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Skipping breakfast is associated with diet quality and metabolic syndrome risk factors of adults

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Abstract

The aim of the present study was to assess the effects of skipping breakfast on diet quality and metabolic disease risk factors in healthy Korean adults. Subjects included 415 employees (118 men, 297 women; 30-50 years old) of Jaesang Hospital in Korea and their acquaintances. Data collected from each subject included anthropometric measurements, 3-day dietary intake, blood pressure, and blood analyses. The subjects were classified into three groups based on the number of days they skipped breakfast: 'Regular breakfast eater', 'Often breakfast eater', or 'Rare breakfast eater'. Participants in the 'Rare breakfast eater' group consumed less rice, potatoes, kimchi, vegetables, fish and shellfish, milk and dairy products, and sweets than did participants in the other two groups (P for trend < 0.05) and ate more cookies, cakes, and meat for dinner (P for trend < 0.05). Participants in the 'Rare breakfast eater' group consumed less daily energy, fat, dietary fiber, calcium, and potassium than did participants in the other groups (P for trend < 0.05). The percent energy from carbohydrates was lower and fat intake was higher in the 'Rare breakfast eater' group than in the other groups (P for trend < 0.01). When diets were compared using the Acceptable Macronutrient Distribution Range for Koreans, 59.1% of subjects in the 'Rare breakfast eater' group consumed more energy from fat compared with the other two groups ($P < 0.005$). According to the Estimated Average Requirements for Koreans, intake of selected nutrients was lower in the 'Rare breakfast eater' group than in the other two groups ($P < 0.05$). The risk of elevated serum triglycerides was decreased in the 'Rare breakfast eater' group (OR, 0.3 [0.1-1.0], P for trend = 0.0232). We conclude that eating breakfast regularly enhances diet quality, but may increase the risk of elevated serum triglycerides.

Key Words: Breakfast consumption, diet quality, metabolic syndrome, 3-day dietary intake

Introduction

Previous studies [1-6] have shown that breakfast consumption is important for maintaining adequate nutrient intake and health. According to a report from the Korean National Health and Nutrition Examination Survey IV (KNHANES IV) [7], 20.9% of Koreans routinely skip breakfast.

In a study of Korean dietary and breakfast habits, Choi *et al.* [8] found that although 55% of the subjects were interested in health, approximately 71% skipped breakfast. Shin *et al.* [9] reported that, although most subjects in their study of Korean dietary habits understood the importance of breakfast, only 33.2% regularly consumed this meal. Another recent study revealed that 41.2% of adult Korean subjects skipped breakfast [10]. The most common reason given for skipping breakfast was "lack of time."

Several studies have concluded that ready-to-eat cereal (RTEC) is a good breakfast choice [4,11-13]; however, the KNHANES data showed that only 2.4% of individuals consumed RTEC [14]. Thus, studies and the implications of their results must be culturally specific.

Previous studies of breakfast consumption in Korea have used the self-reported Dietary History Questionnaire (DHQ) [8,9], the Food Frequency Questionnaire (FFQ) [2,6], or the 24-h recall (24HR) method [2,15,16] to investigate diet quality. However, the accuracy for estimating usual intake is low in the FFQ and DHQ, and the 1-day 24HR method cannot assess an individual's

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usual intake [17]. No study has investigated breakfast consumption using multiple-day dietary intake data, which can accurately measure usual intake. One study [18] indicated that a 3-day dietary record (DR) was comparable to a 7-day DR and better than a 24HR. Other studies [19,20] have shown that a 3-day DR, which estimates nutrient intake by averaging an individual's intake over 3 days, provides a reliable estimate of usual intake.

The purpose of the present study was to assess the effects of skipping breakfast on diet quality and metabolic disease risk factors in adults using 3-day dietary intake data.

Subjects and Methods

Subjects

A total of 425 employees of the Jaesang Hospital in Korea and their acquaintances were recruited between June and September 2009. The subjects were between 30 and 50 years of age and were not taking any medications regularly. Of the 425 subjects, 10 were excluded because their dietary intake was not recorded properly as two weekdays and one weekend day, or because proper 3-day data were not collected. Thus, the data from 415 subjects (118 men and 297 women) were included in the final analyses. All subjects provided informed consent before participating, and the study was approved by the Institutional Review Board (IRB) at Jaesang Hospital, Bundang, Korea (IRB No. IMG09-01).

Research design and method

Dietary assessment

The 3-day dietary intake over one weekend day and two weekdays was collected from each subject using a 24HR and a 2-day DR. To increase the accuracy of the 24HR, the subjects were instructed and interviewed in three stages according to the methods used in a previous study [21]. Food group intake and the amount of energy and nutrients consumed were calculated for each subject using the CAN-pro 3.0 (Korean Nutrition Society, Korea) and were used in the statistical analyses.

Subject classifications

Breakfast was defined as the meal eaten in the morning, and any food or beverages consumed in the morning were classified as breakfast [22]. Because no previous study has used more than 2 days of dietary intake data to classify breakfast consumption, we grouped subjects into three subgroups according to the frequency of skipping breakfast over the 3-day dietary intake data collection period.

