Dietary patterns associated with hypertension among Korean males

Young Ok Kim
Department of Food and Nutrition, Dongduk Women’s University, 23-1 Wolgok-dong, Sungbuk-gu, Seoul 136-714, Korea

Received April 16, 2009; Revised June 8, 2009; Accepted June 17, 2009

Abstract
The objectives of this study were to identify the dietary patterns associated with hypertension among Korean males. Data from the 2001 Korean National Health and Nutrition Survey of 1,869 men aged 20-65 years were used for the analysis. As an initial analysis, a factor analysis was applied to identify major dietary patterns among the subjects. Then logistic regression analysis was conducted to identify the pattern related with hypertension. As a result of the initial analysis, three major dietary patterns were identified. Dietary pattern 1 (traditional) was heavily loaded with vegetables, fish and cereal. Dietary pattern 2 (Western) was loaded with fast foods, bread, meats and dairy products. Dietary pattern 3 (Drinker) was loaded with mostly pork, beer and soju (Korean liquor). From the second stage of the analysis, there was a tendency of positive association between traditional patterns and hypertension risks. However, the tendency did not meet statistical significance level (p<0.05). In summary, unlike findings from European and American studies, vegetables rich traditional dietary patterns did not show any protective effect on hypertension in Korean males. The Korean dietary practice, which is consuming salted vegetables instead of fresh vegetables, might have played a role in these findings. However, the full explanation of the findings remained to be answered with further investigation since none of the dietary patterns identified showed any statistical significance.

Key Words: Dietary pattern, hypertension, Korean, factor analysis, odds ratio

Introduction
Although Korea has achieved a high standard of living and health promotion during the last 40 years, hypertension is still a major public health problem. According to the Korean Health Survey (Ministry of Health and Social Welfare, 1999), 27.8% of adult Koreans have hypertension. It was 27.9% in the 2005 survey (Ministry of Health and Social Welfare, 2005). Strokes triggered by hypertension were one of the six leading causes of death in Korea. Twenty seven point three out of 100,000 deaths were caused by hypertension and the number contributed nearly 70% of deaths from all cardiovascular diseases (Kim et al., 2005). There is general consensus that blood pressure is related with health behaviors of smoking, drinking, exercise and diet. Studies showed that blood pressure is positively related with smoking (Fogari et al., 1996; Geory et al., 1991; Inamura et al., 1996), alcohol consumption (Gruchow et al., 1985; Marmot et al., 1994; Puddey et al., 1985) and negatively related with physical exercise (Arroll & Beaglehole, 1992; Blair et al., 1984; Paffenbarger et al., 1983).

Desirable food habits for preventing hypertension included increasing consumption of whole grains, vegetables, and fruits (Appel et al., 1997; Midgley et al., 1996; Stamler et al., 1996) are well documented from European and American studies. However, because dietary patterns of Koreans differ from people of other countries, the effect could be different. Moreover, many studies have examined the association between the intake of individual nutrients or foods and the risk of hypertension, but only recently has attention focused on the relationship of overall dietary patterns to health risk (Lin et al., 2003). In comparison to individual foods or nutrients, dietary patterns are more realistic in describing the relation of diet to health and disease (Maskarinec et al., 2000), because people do not eat isolated nutrients, but rather meals composed of a variety of foods. Complex combinations of nutrients from the food may interact (Randall et al., 1992).

From 1998, the World Health Organization (WHO) had suggested that dietary guidance for populations should be based on foods (World Health Organization, 1998). In the present investigation, identification of the dietary patterns of Korean males which are related with hypertension was carried out using the national survey data.

Materials and Methods

Data source
The food frequency dietary data of 1,869 male subjects aged 20-65 years from the 2001 Korean National Health and Nutrition Examination Survey (KHANES) were used in the analysis. The
62 items food frequency questionnaire was employed for the dietary survey. Detailed information about the 2001 KHANES is described elsewhere (Kim et al., 2005; Ministry of Health and Welfare, 2005). In brief, for the subject, they were selected based on stratified multistage probability sampling from the total Korean population; therefore, we can have the generalization from these findings to the general Korean population.

