

Dietary patterns of children and adolescents analyzed from 2001 Korea National Health and Nutrition Survey

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Abstract

The purpose of this study was to identify dietary patterns among children and adolescents in Korea and to examine their associations with obesity and some blood profiles. One day food consumption data measured by 24-hour recalls on 2704 subjects aged 1 to 19 were used from 2001 Korea National Health and Nutrition Survey. The data of blood profiles available in the ages of 10 or older was also used. After categorizing each food consumed into 29 food or food groups, five dietary patterns were derived through a factor analysis and subjects were classified into three major dietary patterns via a cluster analysis using the factor scores. Three dietary patterns were identified as 'traditional diet' (25.6%), 'westernized-fast food' (6.2%), and 'mixed diet' (68.2%). The 'traditional diet' pattern had a higher percentage in boys. Both the 'traditional diet' and the 'westernized-fast food' had higher proportions of adolescents (12-19 y) than younger children, while the 'mixed diet' had a higher percentage of preschool children (1-5 y). Obesity rate analyzed within each age group showed no differences among 3 dietary pattern clusters. Blood pressure and all plasma profiles were not different among dietary patterns when adjusted with age and gender. Conclusively, children and adolescents in Korea had three distinct dietary patterns, which were associated with gender and age. These patterns could be useful to plan nutrition interventions for teenager health promotion.

Key Words: Dietary pattern, factorial and cluster analysis, 2001 Korea National Health and Nutrition Survey, blood profiles

Introduction

There has been increasing interest in analyzing dietary factors associated with obesity and chronic degenerative diseases in view of dietary patterns, rather than a single nutrient, food, or a group of foods (Hu, 2002; Kant, 2004; Randall *et al.*, 1990; Randall *et al.*, 1992). People consume foods as meals which are the combination of various foods and nutrients, not as an independent nutrient or food. Moreover, roles of non-nutrients, such as phytochemicals contained in plant foods have emerged to be relevant to chronic disease risk (Craig, 1997). Thus assessment of the food intakes as a whole through identifying dietary patterns may allow us to have inclusive and practical information for research on diet and health, and for developing dietary guidelines to prevent diseases. There were many studies that identified major dietary patterns and determined their relationships with nutritional adequacy or with obesity and disease risks (Beaudry *et al.*, 1998; Fung *et al.*, 2001; Hu *et al.*, 1999; Hu *et al.*, 2000; Randall *et al.*, 1992). Dietary pattern analyses were also reported in Korea for middle school students, adults, and college women by a few studies (Song *et al.*, 2005; Song *et al.*, 2006; Yoo *et al.*, 2004).

Korean children and adolescents were reported to have various

dietary and nutritional problems threatening health such as imbalance of foods and nutrients intake, obesity, high blood pressure and hyperlipidemia (Kim *et al.*, 2001; Lee & La, 1996; Ministry of Health and Welfare, 2002; Park *et al.*, 2000). Comprehensive studies on dietary patterns of children and adolescents may provide useful information to improve these problems. Accordingly, this study aims at identifying dietary patterns of children and adolescents and to examine their associations with obesity and disease risk through the use of 2001 Korea National Health and Nutrition Survey data.

Subjects and Methods

Subjects and data used

This study targeted 2,704 children and adolescents aged 1 to 19 who participated in the 2001 Korea National Health and Nutrition Survey (KNHNS). Among 2,982 children and adolescents 278 whose anthropometric data were not available were excluded.

From 2001 KNHNS conducted between November and December 2001, anthropometric and biochemical data, and food

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consumption data were used. One weekday food intake was surveyed using 24-hour recalls. Trained dietitians visited each household and interviewed family members individually to determine food intake amounts. Supplementary tools such as food models and two-dimensional sizes of food volumes and containers were used to help recall. Food portions were converted into weight according to the standard estimators.

Dietary pattern analysis

For a factor analysis to generate dietary patterns, foods from the data of 2001 KNHNS were classified into 29 food or food groups on the basis of 18 food groups used in Korean food composition table (Office of Rural Development, 2001) and in reflection of food habit characteristics of children and adolescents. Cereals were divided into three categories, that is, grains including wheat flour, noodles and rice cakes, and breads and cakes. Meats were divided into four categories - beef, pork, poultry, and processed meat. Foods whose classifications were not clear or that were the distinctive food behaviors to children and adolescents were independently dealt with. They were kimchi, pizza, hamburger, beverages, tea, jams, and juice. Western sauces category included salad dressings, curry sauce, tomato ketchup, hot sauce, spaghetti sauce, worcester sauce, etc.

