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Breakfast skipping and breakfast type are associated with daily nutrient intakes and metabolic syndrome in Korean adults

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BACKGROUND/OBJECTIVES: Emerging evidence shows that eating breakfast and breakfast types may be associated with health outcomes and dietary intakes in various populations. The aim of this study was to investigate the association between breakfast types in Korean adults with their daily nutrient intakes and health outcomes.
SUBJECTS/METHODS: A total of 11,801 20- to 64-year-old adults (age 42.9 ± 11.8 yrs [mean ± standard error of the mean]; male 41.1%, female 58.9%) in 2007-2009 Korean National Health and Nutrition Survey data were divided into 5 groups based on breakfast types in a 24-hr dietary recall: rice with 3 or more side dishes (Rice3+, 35.3%), rice with 0-2 side dishes (Rice0-2, 34.73%), noodles (1.56%), bread and cereal (6.56%), and breakfast skipping (21.63%). Daily nutrient intakes and the risk of metabolic syndrome were compared among five groups.
RESULTS: Compared with Korean Recommended Nutrient Intake levels, the breakfast-skipping group showed the lowest intake level in most nutrients, whereas the Rice3+ group showed the highest. Fat intake was higher in the bread and noodle groups than in the other groups. When compared with the Rice3+ group, the odds ratios for the risk of obesity and metabolic syndrome were increased in the breakfast skipping, Rice0-2, and noodle groups after controlling for confounding variables.
CONCLUSIONS: The rice-based breakfast group showed better nutritional status and health outcomes when eating with 3 or more side dishes. Nutrition education is needed to emphasize both the potential advantage of the rice-based, traditional Korean diet in terms of nutritional content and the importance of food diversity.

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INTRODUCTION

In recent years, many Asian countries have seen a rapid westernization of their traditional dietary patterns, characterized by high intake levels of animal fats, refined sugar, and low vegetable intake, which has become associated with an increased risk of obesity and other chronic health conditions [1]. Similarly, South Korea has shown a large shift in the overall structure of its traditional dietary patterns in the past 3 decades, which has been associated with changes in disease patterns [2,3].

Traditionally, the common Korean meal type has been characterized by including rice and several smaller side dishes that were usually vegetable-based; the most popular dishes were cooked rice and noodles as the primary carbohydrate source, and cooked vegetables and a small serving of protein (meat, poultry, fish, egg, beans) as side dishes. Kim *et al*. [4] reported that traditional Korean diet, which was characterized by low fat intake and high vegetable consumption, has been associated with a low prevalence of chronic diseases in Korea. Song and Joung [5] further showed that the Korean traditional dietary patterns have been associated with a decreased incidence of metabolic abnormalities, such as high blood pressure and dyslipidemia. Favorable changes in cardiovascular risk factors have been reported by regular consumption of a Korean traditional diet for 12 wk in hypertensive and diabetic patients [6].

Despite the reported beneficial effects of a Korean traditional diet, within the past decade, there has been an increased adoption of nontraditional dietary practices, including selecting more westernized foods such as bread instead of rice. Breakfast has mostly been adapted to the westernized diet, whereas dinner has been maintained mostly as the traditional Korean dietary pattern [7]. In addition to the changed breakfast types, skipping breakfast has become a concern in Korea and worldwide [8-10]. Although many studies have emphasized the importance of eating breakfast [11-14] and shown it is an important determinant of a healthy lifestyle [15], those changes have primarily been observed in Korean and Chinese American

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cultures [7,16,17]. According to a report from the Korean National and Nutrition Examination Survey in 2010, 20.5% of Koreans skip breakfast [10]. Common reasons for skipping breakfast or having a westernized breakfast could include habitual oversleeping-which decreases the amount of time for breakfast in the morning-the increasing availability of 'convenience' foods such as bread because of the rapid development of the processed food industry, and the increasing professional and social participation of Korean women [11,18].

We hypothesize that Korean adults who have continued the traditional Korean breakfast of primarily rice with a variety of side dishes maintain better nutritional quality and health status than Korean adults eating 'convenient', nontraditional breakfasts or skipping breakfast altogether. In this study, we aimed to establish the relationship between daily nutrient intakes and health outcomes with dietary types at breakfast amongst Korean adults using the 2007-2009 Korean National Health and Nutrition Examination Survey (KNHANES).

SUBJECTS AND METHODS

Subjects

This study was based on data obtained from the 4th (2007-2009) KNHANES conducted by the Korean Centers for Disease Control and Korean Ministry of Health and Welfare [10]. The survey is a nationwide representative study using a stratified, multistage probability sampling design for the selection of household units. The sampling frame was based on the 2005 National Census Registry and 31,705 subjects aged $\geq$ 1 year were recruited.

The survey consisted of the following 4 components: the health interview survey, the health behavior survey, the health examination survey, and the nutrition survey. Among the 31,705 subjects, 24,871 (78.4%) participated in the survey; among those, 22,137 subjects participated in the nutrition survey. The inclusion criteria for our study was adults aged 20-64 years; the exclusion criteria were pregnant women and adults who could not be classified into the 5 major breakfast pattern groups we chose to observe. As a result, 11,801 subjects were selected for our analysis. The study was approved by the Korean Centers for Disease Control and Prevention Institutional Review Board.

Dietary intake

The diet in KNHANES was assessed based on 1-day food intake data collected using the 24-hr dietary recall method. Trained interviewers visited each household and instructed respondents to recall and describe the foods and beverages consumed over the previous 24 hr.