Assessment of hypertension

Among the data from the 2001 Korean National Health and Nutrition Survey (KHANES), data of systolic and diastolic blood pressure in a health examination survey were used for the analysis. Hypertension was defined as a systolic blood pressure above 140mmHg or diastolic blood pressure above 90 mmHg.

Assessment of dietary patterns

Factor analysis (Gorsuch, 1983) was conducted to derive dietary patterns from food consumption frequency of 38 food items, using the Factor procedures in SAS (version 8; SAS Institute, Cary, NC). Table 1 shows 38 food items which were categorized from 62 groups to reduce the complexity of the data. The food groups were categorized based on the principles of similarity of nutrient profiles, or culinary usage of the foods, mainly according to the Standard Tables of Food Composition in Korea, 6th Revised Edition (National Rural Living Science Institute, 2001), and the classification of food groups used by the National Nutrition Survey.

The factors were rotated by an orthogonal transformation (Varimax rotation function in SAS) to achieve simpler structure with greater interpretability. We considered components with an Eigen value greater than 1.6 as a significant factor. Eigen value 1.6 were identified as a break-point in the Screen plot and an interpretable level from previous study done by Schulz et al (2003). This served to limit the number of factors, as well as to better identify more meaningful factors. After Varimax rotation, factor scores were saved from the principal component analysis for each individual. All data presented here are from the Varimax rotation. Factor scores were categorized into quintile based on the distribution of the study population.

Statistical analysis for association

To determine the association between dietary patterns and hypertension, the odds ratios (OR) estimated for each quintile compared with the lowest quintile of each dietary pattern using Logistic regression analysis. In this analysis, age, smoking habit, drinking habit and physical activity were used as covariates based on the results of initial analysis. But, in the analysis of drinker pattern, the drinking habit as covariate was excluded.

Results

The characteristics of the study subjects are shown in Table 2. The mean age of the subjects was 40.9 years. The residential areas of the subjects were categorized as metropolitan city (41.9%), middle or small city (35.9%) and rural (22.2%). Among the study subjects, 41.9% of them had education levels of more than college education.

Mean systolic and diastolic blood pressures were 123.4 and 79.9 mmHg, respectively. Hypertension prevalence was 10.0% (20-29 years), 19.2% (30-39 years), 28.1% (40-49 years), 35.1% (50-59 years) and 46.8% (60-65 years).
Table 3 showed dietary patterns identified from the factor analysis in terms of the factor-loading matrices for the 3 major dietary patterns. The 3 major dietary patterns were retained in Screen plot Eigen values for males. In the model, the greater the loading of a given food item to the factor, the larger the contribution of that food item to a specific factor. And a negative loading designates negative association with the factor, while a positive loading designates positive association with the factor.

Dietary pattern 1, which was loaded heavily on vegetables, brown seaweed, fish, mushroom, modestly loaded with pork, chicken, egg with cereal, could be labeled the ‘traditional’ pattern.

Dietary pattern 2 was heavily loaded with fast food, bread, ham, modestly loaded with dairy product, chicken, fish paste and negatively loaded with cabbage (radish) could be labeled the ‘western’ pattern. Dietary pattern 3 which was heavily loaded with beer and soju, modestly loaded with pork and then negatively loaded with beans, cereal, and dairy products could be labeled as the ‘drinker’ pattern.

Table 4 shows mean blood pressure according to quintile of dietary patterns among subjects.

Dietary pattern 1, which was loaded heavily on vegetables, brown seaweed, fish, mushroom, modestly loaded with pork, chicken, egg with cereal, could be labeled the ‘traditional’ pattern.

Dietary pattern 2 was heavily loaded with fast food, bread, ham, modestly loaded with dairy product, chicken, fish paste and negatively loaded with cabbage (radish) could be labeled the ‘western’ pattern. Dietary pattern 3 which was heavily loaded with beer and soju, modestly loaded with pork and then negatively loaded with beans, cereal, and dairy products could be labeled as the ‘drinker’ pattern.

Table 4 showed mean blood pressure according to quintile of dietary patterns among subjects.

