Nutrition Research and Practice (2009), 3(2), 162-166
DOI: 10.4162/nrp.2009.3.2.162

Dietary patterns associated with hypertension among Korean males

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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, unlikely 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; Imamura *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 instead of nutrients (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

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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, 2002).

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

Table 1. Food groups and food items used in dietary pattern analysis

Food group	Food items
Cereal	Rice, Barley, Glutinous rice
Rice cake	Rice cake
Instant noodles	Ramyun
Noodles	Noodles
Bread	Bread
Cake	Cake
Snack	Snack
Soybean curd	Soybean curd
Beans	Beans
Potatoes	Potatoes
Sweet potatoes	Sweet potatoes
Beef	Beef
Pork	Pork
Chicken	Chicken
Ham sausage	Ham sausage
Boiled fish paste	Boiled fish paste
Eggs	Eggs
Blue-backed fish	Mackerel, Tuna
White flesh fish	Scabbard fish, Yellow corvina, Alaska Pollack
Anchovy	Anchovy
Cuttlefish	Cuttlefish
Shellfish	Shellfish
Salted fish	Salted fish
Cabbage Radish	Cabbage, Radish
Green vegetables	Spinach, Cucumber, Red pepper, Carrot, Pumpkin
White vegetables	Bean sprouts, Cabbage
Mushroom	Mushroom
Brown seaweeds	Brown seaweed
Dried laver	Dried laver
Fruits	Tomato, Orange, Persimmon, Apple, Watermelon, Strawberry, Pear, Musk melon, Peach, Banana, Grapes
Dairy products	Milk, Yoghourt, Ice cream
Carbonated beverage	Carbonated beverage
Coffee	Coffee
Tea	Tea
Beer	Beer
Soju	Soju
Korean traditional beverage	Korean traditional beverage
Fast food	Hamburger, Pizza

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 collage 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 matrixes 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.

Diastolic blood pressure were increased with quintile of pattern 1 (traditional) up to 4th quintile and then decreased at the 5th quintile.

Both systolic and diastolic blood pressure did not show any significant variation with quintile of dietary pattern 2 (western).

Systolic blood pressure increased at quintile 2 of dietary pattern 3 (drinker pattern) and then decrease from the quintile 3.

Table 5 showed the results of second stage of analysis based on logistic regression analysis. It showed hypertension risk (in terms of odd ratio) according to the quintile of three dietary patterns identified by 4 analytical models. Crude model was built without adjusting covariance. Model 1 was built with adjusting for age, education, smoking, and drinking status. Model 2 was built with additionally adjusting for physical activity on model 1. Model 3 was built with further adjustments for energy intake on model 2.

In the crude model, hypertension risk was reduced with increasing consumption of traditional dietary pattern (pattern 1) except 2nd quintile). Models 1, 2, and 3 did not show any significant relationship between hypertension and traditional dietary pattern (pattern 1). Even though it was not statistically significant, there was a tendency that hypertension risk increased

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	78.6 ± 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 (0.99-2.05)	1.25 (0.85-1.82)	0.29
	Model 2	1.0 (ref.)	1.51 (1.08-2.11)	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

[1] 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

(odd ratio>1) with increasing quintile (up to the 4th quintile) of pattern 1 (traditional pattern) at models 1, 2, and 3. It may imply that the traditional dietary pattern which was rich in vegetables did not have any protective effect on hypertension risks among Korean males.

However, any of the relationships between hypertension and dietary patterns (1, 2 and 3) were not statistically significant at that model with adjusting covariance.

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 heath point of view.

Unlikely 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. The ages of study subjects could be another factor contributing to the finding. As shown in the table 1, 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

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, unlikely 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.

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