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ORIGINAL ARTICLE

The Influence of Dietary Patterns on the Nutritional Profile in a Korean Child Cohort Study

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Abstract

Objectives: The aim of the present study was to identify the major dietary patterns of seven- and eight-year-old Korean children and to examine the relationship between dietary patterns and obesity, nutrient intake, and diet quality.
Methods: The subjects were 284 seven- and eight-year-old children who participated in the Gwacheon child cohort study. Three dietary patterns emerged from the factor analysis: Korean, modified Western, and Western. Cluster analysis was used to classify the subjects into two dietary groups: Korean and Western diet patterns.
Results: The two different dietary patterns were closely related to dietary quality which in turn was related to health risks. The Western diet group had a lower fiber intake, a higher intake of energy, fat and calcium and a higher dietary diversity score (DDS) than the Korean diet group. The number of days when fruit, milk and dairy products were omitted from the diet was higher for the Korean diet group than for the Western group.
Conclusions: Dietary patterns and related diet quality should be considered when designing nutrition policy and intervention programs for children.

1. Introduction

Inappropriate dietary habits could be an important risk factor for chronic disease [1,2]. Traditionally, studies in nutrition and health have examined chronic disease risk in relation to a single nutrient or food [1,2]. However, because people eat meals comprised of a variety of foods, studying an individuals' complete diet by examining their overall dietary pattern, may provide a more accurate picture of the way people eat [3].

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Although the analysis of dietary patterns has some limitations because the data collection method is subjective and because the data cannot be extrapolated to other populations [4], it is still useful to look into the relationship between diet and disease. Many researchers studied the relationship between diet quality and the variety of foods and food groups [5,6], and a few studies have examined the relationship of diet quality to mortality [7,8]. Eating a variety of foods is recommended by virtually all national and global food-based dietary guidelines [9]. It is usual to quantify food variety by the number of different food items and dietary diversity by the number of food groups consumed over a certain period [10].

It is reasonable to study dietary patterns and quality because the interactions and synergistic effects of foods and nutrients on health are better captured by studying the whole diet rather than individual components [11]. Despite this, few investigations have examined the dietary patterns and nutritional quality of Korean children [12].

The aim of the present study was to identify the overall dietary patterns of seven- and eight-year-old Korean children and to examine the relationship between dietary patterns and obesity, nutrient profiles, and diet quality.

2. Materials and Methods

2.1. Subjects

Data were obtained from a pediatric cohort study conducted in 2006 of second-grade students. Of 467 seven- to eight-year-old children, 284 subjects (156 boys and 128 girls) successfully completed all components of the survey. These are the subjects that were used in the present study. The protocol for the study was reviewed and approved by the Korean National Institute of Health, and informed consent was obtained from the parents and school authorities.

2.2. Physical and biochemical measures

Height and waist circumferences of the children were measured by a trained technician. Weight and percent body fat were measured by bioimpedance analysis using a body composition analyzer (TANITA, BC-418, Japan). To define the obesity index, we used standard body weight defined as the 50th percentile value for children of the same age, sex, and height according to the 2007 Standard for Korean Children and Adolescents Growth [13]. Triglycerides, high-density lipoprotein and insulin levels were measured using a Hitachi-747 automatic analyzer (Hitachi, Tokyo, Japan).

2.3. Dietary assessment

Dietary intake was measured using three-day food records. Parents helped their children complete the dietary records. Food and nutrient intakes were calculated using the CAN-PRO dietary analysis software (Korean Nutrition Information Center, Seoul, Korea) [14].

2.4. Identification of dietary patterns

A total of 580 food items consumed by the participants were classified into 21 groups according to the food groups identified in the Korean Nutrient Database [15]. These modified food groupings are similar to those used by Song et al [16]. Principal components analysis was performed to determine the percentage of energy each food group contributed to the extracted factors. The factors were rotated by an orthogonal transformation (Varimax rotation function in SAS) to achieve a simpler structure with a greater interpretability. The number of extracted factors was based on eigenvalues >1.0, identification of a break point in the scree plot, and interpretability [17]. Major factors were obtained using exploratory factor analysis, and scores for each factor for each individual were calculated. Cluster analysis with factor scores was used to reveal meaningful dietary patterns such as, identifying the nearest neighbor food groups, and ordering their inter-relationships.

2.5. Dietary quality

Two indices of dietary quality were employed: the dietary variety score (DVS) that indicates the cumulative number of different foods consumed in a day, and the dietary diversity score (DDS) that measures the number of food groups out of the five basic groups (grains, meat, vegetables, fruits, and dairy) consumed in one day. Each food group is as one point, and so the maximum possible DDS score is five [6].