Table 2. General characteristics of study subjects (n=1,869)

| Variables       | Mean ± SD   | N (%)    |
|-----------------|-------------|----------|
| Age (year)      | 40.9 ± 11.5 |          |
| Education       |             |          |
| College or higher | 734 (41.9) |          |
| High school or lower | 1133 (60.6) |          |
| Residence       |             |          |
| Metropolitan    | 783 (41.9)  |          |
| City            | 671 (35.9)  |          |
| Rural           | 415 (22.2)  |          |
| Blood pressure (mm Hg) |        |          |
| Systolic        | 123.4 ± 15.4|          |
| Diastolic       | 79.9 ± 10.6 |          |
| Hypertension prevalence |     |          |
| Age 20-29       | 34 (10.0)*  |          |
| Age 30-39       | 109 (19.2)  |          |
| Age 40-49       | 142 (28.1)  |          |
| Age 50-59       | 109 (35.1)  |          |
| Age 60-65       | 65 (46.8)   |          |

* Prevalence adjusted with age population.

Table 3. Factor-loading matrix for 3 major dietary patterns identified from Korean males

| Food group             | Factor1 (pattern 1) | Factor2 (pattern 2) | Factor3 (pattern 3) |
|------------------------|---------------------|---------------------|---------------------|
| Green vegetables       | 0.64                | -                   | -                   |
| Brown seaweed          | 0.64                | -                   | -                   |
| Mushroom               | 0.59                | -                   | -                   |
| White flesh fish       | 0.57                | -                   | -                   |
| Blue-backed fish       | 0.52                | - 0.25              |                     |
| Anchovy                | 0.52                | -                   | -                   |
| White vegetables       | 0.50                | -                   | -                   |
| Dried laver            | 0.48                | -                   | -                   |
| Potato                 | 0.43                | 0.25                | -                   |
| Beef                   | 0.41                | 0.31                | -                   |
| Shellfish              | 0.41                | -                   | -                   |
| Fruits                 | 0.39                | -                   | -                   |
| Pork                   | 0.39                | 0.28 0.37           |                     |
| Eggs                   | 0.38                | 0.31                | -                   |
| Cabbage radish         | 0.35                | - 0.27              | -                   |
| Salted fish            | 0.33                | -                   | -                   |
| Soybean curd           | 0.33                | 0.30                | -                   |
| Sweet potato           | 0.27                | 0.27                | -                   |
| Tea                    | -                   | -                   | -                   |
| Fast food              | -                   | 0.60                | -                   |
| Bread                  | -                   | 0.53                | -                   |
| Ham sausage            | -                   | 0.53                | -                   |
| Snack                  | -                   | 0.52                | -                   |
| Carbonated beverage    | -                   | 0.51                | -                   |
| Instant noodles        | -                   | 0.51                | -                   |
| Dairy products         | -                   | 0.48 -0.19          | -                   |
| Chicken                | 0.34                | 0.46 0.37           |                     |
| Cake                   | -                   | 0.42                | -                   |
| Boiled fish paste      | -                   | 0.42                | -                   |
| Cuttlefish             | 0.26                | 0.31                | -                   |
| Noodles                | -                   | 0.30                | -                   |
| Rice cake              | -                   | 0.26                | -                   |
| Beer                   | -                   | - 0.62              | -                   |
| Soju                   | -                   | - 0.62              | -                   |
| Korean traditional beverage | -           | - 0.35              |                     |
| Coffee                 | -                   | -                   | -                   |
| Beans                  | 0.29                | - 0.30              | -                   |
| Cereal                 | 0.26                | - 0.31              | -                   |
| Variance explained (%) | 5.78                | 3.66 2.06           |                     |

Values are factor loadings; absolute values < 0.25 are not displayed for simplicity.
Table 4. Multivariate adjusted means of systolic and diastolic blood pressure across quintile of dietary pattern score adjusted for age, smoking status, drinking status and physical activity

| Dietary pattern | Quintile of dietary pattern score | p for trend |
|----------------|----------------------------------|------------|
|                | 1 (lowest)                       | 2          | 3          | 4          | 5 (highest) |
| Pattern 1      | Systolic blood pressure          | 127.6 ± 15.9 | 123.9 ± 18.0 | 124.6 ± 15.3 | 122.4 ± 13.6 | 121.4 ± 13.6 | 0.28 |
|                | Diastolic blood pressure         | 79.9 ± 10.2  | 80.0 ± 11.4  | 81.2 ± 11.1  | 81.2 ± 10.4  | 78.7 ± 9.83  | 0.02 |

