 집단의 섭취량을 대변할 수 있을 뿐만 아니라 고 섭취군과 저 섭취군 간의 차이도 나타낼 수 있는 항목을 선정하였다. 총 9개의 과일 항목과 11개의 채소 항목이 식품 섭취 빈도지에 포함되도록 선정되었으며, 섭취 빈도에 대한 응답 항목은 지난 7일 간의 섭취에 대하여 7개의 선택 범주가 제시되었다. 개발된 조사지의 신뢰도와 상대적 타당도에 대한 평가는 서울에 위치한 한 공립 초등학교에 재학 중인 153명의 4~6학년 학생들을 대상으로 실시하였다. 한 달 간의 간격을 두고 2회에 걸쳐 조사를 실시한 자료를 이용하여 검사-재검사 신뢰도를 평가하였으며, 두 번째 방문 시에 28개의 과일 및 채소 항목을 추가로 포함하고 있는 식품섭취빈도 조사지를 더불어 실시한 자료를 바탕으로 상대적 타당도를 평가하였다. 상관 분석과 항목 별 빈도 응답 및 섭취 수준에 따른 집단 내 순위 분류의 일관성에 대한 분석을 실시한 결과, 본 연구에서 개발된 20개 항목의 과일·채소 식품섭취빈도 조사지의 신뢰도와 상대적 타당도가 적정 수준 이상으로 나타났다. 신뢰도를 살펴보기 위한 개별 항목 및 과일, 채소, 과일+채소 섭취 빈도에 대한 상관계수는 0.22~0.64(p<0.001)이었으며, 항목별 빈도 응답의 일관도는 평균 69.3%(<=1 빈도 응답 차이)와 81.3%(<=2 빈도 응답 차이)로 나타났다. 상대적 타당도를 살펴보기 위한 과일, 채소, 과일+채소 섭취 빈도에 대한 상관계수는 0.91~0.93(p<0.0001)로 높게 나타났다. 따라서 본 연구를 통하여 개발된 식품섭취빈도 조사지는 초등 고학년 아동의 과일채소 섭취 수준을 간단히 심사하거나 평가하는 도구로서 유용하리라 사료된다.

Key words : Fruit and vegetable intake, food frequency questionnaire, elementary school children.

Introdunction

Fruits and vegetables are important constituents of a healthy eating pattern, providing various nutrients and non-nutrients including vitamins, minerals, dietary fiber, and phytochemicals. High consumption of fruits and vegetables has been associated with lower risks of chronic diseases, such as cancers and cardiovascular diseases (Bazzano *et al* 2002, Van't Veer *et al* 2000). Acquiring a sound eating pattern at an earlier stage in life certainly has advantages, since positive health outcomes should be more likely to occur and a longer eating habit is more resistant to change. In addition children's con-

sumption of nutritious foods such as fruits and vegetables has been linked with better cognitive development and social adjustment (Center on Hunger, Poverty, and Nutrition Policy 1994, Contento *et al* 1993). Nutrition education programs targeting improvement of children's fruit and vegetable intake have been, therefore, widely acknowledged for its importance and practiced (Chang & Lee 1995, Horne *et al* 1995, Perry *et al* 1998, Baranowski *et al* 2000, Reynolds *et al* 2000).

Successful implementation of nutrition education programs requires an accurate dietary assessment to screen for subjects in need and to evaluate effectiveness of the programs. In addition to accuracy, such a dietary assessment tool should be brief, economic, and easy to administer. A FFQ is generally acknowledged to satisfy the above necessary features the most

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among different dietary assessment methods, since food re- cords and 24-hour recalls are labor- and time-consuming. Use of FFQ for assessing children's diet possesses extra challen- ges beyond those for assessing diet of adults, because chil- dren may have more limited cognitive ability and knowledge of foods. Development and evaluation of FFQ for children has been continuously conducted for various areas of diet in an effort to provide a useful dietary assessment tool during the last decade (Buzzard *et al* 2001, Cullen *et al* 1999, Field *et al* 1999, Harnack *et al* 2006, Jensen *et al* 2004, Rockett *et al* 1995, Vereecken & Maes 2003). A recent domestic study re- ported that a brief FFQ focusing on a few domains of eating habits could reliably assess diet of children aged 9 years or older (Lee & Ahn 2007). However, such a methodological re- search on assessing children's diet has been limited in other aspects of diet.