2.6. Statistical analysis

The Statistical Analysis System (SAS version 9.1, SAS Institute, Cary, NC) was used for data analysis. Cluster analysis using the command of PROC FASTCLUS in SAS version 9.1 (SAS Institute, Cary, NC) was based on the K-means method, and the χ^2 test was used to analyze categorical data. The mean differences between the variables of two clusters were calculated using the Student's t test. Finally, the odds ratio (OR) was used to determine the effect of the dietary quality variables on each cluster groups. A p value < 0.05 was considered to be statistically significant.

3. Result

3.1. Dietary patterns

Three major dietary patterns emerged from the factor analysis: Factor 1 (Korean), Factor 2 (modified Western), and Factor 3 (Western). Table 1 shows the factor loading matrix for the three dietary patterns. Seasonings, vegetables, white rice, and kimchi made a positive contribution to the Korean dietary pattern,

Table 1. Factor loading matrix for the three major dietary patterns and their food groups

Food groups	Dietary pattern factors: Factor 1 (Korean)	Factor 2 (Modified western)	Factor 3 (Western)
Seasonings	0.69		–
Vegetables	0.66	–	−0.25
White rice	0.62	–	–
Kimchi	0.38	0.31	−0.20
Eggs	0.38	–	–
Meats	0.25	0.22	–
Flour and bread	−0.30	–	–
Beverages	–	0.52	–
Potatoes	–	0.46	–
Fruits	–	0.39	–
Poultry	–	0.29	–
Processed meats	–	−0.43	–
Other grains	–	−0.44	–
Cereals	–	−0.21	0.32
Noodles and ramen	–	–	0.52
Cookies, crackers and chips	–	–	0.45
Milk and dairy products	−0.22	0.21	0.39
Pizza and hamburgers	–	0.30	0.35
Sugars and sweets	–	–	0.41
Legumes and nuts	0.27	–	0.30
Fish and seaweeds	0.25		−0.39

For simplicity, values < 0.2 are not listed.

whereas the contribution of flour, bread, milk, and dairy products was negative. In the modified Western dietary pattern, kimchi, beverages, and potatoes made a substantial contribution, but the contribution of grains and processed meat was negative. Noodles, ramen, cookies, crackers, chips, sugar, sweets, pizza, and hamburgers were a large component of the Western dietary pattern; fish and vegetables including kimchi, had a negative contribution. This analysis explained 23.82% of the variance.

A factor analysis of the three dietary patterns was performed to obtain factor scores for each child subject. Using cluster analysis, the subjects were then divided into two clusters: Cluster 1 with 117 (41.2%) subjects and Cluster 2 with the remaining 167 (58.8%). The factor scores for the clusters are presented in Table 2. Factor 1, which represents the traditional Korean meal composed of kimchi and rice, had the highest score in Cluster 1. Thus, Cluster 1 was labeled the "Korean diet pattern." Factor 2 had a high score in Cluster 2 (modified Western) and Factor 3 (Western) and was labeled the "Western diet pattern".

Table 3 shows the mean percentage of energy that each food group contributed to the dietary patterns. The

Table 2. Cluster analysis classification of subjects using factor scores

Variable	Cluster 1 ($n = 117$)[a],*	Cluster 2 ($n = 167$)[a],*
Factor 1	0.5 ± 1.1	−0.3 ± 0.8
Factor 2	−0.6 ± 0.8	0.4 ± 0.9
Factor 3	−0.4 ± 0.9	0.3 ± 1.0

[a]*Values are the mean ± standard deviation (SD) calculated using the Student's t test.*
*$p < 0.001$.

Table 3. Mean percentage energy contribution from each food group according to dietary patterns

Variable	Korean diet ($n = 117$)[a]	Western diet ($n = 167$)[a]
White rice***	16.2 ± 5.5	13.0 ± 4.3
Other grains**	6.5 ± 7.1	4.3 ± 5.1
Noodles and ramen***	7.9 ± 10.2	12.9 ± 10.0
Flour and bread***	5.5 ± 6.3	9.6 ± 8.8
Cereals	1.6 ± 5.3	1.3 ± 5.0
Cookies, crackers and chips**	0.8 ± 2.5	2.2 ± 4.4
Pizza and hamburger***	0.8 ± 5.0	5.4 ± 10.1
Potatoes***	1.2 ± 1.1	2.3 ± 2.5
Sugars and sweets	0.7 ± 0.5	0.9 ± 0.8
Legumes and nuts*	1.4 ± 0.9	1.2 ± 0.8
Vegetables**	0.3 ± 0.2	0.3 ± 0.1
Kimchi*	0.5 ± 0.3	0.4 ± 0.2
Fruits**	1.9 ± 1.5	2.5 ± 1.5
Meats	4.3 ± 2.9	4.4 ± 2.8
Processed meats*	2.2 ± 3.7	1.3 ± 2.0
Poultry***	1.2 ± 2.8	4.1 ± 7.1
Eggs	3.2 ± 2.0	3.0 ± 1.7
Fish and seaweeds	2.0 ± 1.3	1.7 ± 1.1
Milk and dairy products***	3.8 ± 3.6	7.4 ± 3.7
Seasonings***	0.7 ± 0.4	0.6 ± 0.2
Beverages***	0.1 ± 0.2	0.1. ± 1.1