For the analysis, participants were divided into 5 groups based on their dietary breakfast types, which was determined from the 24-hr recalls: rice with 3 or more side dishes, rice with 0-2 side dishes, noodles, bread and cereal, and breakfast skipping. Three or more side dishes were used as a cut-off point for a balanced diet because 3 servings of meat, eggs, or beans and 7 servings of vegetables or side dishes (10 servings/d) are recommended daily in the Korean dietary guidelines [19]. This became 3 servings (1 serving of meat, eggs, or beans and 2 serving of vegetable dishes) when a total of 10 servings of side dishes were divided by 3 meals. Furthermore, using 3 dishes as a cut-off point, the number of breakfast groups was evenly distributed. In the 2 rice groups, side dishes included everything from soup and other dishes eaten with rice except kimchi; kimchi was excluded because most Korean people eat it at every meal and several variations in kimchi exist, so the number of kimchi servings was not considered to reflect a variety of vegetable side dishes or individual intake differences. Furthermore, kimchi intake is a controversial issue because of its high sodium content [20]; therefore, it was not included in the number of side dishes in terms of categorizing a variable diet. Breakfast types that could not be classified into the 5 breakfast pattern groups because there were only a few observations for the group (e.g., porridge) were excluded in the analysis

Daily energy and nutrient intakes and nutrient density per 1,000 kcal during 24 hr were calculated and compared among breakfast pattern groups. The percentage of subjects whose nutrient intake was below the estimated average requirement standard for vitamin and minerals and the 75% of the estimated energy requirement (EER) for energy intake was calculated [19].

Anthropometric measurements and health examination survey

Height and weight were measured based on standard procedures from the 2007-2009 KNHANES (Ministry of Health and Welfare and the Korea Centers for Disease Control and Prevention) and body mass index (BMI). BMI was categorized using the Asia-Pacific standards for Asians: the cut-off point was BMI $\geq$ 25 kg/m^2 (mild obesity). Waist circumference was measured using standardized techniques, with the cut-off points for abdominal obesity being $\geq$ 90 cm and $\geq$ 80 cm for men and women, respectively, based on the Asia-Pacific standards for Asians.

In our analysis, we used the criteria established by the Korean Society for the Study of Obesity based on the National Cholesterol Education Program Adult Treatment Panel III. Blood samples collected in the morning after fasting for at least 8 hr were analyzed and categorized: fasting plasma glucose $\geq$ 110 mg/dl for high blood glucose, triglycerides $\geq$ 150 mg/dl for high triglycerides, total cholesterol $\geq$ 200 mg/dl for high total cholesterol, high-density lipoprotein cholesterol (HDL-C) < 40 mg/dl in men and < 50 mg/dl in women for low HDL-C. Blood pressure was measured using a sphygmomanometer with the subject in a sitting position. Hypertension was defined as a systolic blood pressure $\geq$ 140 mm Hg and/or a diastolic blood pressure $\geq$ 90 mm Hg.

Participants were considered as having metabolic syndrome if at least 3 of the following 5 conditions were present based on criteria established by the National Cholesterol Education Program Adult Treatment Panel III: waist circumstance $\geq$ 90 cm in men and $\geq$ 80 cm in women, plasma glucose $\geq$ 110 mg/dl, serum triglyceride level $\geq$ 150 mg/dl, HDL < 40 mg/dl in men and < 50 mg/dl in women, and systolic and diastolic blood pressure $\geq$ 140/90 mmHg.

Income was divided by quartile and education was divided into 4 groups $\leq$ 6 years, 9 years, 12 years, and $\geq$ 16 years [10]. Smoking was divided into 3 groups; everyday, sometimes, and no smoking. Alcohol drinking was divided into drink $\geq$ 1 cup/mo and < 1 cup/mo; physical activity was regular if subjects

did ≥ 30 min and ≥ 5 times/wk of walking/moderate physical activity or ≥ 20 min and ≥ 3 times/wk of severe activity.

Statistical analysis

All data were reported as mean ± standard error (SE) or as numbers and percentages. Categorical data were analyzed using the chi-square test; continuous data were analyzed using the analysis of covariance after adjusting for sex, age, income, education, smoking, drinking, and physical activity. Probability levels of $P < 0.05$ were considered to be statistically significant and exact P values are listed in the tables and text. Logistic regression was used to examine the relationship between biochemical risk factors associated with metabolic diseases and breakfast meal pattern adjusting for age and sex. All statistical analyses were performed by survey procedures to account for the complex sample design effect and appropriate sample weight using the SAS 9.2 statistical package.

RESULTS

Breakfast types

Table 1 shows general characteristics of study subjects. Of the 11,801 subjects, 35.53% (n = 4,193) were in the rice with 3 or more side dishes (Rice3+) group, 34.73% (n = 4,098) in the rice with 0-2 side dishes (Rice0-2) group, 1.56% (n = 184) in the noodle (Noodle) group, 6.56% (n = 774) in the bread and cereal (Bread) group, and 21.63% (n = 2,552) in the breakfast skipping (Skipping) group. The distribution of breakfast groups significantly differed by sex and age groups, with a higher percentage of women in the Rice3+ group and significantly more participants of older ages in both rice groups; in the other breakfast type groups, there were more participants of younger ages. Breakfast types were also significantly different by income, education, smoking, drinking, and physical activity.