A factor analysis (principal components) was carried out using the intake frequencies of 29 food or food groups, and factor scores were rotated by using Varimax rotation. The factors were extracted on the basis of 1 or higher Eigen value, Scree test, and interpretation possibility. To identify the characteristics of the factors, the collection of food groups with at least 0.2 of absolute value of factor loading was used (Hu *et al.*, 2001; Yoo *et al.*, 2004). A cluster analysis was performed with five factor scores of the subjects calculated at the factor analysis, and through the Ward method subjects were grouped into three clusters of dietary patterns.

Obese and plasma lipid indices

Obese index was calculated from relative body weight, that is, the percentage against standard body weight. As standard body weight, the 50th percentile of body weight for height in the 1998 Korean children's growth standards was used (The Korean Pediatric Society, 1998). Relative body weight less than 80 was classified as underweight, from 80 to 119.9 as normal, and 120 or more as obesity (Back & Yeo, 2006; Ministry of Health & Welfare, 2002).

From plasma lipid concentrations determined in the subjects aged 10 or older in the 2001 KNHNS, LDL-cholesterol, VLDL-cholesterol, ratio of LDL-cholesterol/HDL-cholesterol and atherogenic index (AI) were computed as follows: VLDL-cholesterol= TG/5; LDL-cholesterol= (Total cholesterol - HDL-cholesterol - VLDL-cholesterol); AI= (Total cholesterol - HDL-cholesterol)/HDL-cholesterol.

Table 1. Factor-loading matrix for the 5 major factors

Food or food group	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Grains	0.714			0.220	
Fishes and seashells	0.499				
Seaweeds	0.314				
Kimchi	0.553				
Oils	0.454	0.265		0.303	
Beef	0.236			-0.223	
Vegetables	0.469	0.520			
Sauces-eastern	0.311	0.445		-0.306	
Noodles and rice cake		0.428			
Solid fats and mayonnaise		0.547		0.313	
Pork		0.435			
Alcoholic drinks		0.466			
Pizza and hamburger			0.566		
Cookies			0.271		
Beverages		0.225	0.712		
Teas			0.356		
Sweets			0.291		0.248
Potatoes	0.223			0.320	
Sauces-western				0.529	
Poultry			0.271	0.355	
Processed meats				0.549	
Eggs			-0.298	0.333	
Breads and cakes					0.652
Fruits			0.216		0.230
Milk and its products					0.595
Juices					0.339
Jams					0.421
Legumes ¹⁾					
Seeds and nuts ¹⁾					
Eigen value	2.02	1.66	1.48	1.41	1.35
Characteristic of the factor	Traditional	Traditional-dining out	Fast food-western	Western	Snack

¹⁾ Absolute values less than 0.20 were not listed in the table.

Statistical analysis

All the data was analyzed through the SAS program. Frequency (%), mean, and standard deviation were computed and cross-tabulation and chi-square test, general linear model and Duncan's multiple range test, factor and cluster analysis were performed.

Results

Dietary patterns

The five major factors were extracted through factor analyses using 29 food or food groups as presented in Table 1. Factor

Table 2. Classification of subjects by cluster analysis using factor score

Factor	Cluster 1 (n=691: 25.6%) ¹⁾	Cluster 2 (n=168: 6.2%)	Cluster 3 (n=1,845: 68.2%)
Factor 1***	1.22 ± 0.85 ^{2)c}	-0.30 ± 1.27 ^b	-0.43 ± 0.55 ^a
Factor 2***	0.31 ± 1.08 ^b	0.96 ± 2.38 ^c	-0.20 ± 0.59 ^a
Factor 3***	-0.18 ± 0.66 ^a	2.74 ± 1.98 ^d	-0.18 ± 0.47 ^a
Factor 4***	-0.09 ± 1.22 ^a	1.17 ± 1.92 ^b	-0.07 ± 0.67 ^a
Factor 5***	0.14 ± 1.13 ^b	0.07 ± 1.45 ^a	-0.06 ± 0.89 ^a
Diet pattern of cluster	Traditional diet	Westernized-fast food	Mixed diet

¹⁾ Subject number and percent of total subject number, 2704.