Therefore, the purpose of this study was to conform and evaluate a brief fruit and vegetable FFQ for higher-grade ele- mentary school children. The 2001 KNHANES provided a basic dietary database for choosing FFQ items. The reliability and relative validity of the developed FFQ was evaluated among a convenience sample of 9~11 year-old elementary school children.

Methods

The current study was conducted in a three-step process as follows: 1) examination of major fruit and vegetable items among children, 2) development of a brief food frequency quesionnaire (FFQ) for children's fruit and vegetable consump- tion, 3) testing reliability and relative validity of the FFQ.

1. Examination of Major Fruit and Vegetable Items

1) Subjects

Dietary data from the 2001 Korean National Health and Nutrition Examination Survey (KNHANES) were utilized to ob- serve major fruit and vegetable items among children. The KNHANES is a nation-wide survey of the health and nutri- tional status of Korean citizens conducted every 3 years. The KNHANES has employed a two-stage probability sampling method to select a representative sample of Koreans. A total of 4,000 households were selected and asked for participation in the 2001 KNHANES consisting of four sections, health survey, health attitude & behavior survey, physical examina-

tion, and dietary survey. The section of dietary survey was conducted in approximately a third of the selected households. Out of 9,968 individuals who supplied 24 hour recall dietary data, 591 subjects of 9 to 11 year-old were included in the analysis of this study.

2) Dietary Database

Trained dieticians administered a 24-hour dietary recall em- ploying a multiple-pass approach. In order to improve accu- racy of portion size estimation, two-dimensional food models and food containers of various sizes were used. A booklet of weight information for popular eye-measured volume unit developed by the Korea Health Industry Development Institute was also employed (Lee *et al* 2007). The survey was carried out during a two-month period from November through De- cember in 2001.

In the KNHANES 24-hour dietary recall database, each dish item reported is coded at three levels. First, unique dish code is given to a dish item. Second, every food ingredient for a dish item is given a food code. A dish code can be, thus, related to more than one food codes. Finally a dish item is assigned into one of 29 food groups, given a food group code. This study utilized the food code system to derive infor- mation on fruit and vegetable intake.

3) Statistical Analysis

General information of subjects was generated as a mean and standard deviation for continuous variables or frequency and proportion for categorical variables. Total intake amount for each fruit or vegetable item were calculated for each sub- ject, and then fruit or vegetable items were ordered by mean daily intake amount among study subjects. In addition mean daily intake amount for fruit or vegetable items were also ge- nerated by quartiles of fruit or vegetable consumption. These descriptive analyses was done using SAS software package (version 9.1, Cary, NC, USA).

2. Development of a Brief FFQ for Children's Fruit and Vegetable Consumption

1) Selection of FFQ Item

The list of major fruit or vegetable items generated was carefully reviewed to select items to be included in a brief fruit and vegetable FFQ for children. Items with high con-

sumption amount in the population as well as with standing-out differences in consumption amount between a high-intake group and a low-intake group were selected to ensure the FFQ's performance levels. The process was conducted separately for fruit and vegetable items. In consideration of a clear seasonal effect of the 2001 KNHANES dietary data which was interviewed only during winter, it was decided to add important fruit items for other seasons in spite of their mere presence in the data.

2) Frequency Response Section

The frequency response section in the FFQ was formatted into a seven-category option: almost never, 1~2 times per week, 3~4 times per week, 5~6 times per week, once a day, 2 times a day, and 3 times a day or more often. The last 7-day period was presented as a reference period in consideration of children's limited capability of recollecting the past.

3) Pilot Test

The developed FFQ was pilot tested with 10 4th- and 5th-grade children to check length of time needed and proper choice of vocabulary. Some minor wording changes were made to help clarify questions according to the feedback from those.

3. Evaluation of the FFQ

1) Subjects & Data Collection

Study subjects were recruited from a public elementary school in southwest area of Seoul. A total of 6 4th- to 6th-grade classes (2 classes for each grade) were chosen for participation in this study. The FFQ was self-administered in the presence of the teacher in charge of each participating class. A research assistant, in advance, met with a head teacher to explain several issues about FFQ administration in an effort to collect quality data. The developed FFQ of 20 items was administered twice to each subject at a month interval to assess its reliability. A longer FFQ with additional 28 fruit and vegetable items were also administered at the second visit to utilize as a reference data for assessing relative validity of the FFQ. The developed FFQ took about less than 15 minutes to complete each time, and school supplies were given as incentive goods. Out of 199 students, 40 were excluded from the analysis for this study because they were out of the age span of this study (9 to 11 year-old).