Nutrient intakes

Tables 2 and 3 show total daily energy and nutrient intakes in which the percentages of nutrient intake are compared with Korean Recommended Nutrient Intake levels and nutrient density per 1,000 kcal. Fat intakes were significantly higher in the Bread and Noodle groups than in the other groups ($P <$ 0.0001); sodium intake was the highest in the Noodle group ($P < 0.0001$). When the percentages of daily nutrient intakes are compared with the Korean Recommended Nutrient Intake

Table 1. General characteristics of study subjects

	Rice+ ≥ 3 side dishes	Rice + 1-2 side dishes	Noodles	Bread and cereal	Skipping	*P*-value
Total	4,193 (35.53)	4,098 (34.73)	184 (1.56)	774 (6.56)	2,552 (21.63)	
Sex						0.0004
Male	1,643 (33.88)	1,689 (34.83)	97 (2.00)	326 (6.72)	1,094 (22.56)	
Female	2,550 (36.68)	2,409 (34.65)	87 (1.25)	448 (6.44)	1,458 (20.97)	
Age (yrs)						< 0.0001
20-29	380 (21.42)	438 (24.69)	26 (1.47)	134 (7.55)	796 (44.87)	
30-49	2,177 (35.62)	1,974 (32.30)	122 (2.00)	463 (7.58)	1,375 (22.50)	
50-64	1,636 (41.78)	1,686 (43.05)	36 (0.92)	177 (4.52)	381 (9.73)	
Income						
Q1[1)]	935 (32.41)	1,127 (39.06)	52 (1.80)	117 (4.06)	654 (22.67)	< 0.0001
Q2	1,038 (36.17)	1,026 (35.75)	45 (1.57)	150 (5.23)	611 (21.29)	
Q3	1,051 (36.22)	980 (33.77)	39 (1.34)	213 (7.34)	619 (21.33)	
Q4	1,089 (37.79)	869 (30.15)	44 (1.53)	282 (9.78)	598 (20.75)	
Education						< 0.0001
6 yrs	683 (37.28)	907 (49.51)	21 (1.15)	37 (2.02)	184 (10.04)	
9 yrs	492 (36.50)	582 (43.18)	21 (1.56)	46 (3.41)	207 (15.36)	
12 yrs	1,595 (35.92)	1,416 (31.89)	79 (1.78)	255 (5.74)	1,095 (24.66)	
≥ 16 yrs	1,135 (34.33)	900 (27.22)	59 (1.78)	372 (11.25)	840 (25.41)	
Smoking						< 0.0001
Every day[2)]	681 (27.96)	812 (33.33)	66 (2.71)	134 (5.50)	743 (30.50)	
Sometimes	708 (38.33)	636 (34.43)	27 (1.46)	139 (7.53)	337 (18.25)	
No	2,513 (37.88)	2,355 (35.50)	87 (1.31)	435 (6.56)	1,244 (18.75)	
Drinking alcohol						< 0.0001
≥ 1 cup[3)]	2,086 (33.68)	2,084 (33.65)	118 (1.91)	389 (6.28)	1,516 (24.48)	
< 1 cup	1,816 (38.42)	1,719 (36.37)	62 (1.31)	321 (6.79)	809 (17.11)	
Physical activity						0.0015
Regular[4)]	2,218 (36.05)	2,190 (35.59)	107 (1.74)	383 (6.22)	1,255 (20.40)	
Irregular	1,975 (34,97)	1,908 (33.78)	77 (1.36)	391 (6.92)	1,297 (22.96)	

Data are expressed as numbers and percentages.
Analyzed by chi-square test at $P < 0.05$.
[1)] Q1, lowest income; Q4, highest income.
[2)] Every day: smoking every day; sometimes, smokes sometimes; no, no smoking.
[3)] Per month.
[4)] Regular physical activity, ≥ 30 min and ≥ 5 times/wk of walking/moderate physical activity or ≥ 20 min and ≥ 3 times/wk of intense physical activity.