²⁾ Mean ± SD.

*** p < 0.001 by Generalized linear model.

abc Values with different superscripts in the same row were significantly different by Duncan's multiple range test at p < 0.05.

Table 3. Gender and age distribution by dietary pattern groups

		Total (n=2704)	Traditional (n=691)	Westernized- fast food (n=168)	Mixed (n=1845)	p ²⁾
Gender	Male	1429 (52.8) ¹⁾	427 (61.8)	69 (53.0)	913 (49.5)	p < 0.001
	Female	1275 (47.2)	264 (38.2)	79 (47.0)	932 (50.5)	
Age (year)	1-5	707 (26.1)	50 (7.2)	15 (8.9)	642 (34.8)	p < 0.001
	6-11	1054 (39.0)	266 (38.5)	61 (36.3)	727 (39.4)	
	12-19	943 (34.9)	375 (54.3)	92 (54.8)	476 (25.8)	

¹⁾ n(%).

²⁾ p value by chi-square test.

Table 4. Body weight status distribution by dietary pattern groups

Age (years)	Weight status ¹⁾	Total (n=2704)	Traditional (n=691)	Westernized- fast food (n=168)	Mixed (n=1845)	p ³⁾
Total	Under	73 (2.7) ²⁾	21 (3.0)	5 (3.0)	47 (2.5)	p < 0.05
	Normal	2285 (84.5)	557 (80.6)	139 (82.7)	1589 (86.1)	
	Obese	346 (12.8)	113 (16.4)	24 (14.3)	209 (11.3)	
1-5	Under	12 (1.7)	0 (0.0)	0 (0.0)	12 (1.9)	NS
	Normal	655 (92.6)	46 (92)	14 (93.4)	595 (92.7)	
	Obese	40 (5.7)	4 (8.0)	1 (6.6)	35 (5.4)	
6-11	Under	23 (2.2)	9 (3.4)	2 (3.3)	12 (1.7)	NS
	Normal	879 (83.4)	212 (79.7)	51 (83.6)	616 (84.7)	
	Obese	152 (14.4)	45 (16.9)	8 (13.1)	99 (13.6)	
12-19	Under	38 (4)	12 (3.2)	3 (3.3)	23 (4.8)	NS
	Normal	751 (79.6)	299 (79.7)	74 (80.4)	378 (79.4)	
	Obese	154 (16.3)	64 (17.1)	15 (16.3)	75 (15.8)	

¹⁾ Under: relative body weight < 80,
Normal: 80 ≤ relative body weight < 120.

Obese: relative body weight ≥ 120.

²⁾ n(%).

³⁾ p value by chi-square test.

1 which had the highest eigen value was characterized as a 'traditional diet' since it showed higher factor loading values in grains which include rice, kimchi, fish and shellfish, beef, vegetables, seaweeds, oils and oriental sauces. Factor 2 was characterized as a 'traditional-dining out' pattern with intake of

pork, vegetables, noodles, eastern sauce, oils and alcoholic drinks. Factor 3 was the pattern with intake of pizza and hamburger, poultry, beverages, cookies, sweets and teas, and was distinctive to be a 'fast food-western'. Factor 4 had characteristics of a 'western diet' with higher factor loading values of eggs, poultry, potatoes, processed meat, western sauce, solid fats and mayonnaise. Factor 5 showed higher factor loadings in milk and dairy products, breads and cakes, juices, jams, and fruits, and was characterized as 'snack' pattern.

A cluster analysis based on the five factors derived three clusters that formed 25.6% (n=691), 6.2% (n=168), and 68.2% (n=1845) of total subjects, respectively. Factor scores of 3 clusters were presented in Table 2. Cluster 1 had characteristics of Korean traditional pattern of food use with the highest score for factor 1 (traditional) and was identified as the 'traditional diet' pattern. The second largest number (25.6%) of children and adolescents belonged to this cluster. Cluster 2 was labeled as the 'westernized-fast food' pattern with remarkably high scores for the factor 3 (fast food-western) and factor 4 (western). Only 6.8% of the subjects belonged to the 'westernized-fast food' group. Meanwhile, the largest number of the subjects (68.2%) belonged to cluster 3, but there were no higher scores for any factors so that no noticeable features were found. Accordingly cluster 3 was named as a 'mixed diet' pattern.

