Original Article

Instant noodles, processed food intake, and dietary pattern are associated with atopic dermatitis in an adult population (KNHANES 2009-2011)

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Background and Objectives: The incidence of atopic dermatitis (AD) is continuously increasing in industrialized countries, possibly due to dietary and lifestyle changes. However, the association between processed food intake and AD has not been studied in a large adult population. **Methods and Study Design:** We investigated the association between dietary habits and AD in 17,497 adults in the 2009-2011 Korean National Health and Nutrition Examination Survey (KNHANES). **Results**: We identified 4 dietary patterns using principal components analysis of a 63-item food frequency questionnaire: the "traditional dietary pattern", rich in rice and kimchi; the "processed food pattern", with more meat, instant noodles, soda, and processed foods; the "healthy dietary pattern", high in grains, vegetables, fruits, and seaweeds; and the "drinking dietary pattern", mainly drinking coffee and alcohol. Adjusted odds ratios (ORs) for AD were calculated according to dietary patterns after adjusting for potential confounders with incorporation of sample weights for the complex sample design. The "meat and processed food" pattern was associated with a significant 1.57 fold higher OR for atopic dermatitis than the low consumption group. Further analysis revealed that the increased atopic dermatitis was most closely associated with instant noodles. In contrast, the groups with high intake of rice and kimchi exhibited lower ORs, 0.38 and 0.43 folds, compared to the low intake group. **Conclusion**: Consuming instant noodles, meat and processed foods was associated with increased prevalence of atopic dermatitis, whereas consuming rice and kimchi, and coffee was associated with decreased prevalence of atopic dermatitis.

Key Words: atopic dermatitis, processed foods, coffee, instant noodles, meat consumption

INTRODUCTION

Atopic dermatitis (AD) is an inflammatory skin disease with early onset. It is primarily a disease of infants and children, in whom its prevalence is approximately 20% as compared to a prevalence of about 3-6% in adults.[1] However, the overall prevalence has continuously increased even among adults in industrialized countries such as Korea over the last several decades.[2] This increase in the prevalence may be related to the changes in dietary patterns and environmental factors. While the exact etiology of atopic dermatitis remains poorly understood, its pathophysiology likely represents complex interactions between genetics, physiology, and the environment.[3] Atopic dermatitis is associated with production of large amounts of immunoglobulin E (IgE) antibodies in response to environmental and dietary factors such as pollen, house dust, mites, and certain foods.

Specific nutritional components have been identified as exacerbating factors in atopic dermatitis, and the elimination of these components from the diet has been shown to attenuate the symptoms.[4] These symptoms are partially related to an allergic reaction to a specific food. Although the contribution of these allergies to atopic dermatitis is controversial, up to 40% of children with moderate atopic dermatitis have IgE–mediated food allergies. Several foods have been reported to have a direct harmful or beneficial effect on atopic dermatitis. The supplementation of vitamin D, primrose oil, and borage oil, which are all high in gamma-linolenic acid, as well as probiotics, were shown to have a beneficial effect in intervention and cross-sectional studies.[4-8] In contrast, elimination of certain food components that have induced the food allergy were shown to reduce the symptoms of atopic dermatitis.[9] Evidence is growing that processed foods may cause adverse reactions, including hypersensitivity.[10] This may be related to food additives and foods that are high in certain fats.[11] Increased fat intake itself may worsen atopic dermatitis, whereas the elimination of food additives was

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suggested to be beneficial in some patients.[11] In addition, foods high in proteins have been implicated in the development of atopic dermatitis.[12] Overall, however, the involvement of specific nutrients in the disease process remains controversial.

One example of frequently consumed processed foods is instant noodles. The consumption of instant noodles is relatively high among the Asian population, especially among South Koreans who consumed 74 packages of instant noodles per capita in 2013, the highest consumption in the world.[2] High consumption of instant noodles may represent a health risk since they contain high amounts of saturated fats, sodium, and food additives. Among these, monosodium glutamate (MSG) may be a risk factor for atopic dermatitis.[13] Lee et al (2011) reported that children with atopic dermatitis who decreased their consumption of MSG had decreased serum eosinophil cationic protein levels and exhibited attenuation in the severity of their symptoms.

However, the association between different dietary patterns including instant noodle intake and atopic dermatitis independent of potential confounding factors has not been studied in a large adult population. Therefore, this study aims to examine the association between different dietary patterns, including the intake of processed foods and instant noodles, and the prevalence of atopic dermatitis in adults by using the Korean National Health and Nutrition Examination Survey (KNHANES), a large South Korean population study with a stratified multistage probability sampling design.

METHODS

Design and data collection

This study utilized the 3-year Korean National Health and Nutrition Examination Survey (KNHANES) data from 2009 to 2011, which was obtained from KNHANES IV (2009) and KNHANES V (2010-2011). KNHANES is conducted annually using a rolling sampling design that involves a complex, stratified, multistage, probability-cluster survey of a representative sample of the civilian population in South Korea.[14] The survey is performed by the Korean Centers for Disease Control and Prevention and Korean Ministry of Health and Welfare, and it has three components: health interview, health examination, and nutrition surveys.[15] The Institutional Review Board (IRB) of the Korean Centers for Disease Control and Prevention, and the Keimyung University reviewed and approved the survey (approval no. 2008-04EXP-01-C, 2009-01CON-03-2C, 2010-02CON-21-C, and 2015-01-HR-05-01).