Pattern 2

| Systolic blood pressure | 123.2 ± 14.5 | 122.2 ± 14.3 | 122.9 ± 15.2 | 124.7 ± 15.3 | 123.9 ± 17.5 | 0.27 |
|-------------------------|--------------|--------------|--------------|--------------|--------------|------|
| Diastolic blood pressure| 80.1 ± 10.1  | 76.8 ± 10.6  | 80.3 ± 10.6  | 80.6 ± 10.6  | 79.9 ± 11.1  | 0.08 |

Pattern 3

| Systolic blood pressure | 123.2 ± 16.6 | 125.8 ± 16.1 | 123.9 ± 16.1 | 122.2 ± 13.8 | 121.8 ± 13.9 | 0.01 |
|-------------------------|--------------|--------------|--------------|--------------|--------------|------|
| Diastolic blood pressure| 79.9 ± 11.3  | 81.6 ± 10.8  | 80.1 ± 11.2  | 78.9 ± 9.89  | 79.1 ± 9.60  | 0.05 |

Values are mean ± SD calculated using ANCOVA adjusted for age, smoking status, drinking status, and physical activity.

Table 5. Odds ratios (95% confidence intervals) of hypertension risk by dietary pattern

| Dietary pattern       | Model         | Quintile of dietary pattern score | Trend |
|-----------------------|---------------|----------------------------------|-------|
|                       | 1 (lowest)    | 2                                | 3     | 4     | 5 (highest)  |       |
| Traditional Pattern (1)| crude         | 1.0 (ref.)| 0.88 (0.64-1.22) | 1.01 (0.73-1.39) | 0.73 (0.52-1.02) | 0.58 (0.41-0.82) | 0.00 |
|                       | Model 1       | 1.0 (ref.)| 1.11 (0.80-1.55) | 1.41 (1.00-1.98) | 1.51 (0.81-1.64) | 0.99 (0.68-1.44) | 0.88 |
|                       | Model 2       | 1.0 (ref.)| 1.12 (0.80-1.57) | 1.42 (1.01-1.99) | 1.20 (0.84-1.73) | 1.01 (0.69-1.47) | 0.76 |
|                       | Model 3       | 1.0 (ref.)| 1.12 (0.80-1.58) | 1.42 (1.01-2.01) | 1.21 (0.84-1.74) | 1.03 (0.70-1.50) | 0.81 |
| Western Pattern (2)   | crude         | 1.0 (ref.)| 0.95 (0.69-1.35) | 1.08 (0.76-1.52) | 1.63 (1.17-2.26) | 1.37 (0.98-1.92) | 0.00 |
|                       | Model 1       | 1.0 (ref.)| 0.80 (0.56-1.16) | 0.82 (0.58-1.82) | 1.25 (0.88-1.78) | 0.96 (0.68-1.37) | 0.34 |
|                       | Model 2       | 1.0 (ref.)| 0.80 (0.56-1.16) | 0.83 (0.57-1.19) | 1.24 (0.87-1.76) | 0.96 (0.67-1.37) | 0.36 |
|                       | Model 3       | 1.0 (ref.)| 0.88 (0.53-1.11) | 0.80 (0.56-1.16) | 1.26 (0.88-1.79) | 0.94 (0.66-1.34) | 0.35 |
| Drinker Pattern (3)   | crude         | 1.0 (ref.)| 1.32 (0.96-1.82) | 1.07 (0.77-1.49) | 0.87 (0.62-1.22) | 0.69 (0.49-0.98) | 0.00 |
|                       | Model 1       | 1.0 (ref.)| 1.48 (1.06-2.07) | 1.46 (1.04-2.07) | 1.43 (0.98-2.05) | 1.25 (0.85-1.82) | 0.29 |
|                       | Model 2       | 1.0 (ref.)| 1.51 (1.06-2.11) | 1.50 (1.06-2.12) | 1.51 (1.05-2.17) | 1.35 (0.92-1.98) | 0.14 |
|                       | Model 3       | 1.0 (ref.)| 1.46 (1.04-2.04) | 1.56 (1.03-2.07) | 1.49 (1.04-2.16) | 1.30 (0.88-1.91) | 0.18 |