Subjects who skipped breakfast on 2 or more of the 3 days were classified as a 'Rare breakfast eater' because breakfast was skipped on more than 50% of the days studied. Subjects who skipped breakfast on 1 of the 3 days were placed in the 'Often breakfast eater' group, and those who did not skip breakfast on any of the 3 days of the study were placed in the 'Regular breakfast eater' group.

Food groups

The 1114 individual food items consumed by the subjects were divided into 21 food subgroups using the food classification table from the CAN-pro 3.0 appendix, with modifications based on a previous study [23]. The foods were classified into six food groups: grains; fruits and vegetables; meat, fish, eggs and legumes; milk and dairy products; fats and sweets; and others. This classification was used to determine the dietary composition of the subjects' breakfasts [24]. Food group intake was averaged over three breakfasts. The food group, energy, and nutrient intakes for each meal were analyzed separately to identify the food composition of breakfast, lunch, dinner, and between-meal snacks.

Diet quality

Diet quality is an overall evaluation of food, energy and nutrient intake. The daily intakes of food, energy and nutrients were averaged over the 3 days to estimate usual intake. Prior to evaluating the breakfast diet quality, the average food, energy, and nutrient intakes for this meal were calculated.

Macronutrient intake for the breakfast consumption groups was evaluated according to the Acceptable Macronutrient Distribution Range for Koreans (AMDR) with reference to the Dietary Reference Intakes for Koreans (KDRIs) [24]. The subjects were classified as below, within, or above the AMDR.

Micronutrient intake was evaluated using the Estimated Average Requirements (EAR) and Tolerable Upper Intake Level (UL) with reference to the KDRIs. The selected nutrients, which were referenced in the EAR and UL, were calcium, phosphorus, iron, zinc, vitamin A, niacin, vitamin B_6, vitamin C, and folate. The subjects were classified into risk groups according to intakes that were less than the EAR or more than the UL.

Biochemical, anthropometric, and blood pressure measurements

Anthropometric measurements, blood pressure measurements, and blood collection were conducted at the Biomedical Research Center, and blood samples were analyzed by the Department of Laboratory Medicine at Jaesang Hospital, Bundang, Korea. Blood was collected after an 8-h fast. Enzyme-linked immunosorbance assay (ELISA) kits (Quantikine; R & D Systems, Minneapolis, MN, USA) were used to analyze serum triglycerides (TG), low-density lipid cholesterol (LDL-C), high-density lipid cholesterol (HDL-C), and serum fasting glucose. Systolic (SBP)

and diastolic blood pressure (DBP) was measured using a sphygmomanometer (Diagnostec; Panasonic, Japan). Weight and height were measured using an automatic extensometer (GL-150; G-Tech International, Uijeongbu-si, Korea), and body mass index (BMI) was calculated as weight (kg)/height (m) squared. The subjects were classified according to BMI as underweight < 18.5 kg/m^2, 18.5 kg/m^2 ≤ normal weight < 25 kg/m^2, 25 kg/m^2 ≤ overweight and obese. Waist circumference was measured using a tape measure. Odds ratios (ORs) and 95% confidence intervals (CIs) for metabolic syndrome risk factors were as defined by the International Diabetes Federation (IDF) [25], except the abdominal obesity cut-off point, which was that of the Korean Society for the Study of Obesity (KOSSO) [26].

According to the IDF definition, a person must have central obesity and two of the following four factors to be defined as having metabolic syndrome: elevated TG (≥ 150 mg/dL), reduced HDL-C (< 40 mg/dL in men, < 50 mg/dL in women), high blood pressure (SBP ≥ 130 or DBP ≥ 85 mmHg), or high fasting plasma glucose (≥ 100 mg/dL) [25]. The KOSSO definition of abdominal obesity is a waist circumference ≥ 90 cm for men and ≥ 85 cm for women.

Statistical analysis

All statistical analyses were performed using the Statistical Analysis System version 9.1 (SAS Institute, Cary, NC, USA). The distribution of subjects in breakfast consumption groups was evaluated using the χ^2 test. The mean and standard deviation were calculated for each breakfast consumption group. Mean differences among groups were evaluated using a general liner model (GLM). The ORs and 95% CIs for metabolic syndrome risk factors were calculated using logistic regression analysis. A value of $P < 0.05$ was deemed to be statistically significant.

Results

Characteristics of breakfast consumption groups

The numbers (%) of subjects classified as 'Regular breakfast eater', 'Often breakfast eater' and 'Rare breakfast eater' were 265 (63.9%), 106 (26.5%), and 44 (10.6%), respectively. The distributions of gender, age, and weight according to group are shown in Table 1. Age differed significantly among the breakfast consumption groups ($P < 0.001$).

Food group intake by breakfast consumption group

The total food intake averaged over 3 days was significantly higher among breakfast eaters than among breakfast skippers (Table 2). Compared with the 'Regular breakfast eater' group, the 'Rare breakfast eater' group consumed less rice, potatoes, vegetables, kimchi, fish and shellfish, milk and dairy products, and sweets (P for trend < 0.05).