The present cross-sectional analysis was restricted to participants aged ≥19 years who completed the health examination survey and the nutrition survey (n=17,497; men n=7,129 and women n=10,368). Information on age, education level, smoking history, and alcohol consumption was collected during the health interview according to the KNHANES manual.[15] Age was categorized into five groups (19-29, 30-39, 40-49, 50-59, and ≥60 years). Education level was categorized into three groups: less than high school, high school, and college or more. Height and weight measurements were performed with the participants wearing light clothing without shoes. Body mass index (BMI) was calculated as weight (in kilograms) divided by the square of height (in meters). Waist circumference was measured midway between the costal margin and the iliac crest at the end of normal expiration. Subjects were categorized into three groups according to obesity references for Asian populations[16]: lean (BMI<18.5), normal (18.5≤BMI<25), and obese (BMI≥25). Smoking status was divided into three categories based on self-reported cigarette consumption: current smoker, past smoker, and never-smoker.[14] Never-smokers had smoked <100 cigarettes in their lifetime, and participants who smoked ≥100 cigarettes were categorized as past or current smokers based on the current cigarette consumption. Alcohol consumption was assessed by asking the participants about their drinking behavior during the month before the interview. The participants were asked about the frequency (servings/month) of alcoholic beverage consumption. Alcohol consumption status was categorized into two groups according to daily alcohol consumption: non-drinker and drinker. Regular exercise was defined as participation in moderate exercise (slow swimming, doubles tennis, volleyball, or occupational or recreational activity involving carrying of light objects) on a regular basis for more than 30 mins at a time at least five times per week, or participation in vigorous exercise (running, climbing, fast cycling, fast swimming, football, basketball, rope jumping, squash, singles tennis, or occupational or recreational activity involving carrying of heavy objects) for over 20 mins at a time at least three times per week.

Clinical laboratory tests

Blood samples were collected after a 12-hr overnight fast. They were properly processed and transported in cold storage to the central laboratories (Seoul Medical Science Institute, Seoul, Korea and Seegene Medical Foundation, Seoul, Korea) within 24-hr. Serum 25-OH-D levels were measured with a radioimmunoassay kit (DiaSorin, Stillwater, MN) using a 1470 Wizard gamma counter (Perkin-Elmer, Turku, Finland). The inter-assay variation coefficients were 7.6% and 7.2% at 14.7 ng/mL and 52.5 ng/mL, respectively.[17] Total serum IgE levels were obtained in 2010 from 1588 participants who were randomly sampled from every age and sex group in each district to represent the general Korean population. IgE levels were measured by using a 1470 Wizard gamma-counter (PerkinElmer, Turku, Finland) with ImmunoCAP 100 (Phadia, Uppsala, Sweden). All clinical analyses were performed by the Neodin Medical Institute, a laboratory authorized by the Korean Ministry of Health and Welfare.

Atopic dermatitis

The presence of atopic dermatitis was ascertained from the health interview survey.[15] Atopic dermatitis was determined by a "yes" response to the question "Have you been diagnosed with AD by a doctor?".

Dietary assessment

All subjects were received the instructions to maintain their usual dietary habits prior to assessing the dietary intake. Information on dietary intake was collected using the 24-h recall method. Daily energy intake was calculat-

ed with the Can-Pro 2.0 nutrient intake assessment software, developed by the Korean Nutrition Society. Dietary intake information was collected by administering a validated semi-quantitative food-frequency questionnaire to each participant.[18,19] This questionnaire requested information regarding the participant's consumption of 63 food items. The participant's food intake frequency was quantified using nine categories: "never or seldom," "once a month," "two to three times a month," "one to two times a week," "three to four times a week," "five to six times a week," "once a day," "twice a day," and "three times or more every day."

Statistical analysis

Statistical analyses were performed using the SPSS software (ver. 21 IBM SPSS Statistics). Sample weights were implemented in all analyses to produce estimates that were representative of the civilian Korean population. Dietary patterns were generated by using principal components analysis of the 19 predefined food groups. We determined the number of factors to retain based on eigenvalues >1.0, and interpretability to extract 4 major dietary patterns, which explained 53% of total variance in adult.[20] The orthogonal rotation procedure (varimax) yielded 4 dietary patterns uncorrelated to each other. Foods with factor-loading values ≥0.49 were considered to have important contributions to the specific pattern.[21] Instant noodle intake was divided into 3 categories (<1 time/mo, 1-4 times/mo, >4 times/mo) according to frequency distribution. The descriptive statistics of participants were determined by the frequency distribution of variables, such as age, residence area, smoking and drinking status, the practice of regular exercise and regular walking, and obesity. The frequency distribution according to the classification variable was analyzed using the chi-square test. Odds ratios (ORs) and 95% confidence intervals (CIs) for having atopic dermatitis were calculated according to dietary patterns, while controlling for covariates (gender, age, education level, BMI, energy intake, residence area, and the status of smoking, drinking, and exercise) using the "Logistic Regression" function to incorporate the sample weights for the complex sample design of the survey.[17]

RESULTS

General characteristics of the study population according to the prevalence of atopic dermatitis

Among the 17,497 subjects aged ≥19 years, 385 subjects (2.2%) had atopic dermatitis. Table 1 shows the demographic characteristics of the subjects with respect to atopic dermatitis. Frequency distribution of atopic dermatitis was significantly different according to age, residence area, and education level, but frequency distribution of atopic dermatitis by gender, obesity, exercise, and smoking and drinking status showed no significant difference. The average age of patients with AD was 33.6 years, and AD was more commonly observed in younger subjects (19-39 years, 74.7%), subjects living in urban area, and subjects who received higher education.