Values are OR (95% confidence interval).
Model 1: adjusted for age, education, smoking status and drinking status
Model 2: additionally adjusted for physical activity
Model 3: further adjusted for energy intake

Table 4 suggests that dietary pattern score has a linear trend with increasing quintile. The prevalence of hypertension increased with age. The prevalence was 10%, 19.2%, 28.1%, 35.1% and 46.8% among the study subjects of aged 20-29, 30-39, 40-49, 50-59 and 60-65, respectively. The tendency of consuming a

Discussion

From the factor analysis, three major Korean dietary patterns were identified. Pattern 1 was more or less similar to the ‘Korean traditional’, ‘Healthy’ and ‘Prudent’ pattern observed among Japanese (Sadakane et al., 2008), U.S.A. (Newby et al., 2004) and Norwegian (Konstantinova et al., 2008) population.

Pattern 2 appeared to be the western dietary pattern from the

Korean point of view. Pattern 3 seemed heavily loaded with alcoholic food item such as beer, soju (Korean liquor) and meat products, thus quite an imbalanced dietary pattern from the nutritional health point of view.

Unlike observation from Norwegian and American studies (Konstantinova et al., 2008; Newby et al., 2004), the hypertension risk did not decrease with vegetable rich dietary pattern 1 (traditional) among Koreans. It may be explained by the dietary practice of Koreans who consumed the salted vegetables (Kimchi: fermented cabbage) instead of fresh vegetables (Kim & Lee, 2002). It may imply the sodium consumption from salted vegetable had played an important role in developing hypertension among Koreans.

Pattern 3 seemed heavily loaded with alcoholic food item such as beer, soju (Korean liquor) and meat products, thus quite an imbalanced dietary pattern from the nutritional health point of view.

However, any of the relationships between hypertension and dietary patterns (1, 2 and 3) were not statistically significant at that model with adjusting covariance.
more traditional Korean diet among the aged population than the younger population (Song et al., 2005) might have been a contributed to the findings. According to the another recent study in Korea, the rapid adoption of the westernized dietary pattern has occurred especially among the younger generation (Song et al., 2005). The results were similar to other studies carried out in Japan (Kim et al., 2004).

In summary, unlike findings from other countries, the vegetable rich traditional Korean diet did not show any protective effect on hypertension among Korean males. The prevalence of hypertension with the aging seemed to play an important role on this finding. And the dietary practice of Koreans consuming salted vegetables (as a form of Kimchi) instead of fresh vegetables might have been another contributing factor on these findings.

However, a full explanation of the findings remained to be answered with further investigation since none of the dietary patterns showed any statistical significance with hypertension. The statistical weakness on the model may also suggest that other variables than the variables included in the present study might have played a more important role in developing hypertension among Korean males.

Acknowledgment

The author thanks Dongduk Women's University for their permission of a sabbatical leave to enable this research.

Literature cited

Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, Lin PH & Karanja N (1997). A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. N Engl J Med 336:1117-1124.

Arroll B & Beaglehole R (1992). Does physical activity lower blood pressure? : A critical review of the clinical trials. J Clin Epidemiol 45:439-447.

Blair SN, Goodyear NN & Gibbons LW (1984). Physical fitness and incidence of hypertension in healthy normotensive men and women. JAMA 252:487-490.

Fogari R, Zoppì A, Lusardi P, Marasi G, Villa G & Vanasia A (1996). Cigarette smoking and blood pressure in a worker population: a cross-sectional study. J Cardiovasc Risk 3:55-59.

Geary SM, Williams IM, Stanton WR & Silva PA (1991). Smoking and blood pressure in 15 year olds in Dunedin New Zealand. Br Med J 302:89-90.

Gorsuch RL (1983). Factor Analysis, Lawrence Erlbaum Associates, Philadelphia. USA

Gruchow HW, Sobociński KA & Barbioriai JJ (1985). Alcohol, nutrient intake, and hypertension in adults. JAMA 253:1567-1570.

