

Original Article



Allergen Sensitization and Its Association With Allergic Diseases in the Korean Population: Results From the 2019 Korea National Health and Nutrition Examination Survey

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ABSTRACT

Purpose: Allergen exposure is the most potent factor in allergen sensitization, which affects the exacerbation and severity of allergic diseases. Due to industrialization and climate change, the pattern of allergen sensitization has changed over time, and the incidence of allergic diseases has also increased. This study investigated the status of allergen sensitization in the Korean population and its effects on allergic diseases.

Methods: A total of 2,386 participants aged ≥ 10 years, who underwent 7 specific immunoglobulin E tests for aeroallergens (*Dermatophagoides farinae* [Der f], dog dander, cat epithelium, birch, oak, Japanese hop, and ragweed), were selected among the participants of the 2019 Korean National Health and Nutrition Examination Survey. We compared the demographic characteristics, combined allergic diseases, and sinusitis symptoms between the atopic and non-atopic groups.

Results: The prevalence of allergen sensitization in the general Korean population was 45%, and Der f was the most frequent cause of sensitization (39.9%). The prevalence of sensitization to indoor allergens was highest among teenagers and those belonging to the 20- to 29-year age group ($P < 0.001$). In contrast, there was a high prevalence of sensitization to outdoor allergens among individuals belonging to the age group of 60–69 years. The prevalence of atopic dermatitis (odds ratio [OR], 2.559; 95% confidence interval [CI], 1.689–3.878), allergic rhinitis (OR, 3.075; 95% CI, 2.426–3.897), and otitis media (OR, 1.481; 95% CI, 1.092–2.007) significantly increased by allergen sensitization. Patients with allergen sensitization were more likely to experience the symptoms of rhinitis and sinusitis.

Conclusions: The study findings confirmed that allergen sensitization occurs in approximately half of the general Korean population and affects the prevalence and symptoms of allergic diseases. This suggests that active allergy tests and diagnosis of allergic diseases are necessary in Koreans.

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Disclosure

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Keywords: Hypersensitivity; allergens; allergic rhinitis; Korea; population; health care surveys

INTRODUCTION

Allergic disorders, including allergic rhinitis, asthma, atopic dermatitis, and food and drug allergies, are prominent chronic inflammatory conditions that manifest in all age groups. The global incidence of allergic diseases has steadily increased, and these diseases exert a profound impact on patients' quality of life. The World Health Organization reported that approximately 300 million individuals worldwide are affected by asthma and estimated 450,000 asthma-related deaths occurred in 2019.¹ The 2016 Allergic Rhinitis and its Impact on Asthma guidelines revealed a prevalence range of 1%–40% for allergic rhinitis in the adult population, indicating a consistent upward trend.² In South Korea, the prevalence of asthma among adults aged 19–59 years was reported to be 2.3% in 2017, which was a marginal increase from 2.2% reported in 2008. Correspondingly, allergic rhinitis exhibited an increasing trajectory from 13.5% to 17.1% during the same timeframe, while atopic dermatitis displayed a modest escalation from 3.3% to 3.9%.³ Various factors have contributed to the increase in the incidence of these allergic disorders, with alterations in allergen exposure patterns induced by climatic fluctuations being the pivotal determinant.⁴

Allergen exposure is the most influential factor in allergen sensitization, and sensitization to allergens affects the development, exacerbation, and severity of allergic diseases. In 2018, the Canadian Healthy Infant Longitudinal Development (CHILD) Study published findings on the patterns of allergen sensitization in children and their associations with disease prevalence and progression.⁵ Similar studies investigating allergen sensitization in children have also been conducted in Korea. Some studies measured the total immunoglobulin E (IgE) levels in children to predict atopy and allergic diseases,⁶ while others analyzed trends in allergen sensitization over the past decade.⁷ Moreover, several cross-sectional studies have focused on the prevalence of allergic rhinitis, asthma, and atopic dermatitis among children.⁸

However, most of these studies primarily targeted patients who sought medical care for allergic symptoms. Therefore, limited research has been conducted on the general population regarding the prevalence of allergen sensitization and its relationship with allergic diseases. Consequently, there is a lack of systematic research on the patterns of major allergen sensitization and their impact on allergic diseases in Korea. In 2019, the Korean National Health and Nutrition Examination Survey (KNHANES) measured the specific IgE levels for 7 major aeroallergens in the general population. This study aimed to investigate the status of allergen sensitization and its influence on allergic diseases, including allergic rhinitis, sinusitis, asthma, and atopic dermatitis, in the Korean population based on data from the 2019 KNHANES.