Table 2 shows the mean values and 95% CIs of several variables to assess the nutritional status associated with the prevalence of atopic dermatitis with adjustment for several covariates. Subjects' BMI, an indicator of obesity, was not associated with the prevalence of atopic dermatitis with and without adjusting for potential confounders. Surprisingly, serum IgE levels were not significantly different between the subjects with and without atopic dermatitis. Nutrient intake was significantly different be-

Table 1. Demographic characteristics of participants according to atopic dermatitis

Variable		Atopic dermatitis		*p* value
		Without	With	
N		17,112	385	
Age (yr)†		45.4±0.3	33.6±0.8	<0.001
Age (%)	19-29	1899 (18.6)	153 (53.5)	<0.001
	30-39	3154 (21.2)	87 (21.2)	
	40-49	3173 (22.3)	38 (8.9)	
	50-59	3162 (17.8)	51 (10.8)	
	60-	5724 (20)	56 (5.7)	
Gender (%)	Men	6978 (49.4)	151 (49.8)	0.894
	Women	10134 (50.6)	234 (50.2)	
Residence area (%)	Urban	13010 (79.8)	323 (87.3)	0.001
	Rural	4102 (20.2)	62 (12.7)	
Education level (%)	<High school	6735 (29.9)	75 (13.5)	<0.001
	High school	5657 (38.6)	159 (46.5)	
	College and more	4679 (31.5)	150 (40)	
Obesity (%)	Lean	764 (4.7)	28 (5.9)	0.596
	Normal	10825 (63.4)	239 (62.8)	
	Obese	5388 (31.9)	114 (31.2)	
Exercise (%)	No	15108 (88.9)	337 (87)	0.347
	Yes	1949 (11.1)	48 (13)	
Smoking status (%)	Non smoker	10321 (53.7)	228 (55.9)	0.537
	Past smoker	2195 (13.7)	41 (11.3)	
	Current smoker	4579 (32.5)	116 (32.7)	
Drinking status (%)	No	8346 (42.2)	157 (37.9)	0.165
	Yes	8665 (57.8)	224 (62.1)	

†Values are mean ± standard deviation and calculated using the generalized linear model.

tween the two groups. Daily caloric intake was not significantly different between the subjects with and without atopic dermatitis without adjusting for potential confounders. However, energy intake was significantly higher in the subjects without atopic dermatitis than in those with atopic dermatitis after adjusting for different covariates such as gender, education level, BMI, residence area, and the status of smoking, drinking, and exercise. Interestingly, fat intake was significantly higher in subjects with atopic dermatitis than in those without atopic dermatitis regardless of adjustment for potential confounders. Thus, fat intake may play an important role in development of atopic dermatitis.

The consumption of each food category according to atopic dermatitis

Using food frequency data, four different dietary patterns were generated by using the principal components analysis. Korean adults were categorized into 4 different groups: the "traditional dietary pattern" (TP), rich in rice and kimchi, the "meat and processed food pattern" (MP), with more meat, milk and milk products, noodles, soda, and processed foods including instant noodles, the "healthy dietary pattern" (HP), high in grains, vegetables, fruits, and seaweeds, and the "drinking dietary pattern" (DP), mainly drinking alcohol and coffee. According to the dietary patterns derived from the factor analysis, the frequencies of food groups corresponding to the dietary patterns are presented in Table 3. The frequencies of consuming meat and processed foods including and excluding instant noodles were significantly higher in subjects with atopic dermatitis than in those without atopic dermatitis. However, the frequencies of consuming meat and processed foods and instant noodles after adjustment for age showed insignificant results for both subjects with and without AD. The subjects with atopic dermatitis consumed less rice and kimchi than those without atopic dermatitis regardless of the adjustment for covariates. However, regardless of the adjustment for covariates, no significant differences were observed between subjects with and without atopic dermatitis with regard to consumption frequencies of healthy foods, such as grains, vegetables, and seaweed. In addition, the frequencies of consuming alcohol and coffee were different between the subjects with and without atopic dermatitis regardless of the adjustments for covariates. The subjects with atopic dermatitis had lower consumption of alcohol and coffee.

Demographic and nutrient intake according to the groups of dietary patterns

The subjects were divided into three groups (tertiles) of different dietary patterns according to their consumption frequencies. The subjects in the high tertile group of instant noodles and meat and processed foods were younger (19-39 years, 60%-65%) than those in the low tertile group (>50 years, 66%-71%), whereas the subjects in the high tertile group of rice and kimchi were older than those in the low tertile group (Table 4). In addition, men consumed more instant noodles, meat and processed foods, and alcohol and coffee than women. The subjects in the high tertile group of the instant noodles and MP had a greater tendency toward smoking and drinking than those in the low tertile group.