Age and gender distribution of dietary patterns

Gender and age distributions of 3 dietary pattern groups were presented in Table 3. The 'traditional diet' pattern had a very higher percentage in boys (61.8%) than in girls (p < 0.001), while the 'westernized-fast food' group showed a little bit higher percent in boys (53.0%) than in girls (47.0%). The 'mixed diet' group showed similar ratios between boys and girls.

Both the 'traditional diet' and the 'westernized-fast food' patterns had higher proportions of adolescents aged 12 to 19 (54.3% and 54.8%, respectively) than preschool (1-5 y) and school (6-11 y) children, while the 'mixed diet' pattern had a higher percentage of preschool children, compared with other two patterns (p < 0.001).

Dietary patterns and obesity rate and plasma profiles

As shown in Table 4, there were differences as to obesity rate within each dietary pattern group (p < 0.05). The 'traditional diet' group had the highest obesity rate of 16.4%, while the 'mixed diet' pattern had the lowest at 11.3%. In the 'westernized-fast food' pattern, obesity rate was 14.3%, which was higher than total obesity rate of 12.8%. Percents of underweight were similar among three dietary patterns. However when the association was analyzed within each age group, significant differences had not appeared in all 3 age groups though the 'traditional diet' tended to have higher obesity rates than other two patterns, particularly in school children.

Table 5. Blood pressure and plasma profiles by dietary patterns

Measurements	Traditional (n=491)	Westernized-fast food (n=107)	Mixed (n=670)	p ²⁾	p ³⁾
Systolic BP (mmHg)	111 ± 11.4 ¹⁾	110 ± 13.7	110 ± 11.4	NS	NS
Diastolic BP (mmHg)	65.0 ± 10.9	65.8 ± 10.5	64.4 ± 11.1	NS	NS
Hematocrit (%)	40.8 ± 3.6 ^b	40.7 ± 3.7 ^b	40.0 ± 3.4 ^a	p<0.05	NS
Hemoglobin (g/dl)	13.7 ± 1.3 ^b	13.6 ± 1.5 ^{ab}	13.3 ± 1.2 ^a	p<0.05	NS
Red blood cell (×10 ⁹ /dl)	469 ± 36.8 ^b	464 ± 38.7 ^{ab}	461 ± 36.8 ^a	p<0.05	NS
Triglyceride (mg/dl)	105 ± 62.6	92.9 ± 40.7	101 ± 58.3	NS	NS
Total cholesterol (mg/dl)	161 ± 26.2	162 ± 24.7	165 ± 27.8	NS	NS
HDL-cholesterol (mg/dl)	46.9 ± 9.7	48.1 ± 10.7	47.7 ± 9.6	NS	NS
LDL-cholesterol (mg/dl)	93.0 ± 22.6 ^a	94.8 ± 23.2 ^{ab}	96.5 ± 24.3 ^b	p<0.05	NS
VLDL-cholesterol (mg/dl)	20.9 ± 12.5	18.6 ± 8.1	20.2 ± 11.7	NS	NS
LDL-cho/HDL-cho	2.1 ± 0.7	2.1 ± 0.7	2.1 ± 0.6	NS	NS
Atherogenic index	2.6 ± 0.9	2.5 ± 0.9	2.6 ± 0.8	NS	NS

BP: blood pressure.

¹⁾ Mean ± SD.²⁾ p value by Generalized linear model.³⁾ p value by ANCOVA with covariates of age and gender.^{abc} Values with different superscripts in the same row were significantly different by Duncan's multiple range test at p<0.05.

Blood pressure and plasma profiles of children in the age of 10 or older were demonstrated in Table 5 by 3 dietary patterns. Blood pressure did not show significant differences among the clusters. Hemoglobin, hematocrit and red blood cell count were significantly higher in the 'traditional diet' pattern than in the 'mixed diet' pattern groups (p<0.05). While LDL-cholesterol level was significantly lower in the 'traditional diet' pattern than in the 'mixed diet' pattern (p<0.05). Those significant differences, however, disappeared when adjusted for age and gender. There were no differences in other blood lipid profiles among the 3 pattern groups.