Table 2. Total daily nutrient intake by breakfast types

Nutrient	Rice+ ≥ 3 side dishes		Rice+ 1-2 side dishes		Noodles		Bread and other		Skipping		*P*-value
	Lsmean	SE	Lsmean	SE	Lsmean	SE	Lsmean	SE	Lsmean	SE	
Daily energy and nutrient intake											
Energy (kcal)	2,020.8^{a}	11.8	1,914.6^{b}	12.0	1,961.7^{ab}	54.7	1,952.2^{ab}	27.7	1,671.0^{c}	15.7	< 0.0001
Protein (g)	74.4^{a}	0.5	66.9^{b}	0.5	69.0^{ab}	2.4	71.5^{a}	1.2	59.0^{c}	0.7	< 0.0001
Fat (g)	38.8^{b}	0.4	34.7^{c}	0.4	44.7^{a}	2.0	45.0^{a}	1.0	36.1^{c}	0.6	< 0.0001
Carbohydrate (g)	332.8^{a}	1.8	318.5^{b}	1.9	294.1^{c}	8.5	306.5 ^{bc}	4.3	256.9^{d}	2.4	< 0.0001
Calcium (mg)	557.3^{a}	5.3	463.8^{b}	5.4	454.6 ^{bc}	24.4	590.0^{a}	12.4	415.0^{c}	7.0	< 0.0001
Phosphorus (mg)	1,272.8^{a}	7.6	1,131.0c	7.7	1,070.5^{c}	35.2	1,193.5^{b}	17.8	961.9^{d}	10.1	< 0.0001
Iron (mg)	16.4^{a}	0.2	13.8^{b}	0.2	13.3bc	0.8	14.7^{b}	0.4	12.2^{c}	0.2	< 0.0001
Sodium (mg)	5,466.1^{a}	47.8	5,003.6^{b}	48.6	5,984.2^{a}	221.5	4,330.7^{c}	112.1	4,212.1^{c}	63.5	< 0.0001
Potassium (mg)	3,390.6^{a}	23.6	2,951.2c	24.0	2,885.7^{bcd}	109.3	3,206.4^{b}	55.3	2,616.9^{d}	31.4	< 0.0001
Vitamin A (μgRE)	932.6^{a}	15.2	792.0^{b}	15.5	864.1^{abc}	70.6	878.8^{ab}	35.7	709.3^{c}	20.3	< 0.0001
Thiamin (mg)	1.36^{ab}	0.01	1.25c	0.01	1.46^{a}	0.05	1.29^{bc}	0.03	1.11^{d}	0.02	< 0.0001
Riboflavin (mg)	1.27^{a}	0.01	1.10^{b}	0.01	1.29^{a}	0.05	1.32^{a}	0.02	1.01^{c}	0.01	< 0.0001
Niacin (mg)	17.2^{a}	0.1	15.6^{b}	0.1	16.1^{ab}	0.6	16.3^{ab}	0.3	14.4^{c}	0.2	< 0.0001
Vitamin C (mg)	121.7^{a}	1.6	102.6^{b}	1.6	100.4^{bc}	7.2	116.6^{ab}	3.7	93.4^{c}	2.1	< 0.0001
The proportion of energy intake from carbohydrate, protein, and fat											
Carbohydrate (%)	68.1^{b}	0.2	69.8^{a}	0.2	64.4^{c}	0.7	65.0^{c}	0.4	65.8^{c}	0.2	< 0.0001
Protein (%)	15.0^{a}	0.1	14.3^{b}	0.1	14.6^{ab}	0.3	14.9^{a}	0.2	14.9^{a}	0.1	< 0.0001
Fat (%)	16.9^{c}	0.1	16.0^{d}	0.1	21.0^{a}	0.6	20.1^{ab}	0.3	19.3^{b}	0.2	< 0.0001

Data are expressed as least-squares mean ± SE.
Analyzed by analysis of covariance (adjusted for sex, age, income, education, smoking, alcohol intake and physical activity) at $P < 0.05$ among breakfast type groups.
Letters (a, b, c, d) represent significant statistical differences by Duncan test ($P < 0.05$).

Table 3. Daily nutrient intakes as percentages of recommended intake levels and the nutrient intake density by breakfast types

Nutrient	Rice+ ≥ 3side dishes		Rice+ 1-2 side dishes		Noodle		Bread and other		Skipping		*P*-value
	Lsmean	SE	Lsmean	SE	Lsmean	SE	Lsmean	SE	Lsmean	SE	
Energy and nutrient intake: % of recommended intake level											
Energy (%)	96.9^{a}	0.6	91.6^{b}	0.6	93.3^{ab}	2.6	93.0^{b}	1.3	79.6^{c}	0.7	< 0.0001
Protein (%)	153.1^{a}	1.1	137.5^{b}	1.1	141.0^{ab}	4.9	146.4^{a}	2.5	120.9^{c}	1.4	< 0.0001
Calcium (%)	77.9b	0.7	65.0^{c}	0.7	63.7^{cd}	3.3	82.6^{a}	1.6	57.5^{d}	0.9	< 0.0001
Phosphorus (%)	181.8^{a}	1.1	161.6^{c}	1.1	152.9^{c}	5.0	170.5^{b}	2.5	137.4^{d}	1.4	< 0.0001
Iron (%)	150.4^{a}	1.6	126.0^{b}	1.6	120.6^{bc}	7.3	136.6^{b}	3.7	114.8^{c}	2.1	< 0.0001
Sodium (%)	382.8^{a}	3.3	348.9^{b}	3.4	412.8^{a}	15.5	303.4^{c}	7.9	297.0^{c}	4.4	< 0.0001
Vitamin A (%)	138.3^{a}	2.2	117.3^{b}	2.3	126.4^{abc}	10.4	130.9^{ab}	5.3	105.7^{c}	3.0	< 0.0001
Thiamin (%)	118.5^{ab}	1.0	109.5^{c}	1.0	126.9^{a}	4.6	112.8^{bc}	2.3	96.7^{d}	1.3	< 0.0001
Riboflavin (%)	96.1^{a}	0.8	82.8^{b}	0.8	96.8^{a}	3.5	99.7^{a}	1.8	76.1^{c}	1.0	< 0.0001
Niacin (%)	115.4^{a}	0.9	104.8^{b}	0.9	108.0^{ab}	4.1	109.3^{b}	2.1	94.5^{c}	1.2	< 0.0001
Vitamin C (%)	121.7^{a}	1.6	102.6^{c}	1.6	100.4^{bcd}	7.2	116.6^{ab}	3.7	93.4^{d}	2.1	< 0.0001
Nutrient intake density/1,000 kcal											
Protein (g)	36.8^{a}	0.2	34.8^{c}	0.2	35.1^{abc}	0.7	36.6^{ab}	0.4	35.6^{b}	0.2	< 0.0001
Fat (g)	18.4^{c}	0.1	17.3^{d}	0.1	22.5^{a}	0.6	22.1^{a}	0.3	20.6^{b}	0.2	< 0.0001
Carbohydrate (g)	168.9^{b}	0.5	171.6^{a}	0.5	156.8^{c}	2.2	161.7^{c}	1.1	160.6^{c}	0.6	< 0.0001
Calcium (mg)	283.4^{b}	2.5	248.9^{d}	2.5	249.6^{cd}	11.5	317.1^{a}	5.8	263.7^{c}	3.3	< 0.0001
Iron (mg)	8.3^{a}	0.1	7.4^{b}	0.1	7.3^{b}	0.3	7.7^{b}	0.2	7.5^{b}	0.1	< 0.0001
Vitamin A (μg RE)	464.7^{a}	8.0	418.6^{b}	8.2	441.1^{ab}	37.2	450.9^{ab}	18.8	440.3^{ab}	10.7	0.0024
Thiamin (mg)	0.67^{b}	0.00	0.66^{b}	0.00	0.75^{a}	0.02	0.67^{b}	0.01	0.67^{b}	0.01	< 0.0001
Riboflavin (mg)	0.63^{b}	0.00	0.58^{c}	0.00	0.67^{ab}	0.02	0.68^{a}	0.01	0.62^{b}	0.01	< 0.0001
Niacin (mg)	8.5^{a}	0.0	8.1b	0.0	8.2^{ab}	0.2	8.4^{ab}	0.1	8.5^{a}	0.1	< 0.0001
Vitamin C (mg)	62.2^{a}	0.8	56.0^{b}	0.8	56.6^{ab}	3.7	63.6^{a}	1.9	59.4^{ab}	1.1	< 0.0001