The subjects in the high tertile group of instant noodles and MP had a higher intake of daily protein and fat and a less intake of carbohydrates than those in the low tertile group (Table 5). Sodium intake was higher in the subjects who had high consumption in any dietary pattern. Interestingly, serum levels of 25-OH-D, an indicator of vitamin D status and association with AD, were significantly lower in the subjects in the hightertile group of instant noodles and MP than in the subjects in the lowtertile group, whereas the subjects in the high tertile group of rice and kimchi had higher level of 25-OH-D, as compared with the low consumption group (Table 5). Serum levels of IgE, an indicator of atopic dermatitis, were not significantly different among the groups with respect to the consumption of instant noodles, meat and processed foods, and rice and kimchi.

ORs for the prevalence of atopic dermatitis in different dietary patterns

ORs and 95% CI values for prevalence of atopic dermatitis were calculated according to the tertiles of consumption of instant noodles, meat and processed foods, or rice and kimchi with and without covariate adjustment (Figure 1). Covariates for the model were gender, education level, BMI, residence area, and the status of smoking, drinking, and exercise. In the instant noodles, the high consumption (over 4 times/month) groups showed significantly higher ORs for having atopic dermatitis, 1.98 and 1.57 fold higher, respectively, as compared with the low consumption group (reference group) regardless of adjustment for potential confounders. In the meat and processed food groups, ORs were parallel with those in the instant noodles. However, the odds ratios for having atopic dermatitis were not affected by the frequency of consuming instant noodles (p-value 0.706), or meat and processed foods (p-value 0.488) after adjustment for age. This suggested that high consumption of meat and processed foods including or excluding instant noodles increased the prevalence of atopic dermatitis 2.76 and 2.71 folds, respectively in comparison to low consumption without adjustment for covariates. In contrast, high consumption of rice and kimchi decreased the ORs for the prevalence of atopic dermatitis 0.43 and 0.38 folds, respectively, in comparison to the low consumption with or without covariate adjustment. High consumption of coffee decreased the ORs for the prevalence of atopic dermatitis with and without adjustment for covariates. Odds ratios for atopic dermatitis were not affected by the frequency of alcohol consumption, but they were significantly lowered in the subjects who drank more than 60 servings of coffee per month, implying that coffee might reduce the prevalence of atopic dermatitis.

DISSCUSSION

Atopic dermatitis is one of the most common inflamma tory skin diseases of infants and children. Many environmental factors including foods have been recognized as triggers of this disease.[22] Analyses of data for children and teenagers in the 6-7 yr and 13-14 yr age groups demonstrated a negative association between atopic

Table 2. Means and 95% confidence intervals of biochemical parameters and nutrient intakes according to atopic dermatitis (AD) after covariate adjustment

	Model 1			Model 2			Model 3		
	Without AD	With AD	*p* value	Without AD	With AD	*p* value	Without AD	With AD	*p* value
BMI (kg/m^2)	23.6 (23.6-23.7)	23.5 (23.0-23.9)	0.502	23.7 (23.6-23.9)	23.7 (23.2-24.2)	0.853	23.7 (23.5-23.8)	23.8 (23.3-24.3)	0.576
Serum IgE	255 (223-287)	402 (119-685)	0.31	291 (236-346)	459 (169-749)	0.255	285 (231-340)	471 (179-763)	0.213
Serum 25-OH-D (ng/mL)	17.6 (17.4-17.9)	16.3 (15.6-17.0)	<0.001	18.8 (18.3-19.3)	17.9 (17.1-18.7)	0.01	18.6 (18.2-19.1)	18.3 (17.6-19.1)	0.399
Caloric intake (kcal/d)	2045 (2024-2067)	1994 (1906-2082)	0.254	2111 (2074-2149)	2019 (1923-2115)	0.05	2128 (2091-2166)	1978 (1884-2073)	0.001
Fat intake (%)	18.2 (17.9-18.4)	21.4 (20.2-22.5)	<0.001	17.4 (17.1-17.7)	19.6 (18.5-20.8)	<0.001	17.8 (17.5-18.1)	18.7 (17.5-19.8)	0.117
Carbohydrate intake (%)	67.1 (66.8-67.4)	63.3 (62.0-64.8)	<0.001	68.1 (67.7-68.6)	65.6 (64.2-66.9)	<0.001	67.7 (67.2-68.1)	66.6 (65.3-68.0)	0.135
Protein intake (%)	14.7 (14.6-14.8)	15.3 (14.7-15.8)	0.05	14.5 (14.3-14.7)	14.8 (14.3-15.3)	0.248	14.5 (14.4-14.7)	14.7 (14.1-15.2)	0.597

Model 1: no adjustment.
Model 2: adjusted for gender, education level, BMI, energy intake, residence area, the status of smoking, drinking, and exercise.
Model 3: adjusted for all covariates in model 2 plus age.