2) Statistical Analysis

Correlations coefficients for intake frequency of each FFQ item, fruit, vegetable, and fruit+vegetable intake between the first and second FFQ administration were examined by Pearson correlation analysis. To examine reliability from another view, proportions of the subjects who checked the up to adjacent and up to next to adjacent frequency categories for each FFQ item between the first and second FFQ were generated. In addition subjects were categorized into approximate quartiles based on the intake of fruit, vegetable, and fruit+vegetable. Subsequently, proportions of the subjects categorized into the same and up to adjacent quartiles between the two FFQ administrations were calculated.

To examine relative validity level of the developed FFQ in comparison to the longer FFQ including 28 additional items, Pearson correlation coefficients of intake frequency of fruit, vegetable, and fruit+vegetable between the short FFQ (first one) and the long FFQ were examined. Proportions of the subjects categorized into the same and up to adjacent quartiles of intake frequency of fruit, vegetable, and fruit+vegetable between the short FFQ (first one) and the long FFQ were also generated to examine validity in terms of ranking performance.

Results and Discussion

1. Examination of Major Fruit and Vegetable Items

Table 1 presents general characteristics of the 2001 KNHANES participants aged 9 to 11 years whose 24-hour recall data

Table 1. General characteristics of 9~11 year-old KNHANES (2001) participants with 24-hour recall data

Characteristic		Total (N=591)
Age(years)		9.91±0.84[1]
Gender	Male	320 (54.1)[2]
	Female	271 (45.9)[2]
Height(cm)		142.1±9.0[1]
Weight(kg)		37.7±9.5[1]
Residing area	Metro area	281 (47.5)[2]
	Suburb area	213 (36.0)[2]
	Rural area	97 (16.4)[2]

[1] Mean±SD.
[2] N(%).

were used to examine major fruit and vegetable items in this age group. The mean (±SD) age was 9.91 (±0.84) years, and approximately 54% of the subjects were boys. The mean height and weight values were within a normal range, and majority (83.5%) lived in non-rural areas.

Top 20 vegetable items by intake amount are listed in Table 2. Chinese cabbage kimchi placed in the first place for total subjects, followed by onion, bean sprout, radish, radish kimchi, green onion, spinach, carrot, Chinese cabbage, green pumpkin, cabbage, and so forth. Similar sets appeared on the lists of the highest and the lowest quartile groups of vegetable intake. Specifically Chinese cabbage kimchi also topped the

list for both groups, and the other common items within the 15th place included onion, bean sprout, radish, radish kimchi, green onion, spinach, carrot, pickled radish, green pumpkin, and cabbage. Garlic and cucumber were in the top 10 list for the lowest quartile group but not in the list for the highest quartile group, and vice versa for Chinese cabbage and watery radish kimchi.

While major vegetable items were generally comparable between the highest and the lowest quartile groups, daily mean intake amount for most major vegetable items was found to be greater by several folds in the highest quartile group. These findings imply that a major difference between a high-intake

Table 2. Top 20 vegetable items by intake amount among 9~11 year-old KNHANES (2001) participants with 24-hour recall data