When analyzing food consumption at breakfast, the 15 subjects who skipped breakfast all 3 days were not included in the 'Rare breakfast eater' group (Table 3). The intakes of rice, Western grains, vegetables, kimchi, seaweed, meat, fish and shellfish,

Table 1. The prevalence of breakfast consumption among study subjects N (%)

	Total	Regular breakfast eater[1] (n = 265)	Often breakfast eater[2] (n = 106)	Rare breakfast eater[3] (n = 44)	*P*-value[4]
Gender					
Men	118 (28.4)[5]	75 (63.6)[6]	28 (23.7)	15 (12.7)	0.6355
Women	297 (71.6)	190 (64.0)	78 (26.3)	29 (9.8)	
Age (yrs)					
30-39	165 (39.8)	84 (50.9)	58 (35.2)	23 (13.9)	
40-49	161 (38.8)	111 (68.9)	35 (21.7)	15 (9.3)	0.0002
50-59	89 (21.5)	70 (78.7)	13 (14.6)	6 (6.7)	
Weight status					
Men (n = 118)					
Underweight	1 (0.9)	0.0 (0.0)	1.0 (100.0)	0.0 (0.0)	
Normal weight	75 (63.6)	48.0 (64.0)	18.0 (24.0)	9.0 (12.0)	0.4889
Overweight and obese	42 (35.6)	27.0 (64.3)	9.0 (21.4)	6.0 (14.3)	
Women (n = 297)					
Underweight	18 (6.1)	9.0 (50.0)	8.0 (44.4)	1.0 (5.6)	
Normal weight	221 (74.4)	142.0 (64.3)	56.0 (25.3)	23.0 (10.4)	0.4652
Overweight and obese	58 (19.5)	39.0 (67.2)	14.0 (24.1)	5.0 (8.6)	

[1] Regular breakfast eater: Eat breakfast total 3 days
[2] Often breakfast eater: Skipped breakfast on 1 of the 3 days
[3] Rare breakfast eater: Skipped breakfast on 2 or more of the 3 days
[4] χ^2 test calculated
[5] Column percentage
[6] Row percentage

Table 2. Daily food group intakes according to breakfast consumption subgroup

		Regular breakfast eater[1] (n = 265)	Often breakfast eater[2] (n = 106)	Rare breakfast eater[3] (n = 44)	*P* for trend[4]
Grains	Rice (g)	186.4 ± 96.17	170.2 ± 95.8	140.6 ± 102.3	0.0078
	Eastern grains (g)[5]	54.8 ± 49.3	61.6 ± 50.3	50.3 ± 37.3	0.5631
	Western grains (g)[6]	38.6 ± 46.2	41 ± 42.6	49.2 ± 55.1	0.5264
	Cookies and cakes (g)	10.4 ± 23.1	12.2 ± 21.8	15.6 ± 25.3	0.2923
	Potatoes (g)	40.4 ± 69.8	25.7 ± 35.4	18 ± 22.2	0.0341
Fruits and vegetables	Vegetables (g)	208.2 ± 121.2	177.6 ± 92.2	157.2 ± 75.4	0.029
	Kimchi (g)	70 ± 38.6	62.1 ± 38.6	52 ± 37.4	0.0069
	Fruits (g)	157.9 ± 154.8	120.6 ± 118.1	132.7 ± 169.8	0.4316
	Fruit juice (g)	20.6 ± 71.3	13.8 ± 31	21.7 ± 39.4	0.3313
	Seaweeds (g)	3.5 ± 6.6	3.3 ± 5	2.2 ± 3.2	0.2296
Meat, fish, eggs and legumes	Meat (g)	63.6 ± 47.4	74.6 ± 55.9	83.5 ± 67.7	0.0512
	Processed meat (g)	3.3 ± 6.6	4.4 ± 13.6	4.6 ± 7.9	0.4003
	Fish and shellfish (g)	58.6 ± 45.8	48.1 ± 37.5	37.7 ± 34.3	0.0062
	Eggs (g)	23.9 ± 21.5	20.9 ± 17.7	20.2 ± 19.2	0.0762
	Legumes (g)	31.7 ± 35.8	24.1 ± 31.2	32.6 ± 59.1	0.6196
Milk and dairy	Milk and dairy products (g)	111.4 ± 116.2	101.8 ± 106.6	69 ± 87	0.0254
Fats and sweets	Sweets (g)	10.8 ± 8.1	10.9 ± 8.7	7.5 ± 7.3	0.0237
	Seasoning (g)	41.3 ± 15.9	44.3 ± 26	34.4 ± 13.5	0.3369
	Nuts and seeds (g)	2.9 ± 5.1	2.3 ± 4.4	1.5 ± 3.8	0.132
Others	Alcohol (g)	98.8 ± 271.2	74.8 ± 208.6	145.7 ± 358.6	0.6532
	Coffee and tea (g)	41.2 ± 73.1	54.5 ± 97.7	53.8 ± 90.8	0.1985

[1] Regular breakfast eater: Eat breakfast total 3 days [2] Often breakfast eater: Skipped breakfast on 1 of the 3 days
[3] Rare breakfast eater: Skipped breakfast on 2 or more of the 3 days [4] *P* for trend was adjusted for age, BMI and gender using General Linear Model (GLM).
[5] Eastern grains included: Ramyon, Rice cakes, Noodle, Chinese noodle, Udong, Black-bean-sauce noodle, Sweet steamed rice
[6] Western grains included: Breads, Flour, Cereals, Sweet corn, Doughnut, Sandwiches, Baguette, Bagel, Macaroni
[7] Mean ± SD