Table 3. Means and 95% confidence intervals of consumption of each food category according to atopic dermatitis (AD) after covariate adjustment (servings consumed/month)

	Model 1			Model 2			Model 3		
	Without AD	With AD	*p* value	Without AD	With AD	*p* value	Without AD	With AD	*p* value
Instant noodles	4.26 (4.12-4.4)	5.06 (4.42-5.7)	0.015	3.99 (3.79-4.2)	4.48 (3.82-5.14)	0.145	4.27 (4.08-4.46)	3.91 (3.27-4.56)	0.286
Meat and processed foods excluding instant noodles	72.9 (71.5-74.3)	94.2 (87.3-101)	<0.001	67.8 (66.1-69.4)	81.7 (75.1-88.3)	<0.001	70.5 (69.0-72.0)	76.2 (69.8-82.5)	0.081
Meat and processed foods including instant noodles	77.2 (75.7-78.6)	99.2 (92.2-106)	<0.001	71.8 (70.1-73.5)	86.2 (79.4-93.0)	<0.001	74.8 (73.2-76.3)	80.1 (73.6-86.6)	0.111
Rice and kimchi	137 (136-138)	123 (118-128)	<0.001	141 (139-142)	129 (124-134)	<0.001	139 (137-140)	133 (128-138)	0.015
Grains, vegetables, and sea weeds	206 (203-209)	198 (186-211)	0.208	206 (201-211)	196 (184-209)	0.106	204 (198-209)	201 (189-214)	0.717
Alcohol and coffee	48.0 (47.2-48.8)	42.4 (38.1-46.7)	0.013	49.7 (48.3-51.0)	44.3 (39.8-48.7)	0.014	48.8 (47.4-50.1)	46.1 (41.8-50.4)	0.206

Model 1: no adjustment.
Model 2: adjusted for gender, education level, BMI, energy intake, residence area, the status of smoking, drinking, and exercise.
Model 3: adjusted for all covariates in model 2 plus age.

Table 4. Characteristics of Korean adults according to the tertile categories of instant noodles and dietary patterns

Servings/ month	Instant noodle intake				Meat and processed foods excluding instant noodles				Meat and processed foods including instant noodles				Rice and kimchi				Alcohol and coffee			
	Times/ mo	Times/ mo	Times/ mo	*p*-value	T1	T2	T3	*p*-value	T1	T2	T3	*p*-value	T1	T2	T3	*p*-value	T1	T2	T3	*p*-value
	<1	1-4	>4		<44	44-86	>86		<47	47-91	>91		<120	120-180	>180		<16	16-60	>60	
Age (%)				<0.001				<0.001				<0.001				<0.001				<0.001
19~29	7.1	14.9	29.7		5.2	18.2	34.6		4.5	17.8	35.3		36.1	20.3	8.9		30.8	25.1	9.3	
30~39	5.9	19.7	30.4		9.3	24.0	29.7		8.2	24.4	30.0		21.5	25.2	17.1		16.8	19.3	25.8	
40~49	15.7	25.1	23.0		19.2	26.5	20.2		19.1	26.7	20.0		16.4	22.8	24.9		13.1	18.8	30.0	
50~59	28.2	20.8	10.1		24.9	18.5	10.2		25.8	18.3	9.7		11.5	17.4	21.8		13.9	17.1	20.2	
60~	43.1	19.5	6.9		41.4	12.9	5.4		42.4	12.8	5.0		14.5	14.3	27.3		25.4	19.8	14.7	
Men (%)	31.4	45.4	61.1	<0.001	45.4	51.6	50.4	<0.001	51.1	45.4	51.9	<0.001	44.3	51.0	50.5	<0.001	34.9	47.3	59.2	<0.001
BMI (kg/m^2)	23.8± 0.07	23.5± 0.05	23.6± 0.06	0.002	23.9± 0.06	23.7± 0.06	23.3± 0.06	<0.001	23.9± 0.06	23.7± 0.06	23.6± 0.06	<0.001	23.2± 0.09	23.7± 0.06	23.9± 0.05	<0.001	23.2± 0.07	23.6± 0.06	23.9± 0.06	<0.001
Waist circum-ferences (cm)	81.7± 0.22	80.6± 0.18	80.8± 0.18	<0.001	82.7± 0.19	80.9± 0.18	79.3± 0.2	<0.001	82.7± 0.19	80.8± 0.17	79.4± 0.2	<0.001	79.4± 0.25	80.8± 0.17	82.0± 0.18	<0.001	79.3± 0.22	80.7± 0.18	82.1± 0.2	<0.001
Smoking status (%)				<0.001				0.002				<0.001				0.001				0.002
Current	19.2	28.4	42.1		29.9	33.9	33.3		29.0	33.8	34.1		31.5	34.4	30.9		17.0	30.8	42.7	
Former	11.9	13.4	14.6		14.5	13.7	12.7		14.1	13.9	12.8		13.3	13.5	13.8		10.9	13.9	14.9	
Never	68.9	58.2	43.3		55.7	52.4	54.0		56.9	52.3	53.1		55.2	52.1	55.3		72.1	55.3	42.4	
Drinking status (%)				<0.001				<0.001				<0.001				<0.001				<0.001
No	60.2	44.3	30.8		39.2	38.9	35.8		52.7	39.4	34.7		41.4	38.6	45.7		61.8	38.6	32.7	
Yes	39.8	55.7	69.2		48.6	60.8	64.2		47.3	60.6	65.3		58.6	61.4	54.3		38.2	61.4	67.3	