Discussion

The 3 dietary patterns of 'traditional diet', westernized-fast food, and 'mixed diet' for children and adolescents identified from 2001 KNHNS seemed to be distinctive with each other and seemed to represent the overall patterns of food consumption in Korean children and adolescents. The patterns were consistent with the recent study of Yoo *et al.* (2004) that identified 3 dietary patterns of 'traditional', 'westernized', and 'intermediate' for 318 junior high school students from 3 day recorded food consumption data. In our study the 'westernized-fast food' pattern was named instead of the 'westernized'. The reason is to emphasize the eating trend of western style fast foods but not typical western meals (Table 1 and 2). The subject's composition ratios among 3 patterns were different between the two studies. Compared with the Yoo *et al.* report (2004), the 'westernized-fast food' pattern was very low (6.8% vs 41.2%) and the 'traditional diet' pattern was high (25.6% vs 13.2%). It may be due to the big difference of study samples in size, age (1 to 19 y vs middle school students) and region (nationwide vs Seoul). Many studies

reported on dietary patterns for adult subjects. Examples were 2 dietary patterns-'traditional' and 'modified'-in Korean study from 2001 KNHNS (Song *et al.*, 2005), 2 patterns-'traditional' and 'prudent' (Fung *et al.*, 2001) and 3 patterns-'traditional', 'snack', and 'high-fat' (Randall *et al.*, 1992) in the US population. However the research on dietary patterns for children or adolescents was very limited. There was a study on dietary patterns for 10,139 numbers of 3 year-old children in the United Kingdom, reporting four patterns of 'junk', 'healthful', 'traditional', and 'snacks' (North *et al.*, 2000). If further analyses will be performed in separated age groups such as preschoolers, school children, and adolescents in this study, more age specific dietary patterns would be extracted.

The results showed that the 'traditional diet' had much higher percentages in boys and in the adolescent age group (Table 3). And the 'westernized-fast food' showed similar to the 'traditional diet', but the percent of boys was a little bit higher than that of girls. The 'mixed diet' group had a higher percentage of preschool children with similar ratios between boys and girls. Of the preschool children, 91% were classified into the 'mixed diet' pattern. It is presumed to result from that preschool children are on the forming dietary habits. As they grow up, some of them may move from the 'mixed diet' pattern to either the 'traditional diet' or the 'westernized-fast food' pattern.

As to obesity rate according to dietary patterns, the results by three age groups (Table 4) showed no differences among the 3 dietary pattern clusters, which was in accordance with other studies (Fung *et al.*, 2001; Song *et al.*, 2005; Song *et al.*, 2006; Yoo *et al.*, 2004) that reported no significant differences in BMI among dietary patterns. However, significant differences were demonstrated in body fat (Song *et al.*, 2006) and plasma leptin concentration (Fung *et al.*, 2001) between dietary patterns. Obesity index or BMI may be a too simple determination to

investigate the relationship of diet patterns with obesity risk. Some biochemical data related to obesity may be necessary for the investigation.

Blood pressure and all plasma profiles, including lipid levels, of the subjects were not different among dietary patterns when adjusted with age and gender (Table 5). Other studies (Fung *et al.*, 2001; Song *et al.*, 2005) also showed no significant differences in plasma lipid concentrations between dietary patterns. However Fung *et al.* (2001) showed significant correlations between the western pattern scores and other plasma biomarkers related with coronary vascular disease such as plasma C-peptide, homocysteine, and folate concentrations. In the study of Hu *et al.* (2000) which used the data from the cohort study of US health professionals, reported the incidence of coronary heart disease was positively associated with the 'western' dietary pattern and was inversely correlated with the 'prudent' diet. More comprehensive research will be needed to obtain clear evidence on the associations between dietary pattern and risk of coronary heart disease.

In conclusion, children and adolescents in Korea had three distinctive dietary patterns characterized as 'traditional diet', 'westernized-fast food' and 'mixed diet'. The patterns were associated with gender and age. It is suggested to use these patterns to plan nutrition interventions as well as to prepare dietary guidelines for teenager health promotion.

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