Table 3. Daily food group intakes at breakfast and dinner according to breakfast consumption subgroup

		Breakfast			Dinner		
		Regular breakfast eater[1] (n = 265)	Often breakfast eater[2] (n = 106)	Rare breakfast eater[3] (n = 29)	Regular breakfast eater (n = 264)	Often breakfast eater (n = 106)	Rare breakfast eater (n = 44)
Grains	Rice (g)	55.1 ± 41.20[7]	30.0 ± 28.7	13.4 ± 16.6****[4]	60.3 ± 39.75	64.6 ± 46.7	54.6 ± 46.6
	Eastern grains (g)[5]	5.9 ± 16.3	6.3 ± 16.5	2.3 ± 8.8	16.6 ± 25.4	19.6 ± 26.3	18.6 ± 24.8
	Western grains (g)[6]	12.5 ± 28.1	5.7 ± 13.8	10.3 ± 25.7*	8.7 ± 20.5	12.1 ± 24.2	14.0 ± 32.4
	Cookies and cakes (g)	1.0 ± 6.1	2.4 ± 11.8	2.4 ± 9.1	0.9 ± 5.3	1.4 ± 6.5	3.9 ± 16.1*
	Potatoes (g)	8.9 ± 30.9	2.0 ± 7.5	0.2 ± 1.0	8.8 ± 18.5	7.4 ± 11.9	6.0 ± 10.3
Fruits and vegetables	Vegetables (g)	43.5 ± 45.3	20.6 ± 26.6	10.1 ± 17.3****	62.9 ± 46.3	65.6 ± 45.5	56.1 ± 29.7
	Kimchi (g)	19.6 ± 16.5	11.1 ± 15.1	2.4 ± 4.7****	24.5 ± 19.7	22.9 ± 21.3	22.3 ± 18.3
	Fruits (g)	19.8 ± 45.5	13.7 ± 42.9	5.5 ± 20.4	23.4 ± 46.2	19.0 ± 36.6	26.2 ± 53.5
	Fruit juice (g)	3.3 ± 17.2	1.8 ± 9.9	3.4 ± 13.6	3.0 ± 15.8	0.7 ± 6.5	1.5 ± 10.1
	Seaweeds (g)	0.6 ± 1.9	0.3 ± 0.5	0.1 ± 0.3*	0.8 ± 2.3	1.2 ± 2.9	0.5 ± 1.0
Meat, fish, eggs and legumes	Meat (g)	7.0 ± 11.9	2.6 ± 6.4	1.7 ± 5.8***	28.7 ± 34.6	35.2 ± 44.8	47.8 ± 55.8*
	Processed meat (g)	0.9 ± 2.7	0.6 ± 2.1	0.6 ± 1.6	0.9 ± 3.2	2.3 ± 12.6	1.8 ± 4.2
	Fish and shellfish (g)	12.1 ± 17.5	6.4 ± 11.1	2.6 ± 6.4**	21.7 ± 28.3	21.2 ± 27.0	16.5 ± 23.8
	Eggs (g)	6.7 ± 11.2	3.4 ± 7.2	3.9 ± 15.5**	7.0 ± 10.3	8.2 ± 11.1	7.7 ± 10.2
	Legumes (g)	9.0 ± 18.7	5.2 ± 13.7	2.2 ± 8.4*	9.6 ± 15.8	8.9 ± 18.4	12.4 ± 21.5
Milk and dairy	Milk and dairy products (g)	27.5 ± 54.2	22.0 ± 40.2	14.7 ± 32.9	10.3 ± 32.7	12.4 ± 33.8	4.3 ± 15.2
Fats and sweets	Sweets (g)	2.1 ± 3.3	1.4 ± 2.2	0.9 ± 1.8*	1.8 ± 2.2	2.0 ± 2.7	1.7 ± 1.9
	Seasoning (g)	8.5 ± 6.6	4.5 ± 4.9	1.9 ± 2.2****	14.0 ± 10.6	19.2 ± 22.8	13.4 ± 7.5
	Nuts and seeds (g)	0.7 ± 3.0	0.3 ± 1.1	0.2 ± 0.4	0.7 ± 1.8	0.5 ± 1.3	0.2 ± 0.4
Others	Alcohol (g)	0.7 ± 7.7	0.0 ± 0.0	1.6 ± 8.4	57.1 ± 197.9	50.6 ± 193.3	121.1 ± 353.2
	Coffee and tea (g)	3.9 ± 17.3	6.7 ± 21.3	3.3 ± 10.9	2.5 ± 13.5	4.8 ± 15.1	3.8 ± 14.2