Rank	Total (N=591)		Highest quartile of vegetable intake (N=148)		Lowest quartile of vegetable intake (N=146)	
	Item	Mean intake (g/d)	Item	Mean intake (g/d)	Item	Mean intake (g/d)
1	Chinese cabbage kimchi	58.01	Chinese cabbage kimchi	103.51	Chinese cabbage kimchi	23.11
2	Onion	16.87	Onion	28.87	Onion	5.34
3	Bean sprout	13.90	Bean sprout	26.25	Radish	4.98
4	Radish	12.57	Radish	24.21	Green onion	4.33
5	Radish kimchi.	8.23	Radish kimchi.	15.48	Bean sprout	3.92
6	Green onion	7.12	Spinach	14.83	Radish kimchi.	2.53
7	Spinach	6.69	Chinese cabbage.	12.52	Carrot	2.44
8	Carrot	5.91	Carrot	10.92	Spinach	1.89
9	Chinese cabbage	5.62	Green onion	10.71	Garlic	1.88
10	Green pumpkin	4.31	Watery radish kimchi	9.25	Cucumber	1.74
11	Cabbage	4.18	Radish pickle	8.27	Green pumpkin	1.62
12	Pickled radish	4.07	Green pumpkin	7.78	Chinese cabbage	1.00
13	Garlic	3.70	Cabbage	7.47	Green bean sprout	0.97
14	Cucumber	3.51	Radish leaves	6.63	Pickled radish	0.93
15	Young radish kimchi	3.04	Young radish kimchi	6.07	Cabbage	0.77
16	Watery radish kimchi	2.83	Garlic	5.81	Lettuce	0.73
17	Radish leaves	2.68	Cucumber	5.57	Balloonflower root	0.70
18	Watery kimchi made of flat-sliced radish	1.54	Watery kimchi made of flat-sliced radish	5.45	Young radish kimchi	0.64
19	Pumpkin	1.52	Pumpkin	5.13	Tomato paste	0.61
20	Pepper	1.50	Tomato juice	2.67	Radish leaves	0.60

group and a low-intake group in terms of vegetables is not types of consumed items but amount of those. However, appearance of green onion and garlic in the top 10 list only for the lowest quartile group suggests that seasonings contribute to vegetable consumption amount more in this group compared to the high-intake group. It could be interpreted as relative lack of vegetable intake as an individual food item in the low-intake group. Another notable feature from the findings is that higher-grade elementary school children seem to generally adhere to traditional dietary pattern. Specifically, the most consumed vegetable item was found to be Chinese cabbage kimchi, and radish kimchi also was a key item for the both groups. A few other kimchi items were also listed in the top 20 list among the highest quartile group.

Table 3 displays top 10 fruit items by intake amount for total subjects and the highest quartile group of fruit intake. Since no fruit consumption was reported in the lowest quartile group of fruit intake, a major fruit item list could not be generated for this group. The same set including tangerine, persimmon, apple, Asian pear, and orange juice were in the first to fifth places for both groups. Only subtle difference was the position interchange between persimmon and apple for the second and the third positions.

While major fruit items were generally comparable, daily mean intake amount for each of these major fruit items was found to be much greater in the highest quartile group compared to the total subject group. The findings suggest children with high fruit intake are mainly distinguished quantitatively rather than qualitatively. A worrisome observation from this study is that no fruit consumption was reported among approximately 31% of the study subjects. It is somewhat surprising since food preference for fruits has been shown greater than that for vegetables in children populations (Park & Park 1995, Perez-Rodrigo et al 2003, Cooke & Wardle 2005). It may be attributed to environmental factors such as low availability at home or school and lack of role modeling, as reported by previous studies (Hanson et al 2005, Sandvik et al 2005, Kristjansdottir et al 2006, Koui & Jago 2008).

2. Development and Evaluation of a Brief Ffq for Children's Fruit and Vegetable Consumption

Based on the findings presented in Table 2 & 3, a total of 11 vegetable items and 9 fruit items were selected to be included in a FFQ for children's fruit and vegetable consump-

Table 3. Top 10 fruit items by intake amount among 9~11 year-old KNHANES (2001) participants with 24-hour recall data

Rank	Total (N=591)		Highest quartile of fruit intake (N=148)	
	Item	Mean intake (g/d)	Item	Mean intake (g/d)
1	Tangerine	110.13	Tangerine	306.54
2	Persimmon	27.24	Apple	82.13
3	Apple	26.38	Persimmon	76.75
4	Asian pear	17.41	Asian pear	48.47
5	Orange juice	6.47	Orange juice	16.54
6	Banana	2.26	Melon	5.54
7	Grape	2.09	Grape	5.26
8	Melon	2.01	Ripe persimmon	4.23
9	Ripe persimmon	1.73	Banana	3.97
10	Pear juice	1.58	Pear juice	3.38

tion. For vegetable items Chinese cabbage kimchi, onion, bean sprout, radish, radish kimchi, spinach, carrot, green pumpkin, and cabbage, which were common top 15 items in both the highest and the lowest quartile of vegetable intake, were chosen. Green onion and radish pickle which were also among the common top 15 items, however, were excluded due to relatively smaller intake difference between the two groups and redundancy with radish and radish kimchi, respectively. Chinese cabbage which appeared on the top 10 list only for the highest quartile of intake group was decided to be included. Finally an item of other kimchi was decided to be added in order to reflect a few kimchi items other than Chinese cabbage kimchi and radish kimchi in the top 20 list for the highest intake group.