Table 5. Biochemical and nutrient intake profile of Korean adults according to the tertile categories of instant noodles and dietary patterns

Servings/month	Instant noodle intake				Meat and processed foods excluding instant noodles				Meat and processed foods including instant noodles			
	Times/mo <1	Times/mo 1-4	Times/mo >4	*p*-value	T1 <44	T2 44-86	T3 >86	*p*-value	T1 <47	T2 47-91	T3 >91	*p*-value
Serum IgE (ng/mL)	224±23	231±21	284±27	0.159	302±31	255±25	223±23	0.112	290±31	260±25	227±23	0.207
Serum 25-OH-D (ng/mL)	18.6±0.2	17.7±0.15	17.0±0.16	<0.001	18.6±0.2	17.6±0.16	16.7±0.15	<0.001	18.6±0.2	17.6±0.16	17.0±0.16	<0.001
Energy intake (kcal/d)	1761±17	1998±14	2236±17	<0.001	1808±15	2086±15	2235±19	<0.001	1793±15	2076±15	2255±20	<0.001
Carbohydrates (%)	71±0.26	68±0.2	64±0.2	<0.001	72.1±0.21	64.3±0.2	62.8±0.2	<0.001	73±0.2	66±0.2	63±0.2	<0.001
Protein (%)	4.0±0.09	15±0.07	15±0.07	<0.001	13.8±0.09	14.9±0.07	15.6±0.08	<0.001	14.0±0.08	15±0.08	16±0.08	<0.001
Fat (%)	15±0.19	18±0.15	21±0.15	<0.001	14.0±0.16	18.9±0.16	21.7±0.16	<0.001	13.8±0.15	19±0.16	22±0.16	<0.001
Sodium (mg/d)	4365±60	5105±62	5591±55	<0.001	4648±59	5348±55	5421±63	<0.001	4597±69	5318±54	5489±63	<0.001

	Rice and kimchi				Alcohol and coffee			
	T1 <120	T2 120-180	T3 >180	*p*-value	T1 <16	T2 16-60	T3 >60	*p*-value
Serum IgE (ng/mL)	229±32	254±23	279±27	0.448	203±31	252±23	287±25	0.094
Serum 25-OH-D (ng/mL)	16.9±0.21	17.4±0.16	18.2±0.17	<0.001	17.1±0.2	17.5±0.23	18.0±0.16	<0.001
Energy intake (kcal/d)	1969±22	2069±16	2084±15	<0.001	1848±17	1991±18	2217±16	<0.001
Carbohydrates (%)	64.4±0.27	64.1±0.2	69.4±0.21	<0.001	68.3±0.25	66.8±0.2	66.2±0.2	<0.001
Protein (%)	15.0±0.1	14.9±0.07	14.5±0.07	<0.001	14.5±0.09	14.9±0.05	14.9±0.05	<0.001
Fat (%)	20.7±0.2	19.0±0.15	16.1±0.16	<0.001	17.3±0.21	18.3±0.18	19.0±0.15	<0.001
Sodium (mg/d)	4493±73	5210±55	5515±57	<0.001	4576±56	4998±57	5622±54	<0.001