[1] Regular breakfast eater: Eat breakfast total 3 days [2] Often breakfast eater: Skipped breakfast on 1 of the 3 days
[3] Rare breakfast eater: Skipped breakfast on 2 or more of the 3 days
[4] *P* for trend was adjusted for age, BMI and gender using General Linear Model (GLM). *P for trend < 0.05 **P for trend < 0.01 ***P for trend < 0.001 ****P for trend < 0.0001
[5] Eastern grains included: Ramyon, Rice cakes, Noodle, Chinese noodle, Udong, Black-bean-sauce noodle, Sweet steamed rice
[6] Western grains included: Breads, Flour, Cereals, Sweet corn, Doughnut, Sandwiches, Baguette, Bagel, Macaroni
[7] Mean ± SD

Table 4. Daily energy and nutrients intakes by breakfast consumption subgroup

	Regular breakfast eater[1] (n = 265)	Often breakfast eater[2] (n = 106)	Rare breakfast eater[3] (n = 44)	*P* for trend[4]
Energy (kcal)	1788 ± 468[5]	1718 ± 482	1543 ± 390	0.0002
Carbohydrate (g)	270.0 ± 75.6	258.6 ± 96.1	217.8 ± 63.1	0.1725
Protein (g)	67.5 ± 19.4	63.7 ± 19.6	62.5 ± 25.6	0.2250
Fat (g)	46.0 ± 16.7	47.4 ± 17.2	44.3 ± 13.8	0.0390
Cholesterol (mg)	268.8 ± 143.9	252.7 ± 123.4	238.6 ± 117.3	0.7302
Fiber (g)	19.3 ± 6.3	16.8 ± 5.5	14.8 ± 4.8	0.0168
Calcium (mg)	510.9 ± 193.0	452.7 ± 153.5	363.7 ± 141.6	0.0017
Phosphorus (mg)	973.1 ± 267.6	901.1 ± 319.5	809.6 ± 243.9	0.3504
Iron (mg)	12.4 ± 3.4	12.2 ± 5.1	14.9 ± 24.3	0.0114
Sodium (mg)	3,739.5 ± 1160.6	3,497.8 ± 1137.7	2,994.4 ± 841.9	0.0829
Potassium (mg)	2,648.2 ± 793.0	2,366.0 ± 735.9	2,110.5 ± 597.7	0.0402
Zinc (mg)	8.3 ± 3.5	7.8 ± 2.9	7.5 ± 3.2	0.8777
Vitamin A (μgRE)	729.8 ± 366.4	709.7 ± 340.7	591.3 ± 286.4	0.8219
Vitamin B_1 (mg)	1.2 ± 0.4	1.1 ± 0.4	1.0 ± 0.3	0.1948
Vitamin B_2 (mg)	1.3 ± 0.6	1.2 ± 0.7	1.0 ± 0.5	0.7022
Vitamin B_6 (mg)	2.0 ± 0.6	1.8 ± 0.7	1.6 ± 0.6	0.4664
Niacin (mg)	16.2 ± 5.0	16.3 ± 6.9	14.9 ± 5.2	0.0618
Vitamin C (mg)	82.8 ± 40.7	74.5 ± 41.2	62.6 ± 27.4	0.1632
Vitamin E (mg)	12.9 ± 4.5	12.5 ± 4.4	11.8 ± 3.8	0.7870
Folate (μg)	221.0 ± 77.3	193.4 ± 67.6	183.6 ± 64.7	0.1538
Calories from macronutrients (% energy)				
Carbohydrate	62.0 ± 7.3	60.5 ± 7.2	58.2 ± 8.0	0.0095
Protein	15.2 ± 2.5	15.0 ± 2.5	16.2 ± 4.8	0.2187
Fat	22.9 ± 5.9	24.6 ± 5.9	25.6 ± 6.0	0.0079

[1] Regular breakfast eater: Eat breakfast total 3 days
[2] Often breakfast eater: Skipped breakfast on 1 of the 3 days
[3] Rare breakfast eater: Skipped breakfast on 2 or more of the 3 days
[4] *P* for trend of energy intake was adjusted for age and gender, and those of nutrients intake and calories from macronutrients intake were adjusted for energy, age and gender using General Linear Model (GLM).
[5] Mean ± SD

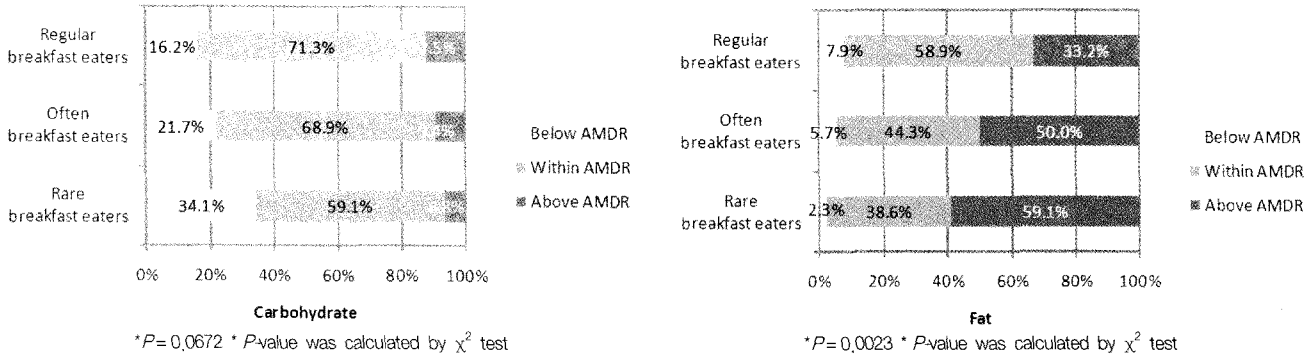

Fig. 1. Proportion with carbohydrate and fat intakes below, within or above the AMDR according to breakfast consumption subgroups. Regular breakfast eater: Eat breakfast total 3 days, Often breakfast eater: Skipped breakfast on 1 of the 3 days, Rare breakfast eater: Skipped breakfast on 2 or more of the 3 days AMDR: Acceptable Macronutrient Distribution Range