Data are expressed as least-squares mean ± SE.
Analyzed by analysis of covariance (adjusted for sex, age, income, education, smoking, alcohol intake, and physical activity) at $P < 0.05$ among breakfast type groups.
Letters (a, b, c, d) represent significant statistical differences by Duncan test ($P < 0.05$).

Table 4. Percentage of subjects with insufficient nutrient intake by breakfast types

Nutrient	Rice+ ≥ 3 side dishes		Rice+ 1-2 side dishes		Noodle		Bread and other		Skipping		*P*-value
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	
Percentage of subjects with nutrient intake below EAR[1)]											
Energy	1,115	26.59	1,380	33.67	60	32.61	247	31.91	1,287	50.43	< 0.0001
Protein	343	8.18	709	17.3	28	15.22	75	9.69	626	24.53	< 0.0001
Calcium	2,645	63.08	3,111	75.92	134	72.83	425	54.91	2,005	78.57	< 0.0001
Phosphorus	156	3.72	336	8.2	28	15.22	53	6.85	463	18.14	< 0.0001
Iron	907	21.63	1,319	32.19	63	34.24	243	31.4	1,152	45.14	< 0.0001
Vitamin A	1,238	29.53	1,769	43.17	74	40.22	245	31.65	1,216	47.65	< 0.0001
Thiamin	1,290	30.77	1,622	39.58	43	23.37	246	31.78	1,197	46.9	< 0.0001
Riboflavin	2,076	49.51	2,531	61.76	83	45.11	315	40.7	1,571	61.56	< 0.0001
Vitamin C	1,510	36.01	1880	45.88	94	51.09	309	39.92	1,426	55.88	< 0.0001
Percentage of subjects with overconsumption of energy, fat, and sodium[2)]											
Energy	697	16.62	558	13.62	34	18.48	127	16.41	259	10.15	< 0.0001
Fat	540	12.88	484	11.81	60	32.61	229	29.59	764	29.94	< 0.0001
Sodium	2,566	61.2	2,288	55.83	135	73.37	391	50.52	1,173	45.96	< 0.0001

Data are expressed as numbers and percentages.
Analyzed by chi-square test at $P < 0.05$.
[1)] Energy: < 75% estimated energy requirement (EER).
[2)] Energy ≥ 125% EER; fat ≥ 25% of total energy from fat; sodium > 2,000 mg (intake goal)

Table 5. Odds ratios of metabolic syndrome variables by breakfast types

	Rice+ ≥ 3 side dishes	Rice+ 1-2 side dishes	Noodles	Bread and other	Skipping
BMI (kg/m^2)					
≥ 25.0	1.0	1.15 (1.04-1.27)	1.19 (0.86-1.65)	0.98 (0.81-1.18)	1.13 (1.00-1.27)
WC (cm)					
≥ 90 for male ≥ 80 for female	1.0	1.14 (1.02-1.27)	1.43 (1.01-2.01)	0.90 (0.73-1.11)	1.20 (1.05-1.37)
Glucose (mg/dl)					
≥ 110	1.0	1.01 (0.83-1.23)	1.40 (0.74-2.66)	0.63 (0.38-1.04)	0.97 (0.74-1.28)
Triglyceride (mg/dl)					
≥ 150	1.0	1.05 (0.92-1.19)	1.47 (0.99-2.17)	0.64 (0.48-0.85)	1.02 (0.86-1.19)
Cholesterol (mg/dl)					
≥ 200	1.0	1.11 (0.93-1.32)	1.27 (0.71-2.29)	1.44 (1.06-1.95)	1.10 (0.88-1.38)
HDL cholesterol (mg/dl)					
< 40 for male/ < 50 for female	1.0	1.10 (1.00-1.21)	0.99 (0.73-1.36)	0.78 (0.66-0.93)	1.04 (0.93-1.16)
Blood pressure (mm Hg)					
Systolic ≥ 140	1.0	1.05 (0.88-1.26)	1.51 (0.83-2.75)	1.11 (0.76-1.63)	0.90 (0.70-1.18)
Diastolic ≥ 90	1.0	1.10 (0.93-1.29)	1.71 (1.07-2.72)	1.05 (0.77-1.45)	1.07 (0.87-1.32)
Metabolic syndrome					
≥ 3 risk factors	1.0	1.23 (1.10-1.38)	1.70 (1.18-2.44)	0.72 (0.56-0.93)	1.20 (1.04-1.38)

Data are expressed as adjusted odds ratio (95% confidence interval).
Odds ratios in bold are significantly different from those of the Rice + ≥ 3 side dishes group.
BMI, body mass index; HDL, high-density lipoprotein; WC, waist circumference.
Analyzed by logistic regression (adjusted for sex, age, income, education, smoking, alcohol intake, and physical activity).

levels, the Skipping group showed the lowest intake level and the Rice3+ group showed the highest intake level in both energy and nutrients. The Bread group showed the highest intake of calcium and riboflavin. Other than the Skipping group, the Rice 0-2 group showed a relatively low intake level of iron and vitamin A.