For the fruit items, tangerine, persimmon, and apple which were the top 3 items were first selected. Orange juice which was the most consumed fruit juice type was also selected. Since availability or accessibility of fruits is much dependent on a season, 5 fruit items including water melon, strawberry, navel melon, grape, and peach were strategically included in the FFQ to overcome seasonal limitation of the 2001 KN-HANES dietary data.

To evaluate reliability of the developed FFQ, Pearson

correlation coefficients between daily intake frequencies of each FFQ item from the first and the second FFQ administration were examined (Table 4). The coefficients were found to be modest, ranging from 0.22 for green pumpkin to 0.58 for spinach. However, they were all statistically significant (*p*< 0.01). These item-to-item correlation coefficients appear a little lower compared to those from a previous study. Cullen *et al* (1999) reported reliability correlation coefficients ranging from 0.42 to 0.71 in a study evaluating a 24-item FFQ among 40

Table 4. Pearson correlation analysis between daily intake frequency of each FFQ item, fruit intake, vegetable intake, and fruit+vegetable intake from first and second FFQ

Item	Correlation coefficient[1]
Tangerine	0.26**
Apple	0.49***
Persimmon	0.33***
Orange juice	0.30***
Watermelon	0.48***
Strawberry	0.26**
Navel melon	0.45***
Grape	0.32***
Peach	0.26**
Chinese cabbage kimchi	0.54***
Onion	0.39***
Bean sprout	0.38***
Radish	0.45***
Radish kimchi	0.38***
Spinach	0.58***
Chinese cabbage	0.26***
Carrot	0.45***
Cabbage	0.53***
Green pumpkin	0.22**
Other kimchies	0.37***
Total fruit	0.53***
Total vegetable	0.63***
Total Fruit+vegetable	0.64***

[1] ***p*<0.001,   ***p*<0.0001.

boys. This may seem to raise a concern about the FFQ's reliability, but assessing each fruit or vegetable item's intake is not a main purpose of the FFQ. Correlation coefficients for intake frequency of total fruit, total vegetable, and fruit + vegetable intake shown in Table 4. The coefficients were reasonably high (0.53 for fruit, 0.63 for vegetable, and 0.64 for fruit+vegetable) and statistically significant (*p*<0.0001), implying proper usability of the FFQ in screening or ranking children in respect of overall fruit and vegetable consumption status.

Viewing reliability from a different aspect, proportions of the subjects who checked up to adjacent and up to next to adjacent frequency categories for each FFQ item between the first and second FFQ were examined (Fig. 1). The mean value of the proportions reporting up to adjacent frequency categories was 69.3% (from 48.4% for grape to 88.1% for watermelon). The proportions surged substantially as a less rigid criterion of consistency was applied. The proportions of those who checked up to next to adjacent frequency categories ranged from.67.9% for grape to 93.7% for cabbage (mean: 81.3%).

To investigate reliability in terms of ranking performance of the FFQ, the level of consistency in categorizing subjects according to the total intake frequency of fruit, vegetable, and fruit+vegetable was examined. Fig. 2 presents proportions of the subjects who categorized into the same and up to adjacent quartiles between the two administrations. The proportions of those who were assigned into the same quartile group were around 45% (44.7% for fruit, 47.8% for vegetable, and 48.4% for fruit+vegetable), and the values substantially increased to approximately 80% by counting those assigned into up to ad-
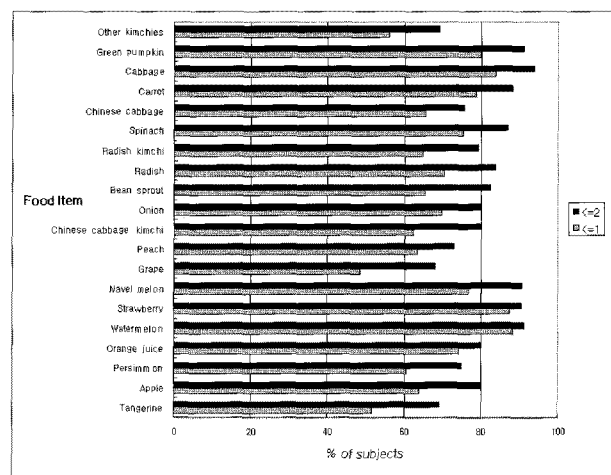