eggs, legumes, sweets, and seasoning were significantly lower in the 'Rare breakfast eater' group than in the 'Regular breakfast eater' group (*P* for trend < 0.05). One subject in the 'Regular breakfast eater' group skipped dinner, leaving 264 subjects in the group (Table 3). The intakes of cookies, cake, and meat at dinner were significantly higher in the 'Rare breakfast eater' group than in the 'Regular breakfast eater' group (*P* for trend < 0.05). The amount of food consumed at lunch and in between-meal snacks did not differ (data not shown).

Daily nutrient intake according to breakfast consumption group

The average daily nutrient intakes are shown in Table 4. The intakes of energy, fat, dietary fiber, calcium, and potassium was significantly lower in the 'Rare breakfast eater' group than in the 'Regular breakfast eater' group (*P* for trend <0.05), whereas

Table 5. The prevalence of intakes below the Estimated Average Requirements (EAR) and above the Tolerable Upper Intake Level (UL) of selected nutrients by breakfast consumption subgroup N (%)

	Subject who eat less than EAR			Subject who eat more than UL			*P*-value[4]
	Regular breakfast eater[1]	Often breakfast eater[2]	Rare breakfast eater[3]	Regular breakfast eater[1]	Often breakfast eater[2]	Rare breakfast eater[3]	
Calcium	190 (71.70)[5]	85 (80.19)	40 (90.91)	0 (0.00)	0 (0.00)	0 (0.00)	0.0109
Phosphorus	16 (6.04)	11 (10.38)	8 (18.18)	0 (0.00)	0 (0.00)	0 (0.00)	0.0192
Iron	85 (32.08)	44 (41.51)	20 (45.45)	0 (0.00)	0 (0.00)	1 (2.33)	0.0085
Zinc	90 (33.96)	48 (45.28)	25 (56.82)	1 (0.38)	0 (0.00)	0 (0.00)	0.0286
Vitamin A	59 (22.26)	26 (24.53)	16 (36.36)	1 (0.38)	0 (0.00)	0 (0.00)	0.3317
Niacin	39 (14.72)	17 (16.04)	11 (25.00)	1 (0.38)	2 (1.92)	0 (0.00)	0.2244
Vitamin B_6	19 (7.17)	19 (17.92)	10 (22.73)	0 (0.00)	0 (0.00)	0 (0.00)	0.0007
Vitamin C	137 (51.70)	60 (56.60)	32 (72.73)	0 (0.00)	0 (0.00)	0 (0.00)	0.0323
Folate	235 (88.68)	99 (93.40)	43 (97.73)	0 (0.00)	0 (0.00)	0 (0.00)	0.0894

[1] Regular breakfast eater: Eat breakfast total 3 days
[2] Often breakfast eater: Skipped breakfast on 1 of the 3 days
[3] Rare breakfast eater: Skipped breakfast on 2 or more of the 3 days
[4] χ^2 test calculated
[5] Percentage of total subjects

Table 6. Anthropometric and biochemical parameters by breakfast consumption subgroup

	Regular breakfast eater[1] (n = 265)	Often breakfast eater[2] (n = 106)	Rare breakfast eater[3] (n = 44)	*P* for trend[4]
Height (cm)	161.4 ± 7.9[5]	162.6 ± 7.6	163.0 ± 8.8	0.7082
Weight (kg)	61.0 ± 10.0	61.2 ± 11.5	60.8 ± 11.5	0.8885
Waist (cm)	78.7 ± 8.2	78.7 ± 8.4	78.3 ± 10.2	0.4302
BMI(kg/m^2)	23.3 ± 2.8	23.1 ± 3.4	22.8 ± 3.3	0.9640
SBP[6] (mmHg)	118.2 ± 13.5	118.7 ± 13.7	116.1 ± 17.3	0.9745
DBP[7] (mmHg)	75.3 ± 9.5	76.0 ± 9.1	76.0 ± 8.8	0.1750
Fasting glucose (mg/dL)	90.0 ± 23.0	87.3 ± 15.6	88.0 ± 14.6	0.4169
TG (mg/dL)	117.1 ± 78.8	105.6 ± 63.8	90.7 ± 40.8	0.0193
HDL-C (mg/dL)[8]	58.0 ± 13.1	60.6 ± 14.8	57.9 ± 13.2	0.4341
LDL-C (mg/dL)[9]	120.8 ± 30.4	112.8 ± 28.5	110.9 ± 28.8	0.1715

[1] Regular breakfast eater: Eat breakfast total 3 days
[2] Often breakfast eater: Skipped breakfast on 1 of the 3 days
[3] Rare breakfast eater: Skipped breakfast on 2 or more of the 3 days
[4] *P* for trend was adjusted for age and gender using General linear model (GLM).
[5] Mean ± SD
[6] SBP: Systolic Blood Pressure
[7] DBP: Diastolic Blood Pressure
[8] HDL-C: (LDL-C), high-density lipid cholesterol
[9] LDL-C: low-density lipid cholesterol

iron intake was significantly higher in the 'Rare breakfast eater' group (*P* for trend < 0.01).