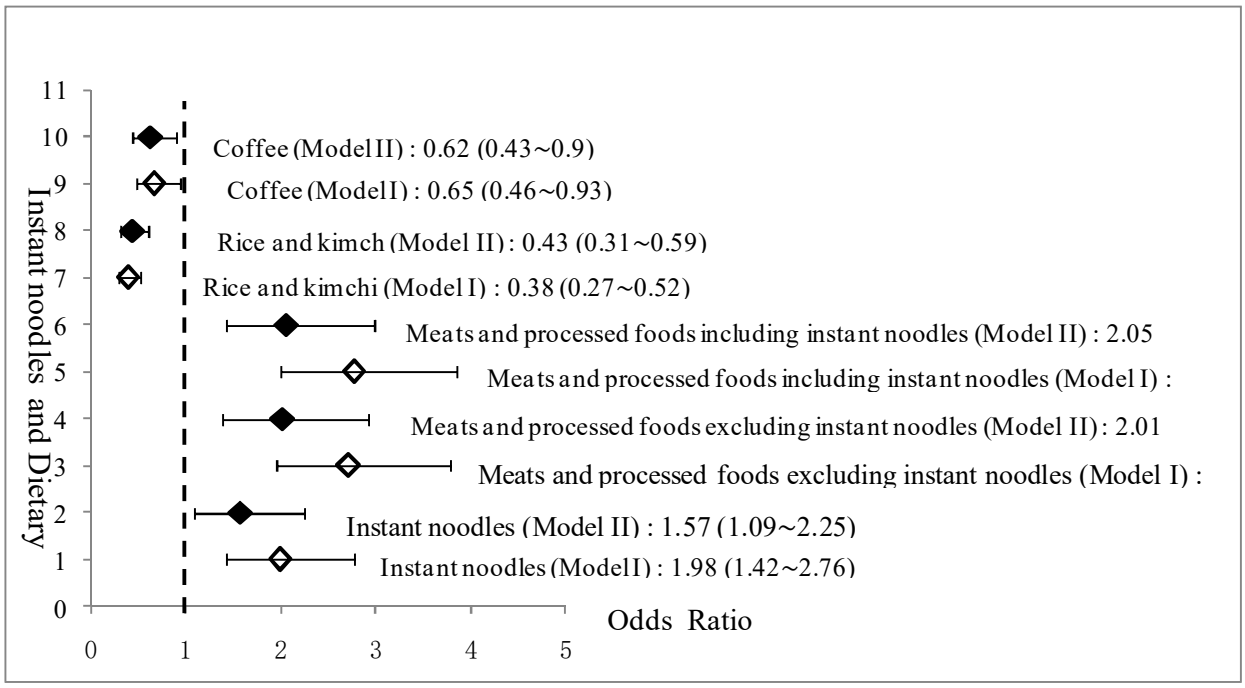

Figure 1. Odds ratios and 95% confidence intervals of atopic dermatitis with respect to various dietary patterns. The odds ratio is presented along the x-axis represented as a diamond, with 95% confidence intervals represented on each side. The various dietary patterns are indicated along the y-axis. Data from two models are presented. Model I was calculated using the logistic regression model and represents a crude odds ratio without adjustment. Model II was calculated using the logistic regression model with adjustment for gender, education level, BMI, energy intake, residence area, smoking status, drinking, and exercise.

dermatitis and Kcals, protein, vegetable nutrients (vitamin A, vitamin E, mono-unsaturated fatty acid, poly-unsaturated fatty acid) cereals, total fiber, and all seafood.[23-25] It is of interest that this association has also been found for asthma and allergic rhino-conjunctivitis, which together with atopic dermatitis constitute the atopic triad, and the antioxidants contained in cereals and vegetables have been speculated to be a reason for this protective effect, although the mechanisms need to be explored.[26]

A recent study showed that the most common foods thought to cause atopic dermatitis in adult patients in Korea were instant food, wheat, instant noodles, beef, pork, and chocolate.[27] In this study, those who eat instant noodles more than four times per month showed a greater tendency to develop atopic dermatitis, indicating the possible danger of food additives used in making processed foods. The nutrient composition of cooked instant noodles per 100 g contain 92 kcal energy, 16.3 g carbohydrates, 2.2 g protein, 2.9 g fat, 36 mg calcium, 48 mg potassium and 728 mg sodium.[28] However the seasoning powder for cooking the instant noodles include MSG as a flavor enhancer, which has been known for a risk factor of AD.[13] With respect to instant noodles, the frying oil used during the production could be the reason for development of atopic dermatitis, and the powdered artificial seasonings could have some harmful effects that lead to development of atopic dermatitis. Trans-fat produced during food manufacturing has been associated to an increased risk of coronary heart disease, and many processed foods made with partially hydrogenated oils (PHOs) contain trans-fat.[29] The interactions between frying fats and fried foods and the conditions of the processing of instant noodles could produce the heat-induced compounds like acrylamide and other toxicological materials related to atopic dermatitis, although the further research on their relationship is necessary.[30] The salt in artificial seasonings does not seem to affect the prevalence of atopic dermatitis since kimchi which contains a lot of salt did not have any adverse effects on atopic dermatitis in this study. The food additives used in processed foods have been considered to act as allergens that trigger the development of atopic dermatitis.[31] The food additives investigated in atopic dermatitis were coloring agents, preservatives, citric acid, and flavoring agents, and children with atopic skin symptoms had a statistically increased risk of a positive reaction to the additives.[32] The food additives that worsened AD in adult patients were food preservatives (sorbic acid, sodium benzoate, p-hydroxybenzoate, sodium metabisulphite and sodium nitrate), antioxidants (BHA, BHT, propylgallate), taste enhancer (monosodium glutamate) and salicylic acid.[9] For patients with atopic dermatitis, mast cell numbers and cytokines involved in the Th2 cell response, such as IL-4, IL-10, and IL-13, were elevated.[33]

Evidence of the association with high serum IgE level, which is considered a crucial pathogenic factor in allergic diseases such as atopic dermatitis, was confirmed in this study although the statistical significance was low in the case of instant noodles. However, this logic was suitable only for instant noodles, and not for the meat and processed foods dietary pattern or rice and kimchi pattern. In the meat and processed foods dietary pattern, subjects who ate the least meat and processed foods showed lowest prevalence of AD although they had the highest serum IgE level. Furthermore, the subjects who ate the maximum amount of rice and kimchi in this study showed lowest prevalence of AD although they had the highest

IgE level. This result suggests that some other factors may be required for IgE to directly contribute to AD. Interleukin-13 (IL-13) plays an important role in the induction of IgE, and polymorphisms in the IL-13 gene are implicated in the pathogenesis of AD.[34] Based on our study, it can be assumed that there may be some regulators in foods that control the expression of IgE and cytokines such as IL-13; however further study is needed. Low serum 25-OH-vitamin D level has been associated with AD in a prior study.[7]

Currently, the use of antibiotics in animal feed has increased to facilitate the mass production of meat, and public health concerns about residual antibiotics in meat are increasing. Wachs and colleagues found that the extensive use of fertilizers and pesticides, as well as the chemical feed formulations for raising animals, contributes to the high rates of chronic diseases and AD.[35,36] The results for our study, which showed that subjects who ate more meat and processed foods showed higher risk of AD are consistent with those findings. Further research into the cause of the association between consumption of meat and atopic dermatitis is needed.