Nutrient density per 1,000 kcal showed that Rice3+ group had high nutrient density for most nutrients excluding total fat, carbohydrate, thiamin, and riboflavin, whereas the Rice0-2 and the Skipping groups showed low nutrient density for protein and the most vitamins and minerals. The Rice0-2 group showed the highest carbohydrate and lowest calcium, riboflavin, and vitamin C density level; the Noodle group had highest fat and iron densities. In the Bread group, the fat density as well as protein, calcium, riboflavin, niacin, and vitamin C densities were relatively high compared with other groups.

When the nutrient-deficient rates-the percentage of subjects whose nutrient intake was below the estimated average require-

ment for micronutrients-and the 75% of EER for energy intake for Koreans were compared among the 5 groups (Table 4), the Skipping group showed the highest rates for all nutrients. The rate was lowest in the Rice3+ group for energy, protein, iron, vitamin A, and vitamin C. For calcium and riboflavin, deficient rates were lowest in the Bread group and highest in the Rice0-2 and Skipping groups. The deficient rates for vitamins A and C were also relatively high in the Rice0-2 and Noodle groups.

When comparing the overconsumption rate for energy (> 125% EER), fat ($\geq$ 25% of total energy from fat) and sodium ($\geq$ 2,000 mg) were highest in the Noodle group. The fat overconsumption rate was highest in the Noodle, Bread, and Skipping groups, and lowest in the Rice3+ and Rice0-2 groups.

Risk factors of metabolic syndrome

Table 5 shows the risk of obesity, dyslipidemia, hypertension, high blood glucose, and metabolic syndrome for the 5 breakfast groups after controlling for potential confounding variables. When compared with the Rice3+ group, the odds ratios for the risk of obesity (BMI $\geq$ 25 kg/m^2) and abdominal obesity (waist circumference $\geq$ 90 cm for men, $\geq$ 80 cm for women) was higher in the Skipping, Rice0-2, and Noodle groups. The odds for the risk of abdominal obesity in the Noodle group were 1.43 times greater than for the Rice3+ group. The risk of hypercholesterolemia was approximately 1.44 times higher, but the risk of hypertriglyceridemia was 36% lower in the Bread group when compared with the Rice3+ group. The risk of metabolic syndrome was also higher in the Rice0-2, Noodle, and Skipping groups with odds ratios of 1.23, 1.70, and 1.20, respectively, but lower in bread group with an odds ratio of 0.72.

DISCUSSION

Our study showed that among a sample size of 11,801 Korean adults aged 24-60 years, 70.26% ate rice with side dishes (the traditional meal type) for their breakfast, 21.63% skipped breakfast-with the highest skipping rate in those aged 20-34 years-and 8.12% followed other breakfast patterns (bread, noodles). We did find that in adults aged 20-29 and 30-39 years, 44.9% and 22.5% skipped breakfast, respectively, which was much higher than the 25.1% breakfast skippers in young American adults there were associated with low nutrient intakes, including calcium and riboflavin [21]. Our study also showed that the Skipping group showed poor daily nutrient intake with a high percentage of energy from fat and a higher risk of obesity and metabolic syndrome when compared with the Rice3+ group, as seen in similar studies that showed detrimental effects of skipping breakfast on cardiometabolic health [22-26]. However, despite those results, a recent study concluded that there was a lack of evidence for a causal relation between skipping breakfast and obesity, although an association was observed between them [27]. In an experiment of causal relation between breakfast and behaviors related to obesity, Leidy *et al*. suggested that the type of breakfast is also important, concluding that a high-protein breakfast reduced evening snacking compared with skipping breakfast, whereas a low-protein breakfast did not [28].

Our data agree with the results of other studies that studied the association of diet and disease patterns among Korean populations in which an association between a rice-based diet with a relatively low prevalence of obesity was shown [3,4,7]. However, we also found that the diversity of foods at breakfast even in rice-based, traditional breakfast is important to daily nutrient intake levels. Among those eating a rice-based breakfast, the Rice3+ group had higher daily nutrient intakes than other groups-especially in nutrients emphasized for Korea such as calcium and riboflavin-and a lower risk of obesity, abdominal obesity, and metabolic syndrome. Eating a rice-based meal with a few sides may lead to an increased consumption of rice instead of a variety of foods that can result in adverse health outcomes. Kim and colleagues reported that a rice-based, traditional dietary pattern as well as a high-fat, high-sweets, and coffee pattern could positively be associated with an increased risk of obesity in Korean [29]. Another study also reported that an unbalanced Korean diet with little variety was related to higher risk of metabolic syndrome and elevated blood pressure [20].

Another distinguishing result in our study was the positive association between noodles at breakfast and blood pressure. The Noodle group showed a high level of fat and sodium intake, with a higher risk of abdominal obesity, metabolic syndrome, and hypertension. The high sodium intake levels may be explained by the high sodium content of noodle soups, which may lead to a higher risk of hypertension and metabolic syndrome. Shin *et al*. reported the association between the increased risk of metabolic syndrome and instant noodle consumption as well, although they included only instant noodles, not all types of noodles [30].