The proportion of energy derived from carbohydrates was significantly lower and that from fat was significantly higher in the 'Rare breakfast eater' group than in the 'Regular breakfast eater' group (*P* for trend < 0.01).

Fig. 1 shows the distribution of subjects classified by the AMDR according to breakfast consumption. The percent of energy derived from protein is not shown because it was relatively constant (Table 4). The percent of energy from fat intake differed significantly among the breakfast consumption groups ($P < 0.01$). The proportion of subjects above the AMDR was highest (59.1%) in the 'Rare breakfast eater' group as compared with the other two groups. No significant difference was found among the breakfast consumption groups in the proportion of energy from carbohydrate intake.

The percentage of subjects whose nutrient intake was below the EAR or above the UL is shown in Table 5. The percentage of subjects who consumed less than the EAR of calcium, phosphorus, iron, zinc, and vitamin C differed significantly among groups. The 'Rare breakfast eater' group had the highest proportion of subjects with micronutrient intakes below the EAR. The frequency of subjects with nutrient intakes above the UL was negligible.

Anthropometric, biochemical, and blood pressure measurements according to breakfast consumption group

No significant difference in anthropometric or blood pressure measurements was found among the three breakfast consumption

Table 7. Odds ratios of metabolic syndrome (IDF) risk factors according to breakfast consumption

	Odds ratio (95% CI)[1]			*P* for trend
	Regular breakfast eater[2] (Reference)	Often breakfast eater[3]	Rare breakfast eater[4]	
Central obesity[7]	1	1.7 (0.9-3.2)	1.3 (0.5-3.4)	0.2077[5]
	1	1.8 (1.0-3.4)	1.6 (0.7-4.2)	0.0958[6]
Elevated BP[8]	1	1.4 (0.8-2.3)	1.0 (0.5-2.2)	0.5262[5]
	1	1.4 (0.8-2.4)	1.2 (0.6-2.5)	0.3638[6]
Elevated fasting glucose[9]	1	1.4 (0.8-2.5)	1.2 (0.5-2.8)	0.3968[5]
	1	1.5 (0.8-2.7)	1.4 (0.6-3.3)	0.2485[6]
Elevated TG[10]	1	0.7 (0.4-1.3)	0.3 (0.1-0.9)	0.0148[5]
	1	0.7 (0.4-1.3)	0.3 (0.1-0.9)	0.0232[6]
Reduced HDL-C[11]	1	1.0 (0.6-1.8)	1.2 (0.5-2.6)	0.7537[5]
	1	1.0 (0.5-1.7)	1.0 (0.4-2.2)	0.9213[6]

[1] Odds ratio was calculated by logistic regression.
[2] Regular breakfast eater: Eat breakfast total 3 days,
[3] Often breakfast eater: Skipped breakfast on 1 of the 3 days
[4] Rare breakfast eater: Skipped breakfast on 2 or more of the 3 days
[5] *P* for trend was adjusted by age and gender using logistic regression
[6] *P* for trend was adjusted by age, energy and gender using logistic regression
[7] Central obesity: Case of waist circumference ≥ 90 cm for men, ≥ 85 cm for women
[8] Elevated BP: Case of systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg
[9] Elevated fasting glucose: Case of serum fasting glucose ≥ 100mg/dL
[10] Elevated TG: Case of serum triglyceride ≥ 150 mg/dL
[11] Reduced HDL-C: Case of serum high-density lipid cholesterol <40 mg/dL for men, <50 mg/dL for women

groups. Biochemical analysis revealed that serum TG was lower in the 'Rare breakfast eater' group than in the 'Regular breakfast eater' group (*P* for trend < 0.05; Table 6), indicating that the risk of elevated serum TG was significantly reduced in subjects who skipped breakfast (OR, 0.28; 95% CI, 0.1-0.9; *P* for trend < 0.05; Table 7).

Discussion

The aim of the present study was to assess the effects of skipping breakfast on diet quality and metabolic disease risk factors in healthy Korean adults. We found that regular breakfast consumption was associated with a high-quality diet, but increased the risk of elevated serum TG.