[a]*Values are the mean ± SD calculated using the Student's t test.*
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Korean diet group was characterized by a high intake of white rice, other grains, vegetables, and kimchi; the Western diet group consumed more noodles, ramen, flour, bread, cookies, pizza, potatoes, milk, dairy products, fruit, and beverages.

3.2. Basic characteristics of the study population

Table 4 shows the characteristics of the subjects in the two cluster groups. There was no significant difference in the health factors, body mass index, percent body fat, systolic and diastolic blood pressure, or in the obesity-related biochemical indices such as TG, leptin and insulin between the two groups. The prevalence of obesity was low and not significantly different between the two groups.

3.3. Dietary quality factors and obesity associated with each dietary pattern

The OR for the DDS was significantly different between the two dietary patterns (OR = 4.3, 95% confidence interval: 2.6−7.1; $p < 0.001$). The dietary pattern was not associated with the DVS. The OR for obesity was not significantly different between the two dietary patterns (Table 5).

3.4. Dietary quality

The Western diet group consumed more foods from animal sources (28.1%) than did the Korean diet group (22.8%) (Table 6). There was no difference in the DVS between the Korean diet and the Western diet groups (30.7 ± 6.6 and 31.4 ± 6.4, respectively). The DDS values were higher for the Western diet group than for the Korean diet group (3.5 ± 0.4 and 3.1 ± 0.6, respectively; $p < 0.0001$). The foods were categorized into the five food groups, grain, meat, vegetable, fruit, milk, and dairy, and the number of days that a certain group of foods was not consumed was calculated by multiplying the number of days missed by the number of subjects (i.e. Korean diet group = 117 × 3, Western diet group = 167 × 3) as shown in Table 6. The children in the Korean diet group ate fruit, milk, and dairy foods less often than those in the Western diet group.

Table 5. Logistic analysis of dietary quality factors and obesity associated with the Western diet group; the Korean diet group was the reference

Variables	OR (95% CI)	*p* value[a]
DVS	1.02 (0.98−1.1)	0.33
DDS[b]	4.3 (2.6−7.1)	<0.001
Obesity[c]	1.0 (0.4−3.1)	0.94

[a] *The p value for the crude OR was calculated using a Wald test;* [b] *DDS (factor 1 to factor 3);* [c] *Obesity scores (normal = 1; obese = 2).*
OR = odds ratio; CI = confidence interval; DVS = dietary variety score; DDS = dietary diversity score.

4. Discussion

We identified specific dietary patterns among Korean children using a combination of factor and cluster analyses. The relationships among 21 food groups were determined using factor analysis. Three dietary patterns emerged: Korean, modified Western, and Western. The factor scores were analyzed using cluster analysis. Two clusters of dietary patterns were identified: a Korean diet group (41.2%) and a Western diet group (58.8%). A study by Song et al, using similar food items and food groupings, also identified two clusters [16]. In that study, one cluster group was characterized by high intakes of rice, kimchi, fish and seaweed. Labeled the “Korean traditional pattern” group, this cluster accounted for 30% of the subjects. The other cluster, which

Table 4. Characteristics of subjects by dietary pattern groups

Variable	Korean diet (n = 117)[a]	Western diet (n = 167)[a]
Age (in yr)	7.9 ± 0.3	7.9 ± 0.3
Boys	68 (58.1%)	88 (52.7%)
Obesity[b]	6 (5.1%)	8 (4.8%)
Height (cm)	127.6 ± 4.8	128.1 ± 5.2
Weight (kg)	26.8 ± 4.4	27.1 ± 5.0
Body Mass Index (kg/m^2)	16.4 ± 2.0	16.4 ± 2.2
Body fat (%)	16.3 ± 5.8	16.5 ± 6.2
Waist circumference (cm)	55.5 ± 5.5	55.7 ± 5.9
Triglyceride (mg/dL)	65.2 ± 29.4	63.5 ± 33.3
Total cholesterol (mg/dL)	163.1 ± 25.4	172.6 ± 28.6
HDL-cholesterol (mg/dL)	60.5 ± 12.2	60.6 ± 11.1
Glucose (mg/dL)	82.1 ± 7.2	81.4 ± 6.1
Systolic blood pressure (mmHg)	91.7 ± 10.0	91.5 ± 8.4
Diastolic blood pressure (mmHg)	59.1 ± 7.9	58.6 ± 6.8
Insulin (μU/mL)	4.8 ± 2.5	4.4 ± 2.6
Leptin (ng/mL)	3.7 ± 3.1	4.0 ± 3.6