The negative association between the rice and kimchi dietary pattern and atopic dermatitis in this study is of particular interest. The rice and kimchi dietary pattern, which showed the maximum beneficial effect on AD risk in this study, is the main staple food in Korea. Some of the salient nutrition facts of kimchi per 100 g are: 18 kcal, energy; 3.9 g, carbohydrates; 2.0 g, protein; 0.5 g, fat; 47 mg, calcium; 300 mg, potassium; and 1,146 mg, sodium.[28] As kimchi is made using vegetables, high consumers of kimchi are more likely to have plant-origin probiotics and antioxidants. Probiotics are potentially beneficial bacteria that are needed for establishing healthy gut microflora, and they promote antiallergic processes such as Th-1 type immunity and increase TGF-β which plays an essential role in suppression of Th-2-induced allergic response.[37] Kimchi contains many probiotics and a Korean adult consumes an average of 50-200 grams of kimchi every day.[38,39] Lactobacillus fermentum which is isolated from kimchi has been reported to be effective in preventing atopic dermatitis in children.[40,41] Also, the red pepper seed in kimchi showed superoxide anion radical scavenging, nitric oxide scavenging, and SOD activity.[42] Nitric oxide and reactive oxygen species have immunomodulating effects on inflammation and cause inflammatory skin diseases like atopic dermatitis.[43]

In the alcohol and coffee pattern, alcohol was not significantly associated with AD, whereas high frequency of coffee consumption lowered the prevalence of AD. Coffee has been known to exert anti-inflammatory effects by suppressing the expression of nitric oxide synthase;[44] however, it is still controversial whether it has a beneficial effect on food allergy.[45,46] Our study did not show what type of coffee, for example instant coffee or aqueous extracts of coffee beans, was consumed; hence, it was still difficult to conclude which component of coffee was beneficial in AD.

Since instant noodle is a type of snack rather than a main staple food in Korea, it is mostly consumed by the younger generation, and the generation gap in the instant noodle and processed food intake was wide and disproportionate, as shown in Table 4. In Korea, the popularity of processed foods has increased since the 1980s; therefore, there was not much chance for the elderly population to consume instant noodles and processed foods. In addition, as shown in Table 1 and Table 4, the age distribution for the prevalence of AD was skewed: the younger generation consumed more instant noodles and other processed foods and also had a higher prevalence of AD. This indicates that the development of AD was more dependent on the level of intake of processed foods, and the assessment of the influence of age on the prevalence of AD was not significant in this study. This discrepancy between age unadjusted and adjusted results, as shown in Table 3, are due to the differences in consumption between the different age groups. The purpose of this study was to investigate the health risk of processed foods in the development of AD, rather than to assess the effect of age difference on the prevalence of AD.

In conclusion, high consumption (over 4 times/month) of instant noodles and high consumption of meat and processed foods including or excluding instant noodles was associated with the prevalence of atopic dermatitis in this study. In contrast, high consumption of kimchi and rice, and coffee was negatively associated with the prevalence of AD. The consumption of alcohol did not affect the prevalence of AD significantly. The younger generation consumed more amounts of instant noodles and processed foods and showed higher prevalence of AD. The results of this study have implications for the nutrition education for the general population, in order to attempt to decrease risk factors for AD.

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The authors declare no conflicts of interest.

AUTHOR DISCLOSURES

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Original Article

Instant noodles, processed food intake, and dietary pattern are associated with atopic dermatitis in an adult population (KNHANES 2009-2011)

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方便面、加工食品的摄入量和膳食模式与成人的特应性皮炎相关（2009-2011 年韩国全国健康和营养调查）

背景与目的：特应性皮炎的发生率在工业化国家持续增加，可能是由于饮食和生活方式的改变。然而，加工食品与特应性皮炎的关系还没有在大人群中研究过。**方法与研究设计**：我们研究了 2009-2011 年韩国全国健康和营养调查中 17,497 名成年人饮食习惯与特应性皮炎的关系。**结果**：我们采用主成分法分析了含有 63 个条目的食物频率问卷，确定了 4 个膳食模式："传统膳食模式"：富含大米和泡菜；"加工食品模式"：更多的肉、方便面、饮料、加工食品；"健康膳食模式"：高谷物、蔬菜、水果和海藻；"饮用膳食模式"：主要饮用咖啡和酒精。校正掺入复杂样本设计的样本权重等潜在混杂因素，根据膳食模式计算校正的比值比（ORs）。"肉和加工食品"模式高摄入组比低摄入组特应性皮炎的 OR 值高 1.57 倍。进一步分析显示：特应性皮炎的增加与方便面关系最密切。相反，大米和泡菜高摄入组与低摄入组相比，OR 值较低，分别为 0.38 和 0.43。**结论**：方便面、肉类和加工食品的摄入与特应性皮炎的患病率增加有关，而大米、泡菜和咖啡的摄入与特应性皮炎的患病率降低有关。

关键词：特应性皮炎、加工食品、咖啡、方便面、肉类摄入