We used 3-day dietary intake data to classify the subjects into three breakfast consumption groups: 'Rare breakfast eater', 'Often breakfast eater', and 'Regular breakfast eater'. Previous studies [2,6,10] classified breakfast consumption into two groups: breakfast eaters (or regular breakfast consumers) and breakfast skippers (or irregular breakfast consumers) based on 24HR data or self-reported questionnaire responses. The 2001 KNHANES data showed whether a person had eaten each meal during the 2 days before the 24HR interview [7]. Yun *et al.* [10] used a questionnaire to determine the number of times breakfast was skipped by each subject during the week, and classified subjects who skipped breakfast more than 4 days/week as breakfast skippers. Lee *et al.* [2] also used a questionnaire to classify subjects as breakfast eaters or breakfast skippers; they classified subjects who ate breakfast fewer than 2 days/week as irregular breakfast eaters. Most large-scale nutrition surveys have used dietary surveys, generally a 1-day 24HR, to classify breakfast consumption groups [5,11,15,16]. A strength of the present study was the use of 3-day dietary intake data, which enabled the measurement of usual intake with more accuracy than with a 1-day dietary intake method, the DHQ, or the FFQ.

Although energy intake was highest in the 'Regular breakfast eater' group (Table 4), we observed no significant difference in weight among groups (Table 1). Cho *et al.* [11] reported that breakfast skippers had a lower daily total energy intake but a higher BMI than did breakfast eaters. Kant *et al.* [1] studied the relationships among breakfast energy density, diet quality, and BMI, and reported that the energy density of breakfast was positively correlated with BMI in men but the BMI of female breakfast reporters was lower. Williams [5] reported no association between breakfast consumption and BMI, although energy intake was significantly higher in regular breakfast consumers. These results suggest that although skipping breakfast results in a significantly lower daily energy intake, it cannot be used to control body weight.

Food and nutrient intake are closely associated with eating frequency. Because people eat food, not nutrients, it is necessary to describe which foods provide the proper balance of nutrients. The breakfast eaters in our study consumed more food from most of the five food groups than did breakfast skippers (Table 2). The dinner dietary analysis showed that cookies, cake, and meat consumption were higher among breakfast skippers than among breakfast consumers (Table 4). Lee *et al.* [2] reported that irregular breakfast consumption in men resulted in overeating at other meals and a higher daily intake of high-fat meat. Thus, skipping breakfast can lead to inadequate nutrient intake and imbalanced macronutrient composition. Furthermore, the higher

consumption of meat at dinner among breakfast skippers may explain why iron intake was significantly higher in the 'Rare breakfast eater' group, whereas other nutrient intakes were higher in breakfast eaters (Table 4).

The 'Rare breakfast eater' group had an inadequate intake of micronutrients and a higher percentage of subjects whose intake of calcium, vitamin C, and folate was below the EAR as compared with the other groups. Our findings are consistent with previous studies. Williams [5] evaluated the impact of skipping breakfast on the recommended daily intake (RDI) of Australians and found that breakfast eaters were more likely to have proper nutrient intakes, particularly thiamin, riboflavin, calcium, magnesium, and iron. Yeoh *et al.* [16] reported that protein, niacin, calcium, and iron intakes in elementary-, junior high-, and high-school students who skipped breakfast was inadequate according to the EAR. Thus, eating breakfast is better for overall diet quality.

The 'Rare breakfast eater' group consumed a significantly higher proportion of energy from fat (Fig. 1) and derived a lower proportion of energy from carbohydrates ($P < 0.07$). This result was similar to that reported by Macdiarmid *et al.*[27], who showed that carbohydrate intake falls as fat intake increases. Shim *et al.* [15] reported that breakfast skippers had a low total fat intake, but derived a higher proportion of energy from fat than did breakfast eaters. Lee *et al.* [2] reported that irregular breakfast consumption by men and women resulted in a higher percentage of energy from fat, but that only men derived less energy from carbohydrates. These results indicate that skipping breakfast can cause a change in macronutrient intake. Excess fat intake leads to the storage of fat in the body and weight gain [28]. In the present study, the logistic regression analysis revealed a higher risk of elevated serum TG levels in the 'Regular breakfast eater' group than in the 'Rare breakfast eater' group, perhaps because breakfast skippers had a lower daily total energy intake and higher proportion of energy derived from fat compared with breakfast eaters. In contrast, previous studies [29,30] have demonstrated that a high-carbohydrate diet increases serum TG levels. West *et al.* [31] reported that a high-carbohydrate diet resulted in higher fasting TG levels than did a high-fat diet. Turley *et al.* [32] also reported that low fat intake and high carbohydrate and fiber intakes lowered total Cholesterol and LDL-C, with minor adverse effects on HDL-C and serum TG. Further studies are needed to determine how breakfast consumption affects an individual's health, especially their lipid profile.

Our study has several limitations. First, we used a cross-sectional study design; thus, a causal relationship between breakfast consumption and the risk of metabolic syndrome could not be confirmed. Second, the present study used 3-day dietary intake data to classify breakfast consumption patterns, which was not validated to represent normal breakfast consumption. Third, our subjects were self-selected and recruited within a limited region of a metropolitan area. Fourth, the aim of the study was to assess the association between skipping breakfast and the risk of metabolic syndrome, but the prevalence of metabolic syndrome was very low in our study. Finally, we did not collect lifestyle information such as physical activity, alcohol consumption, and smoking habits, which can influence dietary intake and the risk of metabolic syndrome.

In conclusion, regular breakfast intake enhances diet quality, but may increase the risk of elevated serum TG.

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