[a] *Values are the mean ± SD;* [b] *Obesity index (%) = [(Present weight − standard weight)/standard weight]×100. Obesity is defined as obesity index ≥ 20%.*

Table 6. Comparison of plant and animal food percentage, DVS, DDS, and the number of days that a food group was not consumed in the two dietary groups

Variables	Korean diet ($n = 117$)	Western diet ($n = 167$)
Plant:animal		
Food (%)[a],*	77.2:22.8	71.9:28.1
DVS	30.7 ± 6.6[b]	31.4 ± 6.4[b]
DDS*	3.1 ± 0.6[b]	3.5 ± 0.4[b]
Food group[c]	Korean diet ($n = 117 \times 3$)	Western diet ($n = 167 \times 3$)
Grains	0 (0)	0 (0)
Meats	1 (0.3)	0 (0)
Vegetables	0 (0)	1 (0.2)
Fruits**	89 (30.1)	89 (19.2)
Milk and dairy*	156 (52.7)	118 (25.4)

[a]*Food percentage values = (plant food group weight/total food group weight)×100:(animal food group weight/total food group weight)×100;* [b]*Values are mean ± SD;* [c]*The number of days that a given food group was not consumed (% of total in group).*
*$p < 0.001$ (using Student's t test); **$p < 0.001$ (using χ^2 test).

accounted for 66.9% of the subjects, was labeled the "modified pattern". This group had high intakes of noodles, ramen, flour, bread, pizza, hamburgers, snacks, sugar, sweets, meats, and beverages. In the present study, 41% of the subjects were included to the traditional pattern group. It could be occurred by the difference of the ages of our subjects (7−8 years old) and those of Song et al (12−14 years old) or the regions studied (Gwacheon, a mid-sized urban city, in the latter study and Seoul, a large metropolitan city, in the former study). Older children may choose more Western foods; however, comprehensive, longitudinal studies must precede conclusions about differences in age-related food choices.

The increasing rate of obesity in Korea has raised public health concerns. Oh et al have estimated that 19% of Korean adolescents are obese [18]. However, in the present study, the prevalence of obesity was between 4.8 and 5.1%, depending on dietary patterns. Although a direct comparison is difficult because of different criteria for obesity, the incidence of childhood obesity was lower in Gwacheon than in other areas. However, no significant differences were found in physical characteristics or biochemical indices between the two dietary groups. A multivariate model showed that obesity was not significantly related to eating patterns. The absence of a relationship between dietary pattern and disease observed in the present study might be explained by the low incidence of obesity and metabolic disorders among young children, particularly amongst children in Gwacheon where most residents are middle class. Studies in areas with a high incidence of childhood obesity and related diseases need to be conducted to observe the relationship between dietary patterns and health outcomes among children.

Although we did not find a significant relationship between health outcomes and dietary patterns, we found that dietary patterns influenced dietary quality and the nutrient intake profile. We used the DVS and DDS to determine dietary quality. The results of the DVS indicated that the subjects (30.7% in the Korean diet group and 31.4% in the Western diet group) consumed a variety of foods. The DVS values were higher for our subjects than for middle school and elementary school students (22.4% and 19.9%, respectively) in earlier studies [19,20]. The DDS for children in the present study was 3.5 for the Western diet group and higher for the Korean diet group. Our result does not agree with an earlier study by Yoo et al, in which a DDS of 3.95 for the Western diet group, higher than the score for the traditional and intermediate diet groups, was reported [12]. We found a significant difference in the percentage of days in which a specific food group was omitted between the two dietary pattern groups. The Korean diet group omitted fruit, milk, and dairy foods on more days than did the Western diet group. In particular, in the Korean diet group, milk and dairy foods were omitted up to 52.7% of the time. This suggests that, although the method of data collection may be open to interpretation, the Korean diet group may have an imbalance in specific nutrients like calcium. Nevertheless, our finding on the relationship between nutrient intake and dietary pattern is consistent with other studies [21].

In our study, even though the Western diet contained high levels of energy and fat, it was not related to the prevalence of obesity. Because the Western diet had a higher DDS score than the Korean diet, for a balanced diet, children in the Korean diet group need to be encouraged to consume more fruit, milk and dairy products.

Thus, nutritional information about the relationship between dietary patterns and dietary quality can be applied to promote more healthy outcomes for children. Specifically, the dietary pattern information identified in the present study can be used to plan nutritional interventions and prepare healthy dietary guidelines for children.

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