Fig. 1. Proportions of ≤ 1 and ≤ 2 frequency category differences for each FFQ item between first and second FFQ.
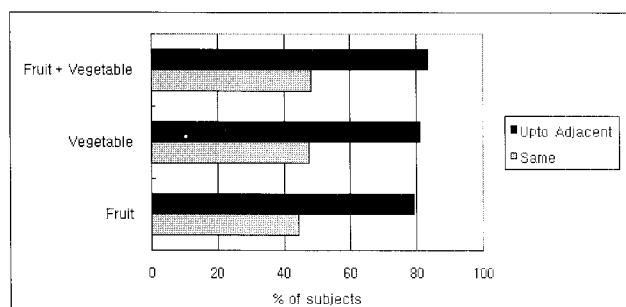
Fig. 2. Proportions categorized into same and upto adjacent quartile of fruit, vegetable, and fruit+vegetable intake frequency between first and second FFQ.
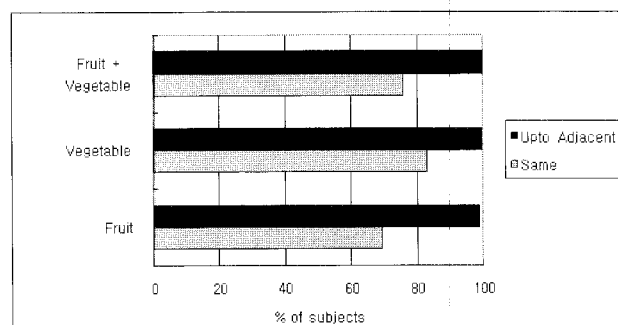

Fig. 3. Proportions categorized into same and upto adjacent quartile of fruit, vegetable, and fruit+vegetable intake frequency between short (first one) and long FFQ.

jacent quartiles (79.3% for fruit, 81.1% for vegetable, and 83.7% for fruit+vegetable).

Table 5 presents Pearson correlation coefficients for intake frequency of fruit, vegetable, and fruit+vegetable between the developed (first one) and the long FFQ to evaluate relative validity level of the developed FFQ. The coefficients were all greater than 0.90 and statistically significant ($p<0.001$). The FFQ's validity in terms of ranking performance was also observed very satisfactory, with proportions categorized into the same intake quartile between the short (first one) and the long FFQ ranging from 69.2% for fruit to 83.0% for vegetable (Fig. 3). Furthermore most subjects were found to be categorized into the up to adjacent intake quartile for fruit, vegetable, and fruit+vegetable.

Recognizing necessity of reasonably accurate as well as less resource-intensive dietary assessment methods for child and adolescent populations, several researchers have recently conducted FFQ development and evaluation studies among youth populations (Buzzard et al 2001, Cullen et al 1999, Field et al 1999, Harnack et al 2006, Jensen et al 2004, Rockett et al 1995, Vereecken & Maes 2003). Data on performance levels of FFQs for overall diet in this age group have been

Table 5. Pearson correlation analysis for intake frequency of fruit, vegetable, and fruit+vegetable between short (first one) and long FFQ

Variable	Correlation coefficient[1]
Total fruit	0.93***
Total vegetable	0.91***
Total fruit + vegetable	0.93***

[1]***$p<0.0001$.

a little controversial. The youth/adolescent questionnaire (YAQ) was shown to have reasonable ability to assess eating habits of older children and adolescents in a study based on a multiethnic sample of 179 youths aged 9 to 18 years (Rockett et al 1995). However, another study evaluating a semiquantitative FFQ for children's overall diet has reported different reliability and validity levels depending on age (Field et al 1999). The authors concluded that one should assess subjects' level of abstract thinking and familiarity with the concept of 'average intake' before administering the FFQ to 4th and 5th grade children.