The Bread breakfast group had the highest levels of calcium and riboflavin intake, but also had a high level of fat intake. This may have occurred in the Bread group because the foods often eaten with bread or cereal-such as milk, cheese, and processed meat-because Koreans may think bread or cereal mixes well with those foods that originated from western countries (bread and cereal are not traditional foods in Korea). The Bread group also showed a higher risk of hypercholesterolemia, as we expected; these results were similar in individuals who ate a bread-based diet for breakfast: they were more likely to have elevated serum total cholesterol levels [14]. However, in our study, the Bread group was not associated with the risk of obesity and metabolic syndrome. These results disagree with significant positive associations between western dietary patterns or oily food and serum triglyceride levels, blood pressure, abdominal obesity, and metabolic syndrome [31-33]. We believe that the reasons these did not lead to metabolic syndrome in the Bread group may result from the unexpectedly relatively lower risk for high blood triglycerides and low HDL levels. We also believe these results in the Bread group may be related to the relatively lower carbohydrate intake compared with carbohydrate intake in the other groups. Similar results were reported in other studies: that too much carbohydrate intake was significantly associated with higher serum triglyceride and low HDL in Korean adults [34,35]. Another study also showed an association with a lower risk of low HDL in women in the semi-western diet, characterized by a relatively high

intake of meat and poultry [20].

One of the limitations of this study is that breakfast consumption type and daily nutrient intakes were estimated using a 24-hr dietary recall method, which may have resulted in the misclassification of usual dietary patterns by individuals because a single 24-hr dietary recall may not reflect the usual breakfast habits and food intakes of a population. Another limitation is that our study is a cross-sectional analysis, which allowed us to look at the association between breakfast types with biochemical and anthropometric indices, but limited us from making any conclusions of definitive causality and long-term health outcomes. However, despite these limitations, we found that breakfast plays an influential role in the Korean adult's overall nutritional status and that breakfast types may be a good indicator of the overall dietary and health status of an individual based on the differences in the daily nutrient intake levels and health status among the 5 breakfast groups.

A major strength of this study is that the subjects were selected to represent the general population; as a result, this reduces the errors of results from the bias of sample selection. Additionally, we were able to obtain useful information related to dietary types at breakfast, enabling us to adjust for related confounding variables including sex, age, income, education, smoking, drinking, and physical activity in contrast to many other studies that have primarily focused only on the importance of breakfast eating [36,37].

In conclusion, the traditional Korean, rice-based breakfast reflected the most desirable nutritional status and health outcomes when eaten with 3 or more side dishes, showing both the potential advantage of a rice-based diet in terms of nutritional content and the importance of food diversity. Our findings suggest that the Skipping group had poor daily nutrient intake patterns, whereas the Noodle breakfast group showed high fat and/or sodium intake and a higher risk of hypertension, or metabolic syndrome. This study suggests a need for increased nutrition education to help reduce the practice of skipping breakfast-and an increased need for strategies to effectively tackle the issue of balancing foods at meals.

