Dietary Patterns and Metabolic Syndrome in Korean Adolescents: 2001 Korean National Health and Nutrition Survey

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Running title: Dietary patterns and Metabolic syndrome in Adolescents
The presence of metabolic syndrome (MS) in children and adolescents represents a high-risk state that conveys an increased risk of metabolic disease (1, 2). The importance of the role of dietary patterns cannot be overemphasized because of the relation to metabolic disease. Although previous studies showed that some dietary patterns were related to the risk of MS (3-6), these studies have focused on adults and were rarely conducted on children or adolescents in a national base survey. Therefore, the aim of this study was to identify dietary patterns and to examine the association between dietary patterns and MS in Korean adolescents. Although studies on the Korean population may yield unique results primarily due to the ethnic homogeneity inherent to the Korean population with very little genetic diversity, the results tend to be applicable to other countries as well.

RESEARCH DESIGN AND METHODS

The 2001 Korean National Health and Nutrition Survey, a cross-sectional and nationally representative survey, was conducted from November to December in 2001. A stratified, multistage, probability sampling design was used with selection made from sampling units. Weights indicating the probability of being sampled were assigned to each participant, enabling the results to represent the entire Korean population. A total of 12,441 persons participated in the Health Interview Survey including a 24-hour dietary intake recall. Complete data were obtained from 10,051 participants (80.8%). Of these, the data from 1484 adolescent subjects aged 10 to 19 years was examined. Among them, 1271 subjects (655 boys and 616 girls) had laboratory tests taken. Subjects who had not fasted for at least 7 hours, or for whom the duration of fasting was unknown were excluded from the analysis (n=327). The final sample consisted of 944 (501 boys and 443 girls) adolescent subjects.

For MS definition, the published age-modified standards of the MS criteria of NCEP ATP III were used (7). In this study, these criteria were modified for adolescents to include elevated blood pressure defined as systolic or diastolic blood pressure > 90th percentile of age, sex, and height based on the Korean Pediatric Society, 1999 (8, 9); fasting plasma glucose ≥ 100 mg/dL (10); triglyceride concentration ≥ 110 mg/dL; HDL-cholesterol concentration < 40 mg/dL. Waist circumference at or above the 90th percentile value for age and sex were classified as having abdominal obesity. Subjects who met at least 3 of the 5 criteria were classified as having an MS phenotype.

The dietary intake was collected by a 24-hour recall. Food grouping was based on the classification of food groups used by the Korean Nutrient Database (Korean Nutrition Society, 2005). All statistical analyses were conducted using the SUDAAN release 9.0 (Research Triangle Institute, Research Triangle Park, NC, USA).

RESULTS

The patterns were labeled according to the highest consumption of food groups. The largest cluster (55.2%) had the highest consumption of rice and kimchi, fish, seaweed and legumes and was labeled as the “Korean traditional” pattern group. Another cluster (26.1%) had the highest consumption of flour and bread, pizza and hamburger, snacks and cereals, sugars and sweets, meats, and beverages (carbonated) and was labeled
as the “Western” pattern group. The smallest cluster (18.7%) had the highest consumption of noodles and dumplings with some consumption of rice and kimchi and was labeled as the “Modified” pattern group.

In both genders, the total energy intake and percentage of energy from protein and fat were highest and the percentage of energy from carbohydrates was lowest in the “Western” group. In the “Korean traditional” group, the percentage of energy from carbohydrates was highest and the percentage of energy from fat was lowest.

The prevalence of abdominal obesity was higher in the “Western” group with 16.08% (11.61-21.85) than in the “Korean traditional” group with 9.76% (7.38-12.80) or the “Modified” group with 9.75% (5.44-16.88). The highest prevalence of high triglyceride and high fasting plasma glucose was also found in the “Western” group. The prevalence of MS was not significantly different among dietary patterns.

Table 1 shows the odds ratio for individual risk factors of MS classified by dietary patterns. After adjusting for sex and age, the odds ratio of MS was not significantly different among dietary patterns, however, the odds ratio of abdominal obesity was significantly higher in the “Western” group.

CONCLUSION
Using the food groupings, three distinct dietary patterns, “Korean traditional”, “Western” and “Modified” groups were identified in Korean adolescents. Among them, the “Korean traditional” group was the most prevalent (55.2%), followed by the “Western” group (26.1%) and the “Modified” group (18.7%).

With the increased economic growth, the percentage of energy from fat in the diet has rapidly increased in Korea (11), which is related to the introduction and wide-spread availability of fast-food restaurants. In the “Western” group, the energy intake from fat was much higher as compared to the “Korean traditional” and “Modified” group. Although there was no significant difference in the odds ratio for MS after adjusting for age and sex, the odds ratio for abdominal obesity was the highest in the “Western” group. This result could be related to the fact that abdominal obesity is an earlier expressed phenotype of MS in adolescents.

This study has some limitations, mainly due to the cross-sectional design, which makes it difficult to determine causality. Even after some adjustments were made, there still might be a potential for residual confounding. Although the 24-h recall method is useful to estimate population means, the values from the single recalls cannot be corrected for intra-individual daily variation in consumption. In addition, the lack of information regarding saturated fatty acids is problematic.

In conclusion, the “Korean traditional” is the most prevalent dietary pattern in Korean adolescents. The odds ratio for abdominal obesity in the “Western” group was significantly higher than in the “Korean traditional” or “Modified” group, although there was no difference in the odds ratio for MS among the different dietary patterns.

Acknowledgement
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REFERENCE

<table>
<thead>
<tr>
<th></th>
<th>Korean traditional pattern N=539</th>
<th>Modified pattern N=182</th>
<th>Western pattern N=223</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unadjusted</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metabolic syndrome</td>
<td>1</td>
<td>0.839 (0.472-1.493)</td>
<td>0.971 (0.547-1.727)</td>
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<tr>
<td>Abdominal obesity</td>
<td>1</td>
<td>0.998 (0.470-2.123)</td>
<td>1.807 (1.096-2.977)</td>
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<td>Elevated blood pressure</td>
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<td>0.873 (0.545-1.397)</td>
<td>0.732 (0.458-1.169)</td>
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<td>Fasting plasma glucose ≥ 100 mg/dL</td>
<td>1</td>
<td>0.823 (0.535-1.267)</td>
<td>1.029 (0.728-1.456)</td>
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<td>Triglyceride ≥ 110 mg/dL</td>
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<td>1.133 (0.691-1.858)</td>
<td>1.410 (0.963-2.066)</td>
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<td>HDL-cholesterol ≤ 40 mg/dL</td>
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<td>1.137 (0.731-1.769)</td>
<td>0.848 (0.528-1.364)</td>
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<td><strong>Adjusted for age and sex</strong></td>
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<td></td>
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<tr>
<td>Metabolic syndrome</td>
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<td>0.868 (0.482-1.561)</td>
<td>1.010 (0.566-1.803)</td>
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<td>0.867 (0.534-1.408)</td>
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