However, the FFQs assessing single or a few categories of diet such as fruit and vegetable consumption have been generally demonstrated to measure children's diet with moderate to good reliability and validity, consistent with the findings from the current study. A 24-item FFQ including fruit, juice, and vegetable items was evaluated among 40 boys aged 9 to 12 (Cullen et al 1999). The 24 food items were those identified from the 1994 Continuing Survey Food Intake in Individuals data as the most common sources. Reliability correlation coefficients ranged from 0.42 to 0.71 across dietary measurements (i.e., juice, fruit, vegetables, combined consumption of juice, fruit, and vegetables), and validity coefficients ranged from 0.24 to 0.78 against 4-day 24-hour dietary recall data. Buzzard et al (2001) developed a brief FFQ for assessing fat, fiber, fruit, and vegetable intakes of children. Major food contributors to fat, fiber, fruits, and vegetables to be included in the FFQ were identified by reviewing dietary recall and food record data. Reliability of the developed FFQ was examined among 539 6th graders. Correlation coefficients for reliability were 0.58 for fat, 0.49 for fiber, and 0.51 for fruits and vegetables.

In the current study, the reliability of the developed children's fruit and vegetable FFQ was evaluated using multiple approaches. The study results demonstrated that the FFQ is highly reliable in terms of consistency in item-to-item frequency responses and ranking subjects by fruit and vegetable intake levels. Correlation analyses also showed its reasonably high reliability in estimating fruit, vegetable, and fruit+vegetable consumption. In addition, the relative validity of the developed FFQ in comparison with the longer FFQ was observed high from the correlation and ranking agreement analyses. These findings suggest that the 20-item fruit and vegetable FFQ may serve as a useful screening or assessing tool for higher-grade elementary school children's fruit and vegetable intake.

This study has a few limitations. The KNHANES' 24-hour dietary recall data were collected during a two-month period from November through December, so it is possible that the fruit and vegetable items included in the FFQ may not be generalizable to other times of a year. However, a part of this limitation may have been overcome by adding major fruit items representing the other seasons. It is possible that the FFQ's reference period of the last 7-day hinders capturing children's usual fruit intake due to high intra-individual variability in fruit consumption. This concern may had been avoided by increasing a reference period to the last month and adding a frequency response option of 5~11 times a month. However, it was decided to use the last 7-day period as a reference considering children's limited capability of recollecting the past. Another limitation pertains to examining relative validity by comparing the developed FFQ to the longer FFQ instead of to multiple-day food record or dietary recall data. It is likely, though, that high relative validity is good enough to successfully rank children according to fruit and vegetable consumption status, which is often a required virtue of a dietary assessment tool in different settings.

Summary and Conclusion

The current study examined consumption levels of major fruit and vegetable items among children aged 9~11 years using the 2001 KNHANES dietary recall data to conform a brief FFQ for higher-grade elementary school children's fruit and vegetable intake. Comparison of mean intake for fruit and vegetable items between the highest and the lowest intake quartile showed that major types of fruit and vegetable items are comparable in overall. Specifically several vegetable items

such as Chinese cabbage kimchi, onion, bean sprout, radish, radish kimchi, spinach, carrot, green pumpkin, and cabbage were in the top 15 vegetable items list for both groups, and the top 5 fruit items including tangerine, persimmon, apple, Asian pear, and orange juice were common for total subjects and the highest quartile group of fruit intake. However, intake levels of these shared major items were substantially different, reflecting children with high fruit or vegetable intake are mainly distinguished quantitatively rather than qualitatively. Other notable features included the appearance of Chinese cabbage and a few kimchi items only in the major vegetable item list for the highest intake group.

Based on these findings, a brief fruit and vegetable FFQ for higher-grade elementary school children was developed to comprise a total of 9 fruit and 11 vegetable items and tested for reliability and relative validity in a convenience sample of 153 9 to 11 year-old children. The study results demonstrated that the FFQ is highly reliable in terms of consistency in item-to-item frequency responses and ranking subjects by fruit and vegetable intake levels. Correlation analyses also showed its reasonably high reliability in assessing fruit, vegetable, and fruit+vegetable consumption. In addition, the relative validity of the developed FFQ in comparison with a longer FFQ was observed high from correlation and ranking agreement analyses. Therefore, it can be concluded that the developed 20-item fruit and vegetable FFQ may be utilized as a simple screening or assessing tool for higher-grade elementary school children's fruit and vegetable intake.

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