REFERENCES

1. Popkin BM. Nutritional patterns and transitions. Popul Dev Rev 1993;19:138-57.
2. Kim SH, Oh SY. Cultural and nutritional aspects of traditional Korean diet. World Rev Nutr Diet 1996;79:109-32.
3. Lee MJ, Popkin BM, Kim S. The unique aspects of the nutrition transition in South Korea: the retention of healthful elements in their traditional diet. Public Health Nutr 2002;5:197-203.
4. Kim S, Moon S, Popkin BM. The nutrition transition in South Korea. Am J Clin Nutr 2000;71:44-53.
5. Song Y, Joung H. A traditional Korean dietary pattern and metabolic syndrome abnormalities. Nutr Metab Cardiovasc Dis 2012;22:456-62.
6. Jung SJ, Park SH, Choi EK, Cha YS, Cho BH, Kim YG, Kim MG, Song WO, Park TS, Ko JK, So BO, Chae SW. Beneficial effects of Korean traditional diets in hypertensive and type 2 diabetic patients. J Med Food 2014;17:161-71.
7. Lee SK, Sobal J, Frongillo EA Jr. Acculturation and dietary practices among Korean Americans. J Am Diet Assoc 1999;99:1084-9.
8. Haines PS, Guilkey DK, Popkin BM. Trends in breakfast consumption of US adults between 1965 and 1991. J Am Diet Assoc 1996;96: 464-70.
9. Ministry of Health, Labor and Welfare (JP). The National Health and Nutrition Survey 2004. Tokyo: Ministry of Health, Labor and Welfare; 2005.
10. Ministry of Health and Welfare, Korea Centers for Disease Control and Prevention. Korea Health Statistics 2009: Korea National Health and Nutrition Examination Survey (KNHANES IV-3). Cheongwon: Korea Centers for Disease Control and Prevention; 2010.
11. Cheong HS, Kim JJ. Study on breakfast habits of workers and college students in Gyeongnam area. Korean J Food Cookery Sci 2010;26: 791-803.
12. Lee S, Chung SJ, Choi K. Relationship between nutrient intake and biochemical index with breakfast eating in Korean adults: analysis of data from the 2007 National Health and Nutrition Survey. Korean J Food Cult 2011;26:94-9.
13. Ruxton CH, Kirk TR. Breakfast: a review of associations with measures of dietary intake, physiology and biochemistry. Br J Nutr 1997;78:199-213.
14. Shim JE, Paik HY, Moon HK. Breakfast consumption pattern, diet quality and health outcomes in adults from 2001 National Health and Nutrition Survey. Korean J Nutr 2007;40:451-62.
15. Kim Y, Yoon J, Kim H, Kwon S. Factors related to eating breakfast of middle and high school students in Seoul. Korean J Community Nutr 2010;15:582-92.
16. Lee SK. Acculturation, meal frequency, eating-out, and body weight in Korean Americans. Nutr Res Pract 2008;2:269-74.
17. Lv N, Brown JL. Chinese American family food systems: impact of Western influences. J Nutr Educ Behav 2010;42:106-14.
18. Cho SH, Jang JH, Ha TY, Lee KS, Kim MK, Seo JS. A survey on breakfast of workers in Daegu area. Korean J Community Nutr 2004;9:673-82.
19. The Korean Nutrition Society. Dietary Reference Intakes for Koreans. 1st rev. Seoul: The Korean Nutrition Society; 2010.
20. Oh HY, Kim MK, Lee M, Kim YO. Macronutrient composition and sodium intake of diet are associated with risk of metabolic syndrome and hypertension in Korean women. PLoS One 2013;8:e78088.
21. Deshmukh-Taskar PR, Radcliffe JD, Liu Y, Nicklas TA. Do breakfast skipping and breakfast type affect energy intake, nutrient intake, nutrient adequacy, and diet quality in young adults? NHANES 1999-2002. J Am Coll Nutr 2010;29:407-18.
22. Cho S, Dietrich M, Brown CJ, Clark CA, Block G. The effect of breakfast type on total daily energy intake and body mass index: results from the Third National Health and Nutrition Examination Survey (NHANES III). J Am Coll Nutr 2003;22:296-302.
23. Min C, Noh H, Kang YS, Sim HJ, Baik HW, Song WO, Yoon J, Park YH, Joung H. Skipping breakfast is associated with diet quality and metabolic syndrome risk factors of adults. Nutr Res Pract 2011;5: 455-63.
24. Deshmukh-Taskar P, Nicklas TA, Radcliffe JD, O'Neil CE, Liu Y. The relationship of breakfast skipping and type of breakfast consumed with overweight/obesity, abdominal obesity, other cardiometabolic risk factors and the metabolic syndrome in young adults. The National Health and Nutrition Examination Survey (NHANES): 1999-2006. Public Health Nutr 2013;16:2073-82.
25. Barr SI, DiFrancesco L, Fulgoni VL 3rd. Consumption of breakfast and the type of breakfast consumed are positively associated with

nutrient intakes and adequacy of Canadian adults. J Nutr 2013;143:86-92.
26. Smith KJ, Gall SL, McNaughton SA, Blizzard L, Dwyer T, Venn AJ. Skipping breakfast: longitudinal associations with cardiometabolic risk factors in the Childhood Determinants of Adult Health Study. Am J Clin Nutr 2010;92:1316-25.
27. Brown AW, Bohan Brown MM, Allison DB. Belief beyond the evidence: using the proposed effect of breakfast on obesity to show 2 practices that distort scientific evidence. Am J Clin Nutr 2013;98:1298-308.
28. Leidy HJ, Ortinau LC, Douglas SM, Hoertel HA. Beneficial effects of a higher-protein breakfast on the appetitive, hormonal, and neural signals controlling energy intake regulation in overweight/obese, "breakfast-skipping," late-adolescent girls. Am J Clin Nutr 2013;97:677-88.
29. Kim J, Jo I, Joung H. A rice-based traditional dietary pattern is associated with obesity in Korean adults. J Acad Nutr Diet 2012;112:246-53.
30. Shin HJ, Cho E, Lee HJ, Fung TT, Rimm E, Rosner B, Manson JE, Wheelan K, Hu FB. Instant noodle intake and dietary patterns are associated with distinct cardiometabolic risk factors in Korea. J Nutr 2014;144:1247-55.
31. Amini M, Esmaillzadeh A, Shafaeizadeh S, Behrooz J, Zare M. Relationship between major dietary patterns and metabolic syndrome among individuals with impaired glucose tolerance. Nutrition 2010;26:986-92.
32. Shin A, Lim SY, Sung J, Shin HR, Kim J. Dietary intake, eating habits, and metabolic syndrome in Korean men. J Am Diet Assoc 2009;109:633-40.
33. Kim JA, Kim SM, Lee JS, Oh HJ, Han JH, Song Y, Joung H, Park HS. Dietary patterns and the metabolic syndrome in Korean adolescents: 2001 Korean National Health and Nutrition Survey. Diabetes Care 2007;30:1904-5.
34. Park SH, Lee KS, Park HY. Dietary carbohydrate intake is associated with cardiovascular disease risk in Korean: analysis of the third Korea National Health and Nutrition Examination Survey (KNHANES III). Int J Cardiol 2010;139:234-40.
35. Yang EJ, Chung HK, Kim WY, Kerver JM, Song WO. Carbohydrate intake is associated with diet quality and risk factors for cardiovascular disease in U.S. adults: NHANES III. J Am Coll Nutr 2003;22:71-9.
36. Veltsista A, Laitinen J, Sovio U, Roma E, Järvelin MR, Bakoula C. Relationship between eating behavior, breakfast consumption, and obesity among Finnish and Greek adolescents. J Nutr Educ Behav 2010;42:417-21.
37. Kwon SJ, Lee JW, Ku NS, Shin MS, Seo JS, Woo MK, Song MY. Improve dietary habits. In: Food Habits for Wellbeing. Paju: Kyomunsa; 2006. p.17-20.