Imamura H, Tanaka K, Hirae C, Futagami T, Yoshimura Y, Uehida K, Tanaka A, Kobata D (1996). Relationship of cigarette smoking to blood pressure and serum lipid and lipoproteins in men. Clin Exp Pharmacol Physiol 23:397-402.

Kim MK, Sasaki S, Sasazuki S & Tsugane S (2004). Prospective study of three major dietary patterns and risk of gastric cancer in Japan. Int J Cancer 110:435-442.

Kim MK, Lee JY & Kim Y (2005). Effects of alcohol consumption to blood lipids among Korean adults: the 2001 Korean National Health and Nutrition. Cancer prevention Research 10:173-179.

Kim Y & Lee SY (2002). Dietary patterns and health behaviors of hypertensive Korean adults. Nutraceuticals and Food 7:201-206

Konstantinova SV, Tell GS, Vollset SE, Ulvik A, Drevon CA & Ueland PM (2008). Dietary patterns, food groups and nutrient as predictors of plasma choline and betaine in middle-aged and elderly men and women. Am J Clin Nutr 88:1663-1669.

Lin H, Bermudez Ol & Tucker KL (2003). Dietary patterns of Hispanic elders are associated with acculturation and obesity. J Nutr 133:3651-3657.

Marmot MG, Elliott P & Shipal AJ (1994). Alcohol and blood pressure: The isentals study. Br Med J 308:1263-1267.

Maskarinec G, Novotny R & Tasaki K (2000). Dietary patterns are associated with body mass index in multiethnic women. J Nutr 130:3068-3072.

Midgley JP, Matthew AG & Greenwood CMT (1996). Effect of reduced dietary sodium on blood pressure: A meta-analysis of randomized controlled trials. JAMA 275:1590-1597.

Ministry of Health & Social Welfare (1999). Report of National Health and Nutrition Survey Report - #11-1460000-001727-12, Ministry of Health and Social Welfare, Seoul. Republic of Korea.

Ministry of Health & Welfare (2005) Report of 2005 National Health and Nutrition Survey. Ministry of Health and Social Welfare, Seoul. Republic of Korea

National Rural Living Science Institute (2001). Food Composition Table, 6th revision, Rural Development Administration, Seoul. Republic of Korea

Newby PK, Muller D, Hallfrisch J, Andrews R & Tucker KL (2004). Food patterns measured by factor analysis and anthropometric changes in adults. Am J Clin Nutr 80:504-513.

Paffenbarger RC, Wing AL & Hyde RT (1983). Physical activity and incidence of hypertension in college alumni. Am J Epidemiol 117:245-257.

Puddey IB, Beilin LJ & Vandongen R (1985). Evidence for a direct pressure effect of alcohol consumption on blood pressure in normotensive men: A randomized controlled trial. Hypertension 7:707-713.

Randall E, Marshall J, Brasure J & Graham S (1992). Dietary patterns and colon cancer in western New York. Nutr Cancer 18:265-276.

Sadakane A, Tsutsunami A, Gotoh T, Ishikawa S, Ojima T, Kario K, Nakamura Y & Kayaba K (2008). Dietary pattern and level of blood pressure and serum lipids in a Japanese population. J Epidemiol 18:56-67.

Schulze MB, Hoffman MB, Kroke A & Boeing H (2003). An approach to construct simplified measure of dietary patterns from exploratory factor analysis. Br J Nutr 89:409-419.

Song YJ, Joung H, Engelhardt K, Yoo SY & Paik HY (2005). Traditional v. modified dietary patterns and their influence on adolescents’ nutritional profile. Br J Nutr 93:943-949.

Stamler J, Caggiula A, Grandits GA, Kjelsberg M & Cutler JA (1996). Relationship to blood pressure of combination of dietary macronutrients: finding of the Multiple Risk Factor Intervention Trial (MRFIT). Circulation 94:2417-2423.

World Health Organization (1998). Report of joint FAO/WHO consultation: Preparation and use of food-based dietary guidelines. World Health Organization, Geneva, Switzerland