MATERIALS AND METHODS

Study population

The KNHANES is a nationwide health and nutrition survey conducted in accordance with Article 16 of the National Health Promotion Act, which was enacted in 1995. The 2019 KNHANES was conducted with the approval of the Institutional Review Board of the Korea

Centers for Disease Control and Prevention (approval number 2018-01-03-C-A), and informed consent was obtained from all participants before the commencement of the survey.

This study analyzed a total of 2,386 participants, aged ≥ 10 years who underwent specific IgE antibody testing for allergens among the 8,110 Korean individuals who participated in the 2019 KNHANES. Information regarding the participants' age, sex, income quartile, living arrangements, residential area, and level of education was collected. Data regarding physician-diagnosed allergic diseases (asthma, allergic rhinitis, atopic dermatitis, sinusitis, and otitis media) were also collected.

Questionnaire

An additional questionnaire regarding the symptoms of allergic rhinitis and sinusitis was administered to a randomly selected subset of 570 participants. The diagnostic accuracy of allergic rhinitis was determined through objective tests such as blood investigations for allergen-specific antibodies and skin prick test. The questionnaire included the following items:

1. Allergic rhinitis: Presence of symptoms of allergic rhinitis, such as sneezing, runny nose, nasal congestion, and itching, unrelated to cold symptoms (fever, sore throat) within the past 12 months. Information regarding the seasonality, duration, and impact on daily life was collected for symptomatic individuals.
2. Sinusitis: Presence of symptoms such as nasal discharge or postnasal drip, nasal congestion, facial pain or pressure, and an accompanying loss of smell.

Specific IgE analysis

Specific IgE levels for 7 representative allergens were measured by immunofluorescence analysis using an ImmunoCAP 100 system (Phadia Laboratory System; Thermo Scientific, Waltham, MA, USA). The allergens included *Dermatophagoides farina* (*Der f*), dog dander, cat epithelium, birch, oak, Japanese hop, and ragweed. A result of ≥ 0.35 kU/L on the ImmunoCAP test was considered positive for each allergen. If positive findings were observed for 1 or more allergens, the participant was classified into the atopic group. If no positive findings were observed for any allergen, the participant was classified into the non-atopic group. Allergens were categorized as perennial (year-round) or seasonal. *Der f*, dog dander, and cat epithelium were classified as perennial allergens, while birch, oak, Japanese hop, and ragweed were classified as seasonal allergens.

Statistical analysis

Statistical analyses were performed using SPSS version 16.0 (SPSS Inc, Chicago, IL, USA). Continuous variables were presented as means and standard deviations, while categorical variables were presented as counts and percentages. The χ^2 tests were conducted to examine the prevalence of allergens across different age groups. The χ^2 and Student's *t*-tests were performed for comparisons between the atopic and non-atopic groups. Binary logistic and linear regression analyses were conducted for each variable, after adjusting for age and sex, and the associated *P* values were obtained. To assess the impact of allergic sensitization on allergic diseases, binary logistic regression was performed after adjusting for age and sex, and the odds ratios (ORs) and 95% confidence intervals (CIs) were determined. Statistical significance was set at $P < 0.05$.

RESULTS

Allergen sensitization in Koreans

Among the 2,386 individuals who underwent specific IgE tests for allergens, a total of 1,077 individuals (45.1%) were sensitized to at least 1 allergen. Regarding specific allergens, the highest prevalence was observed for *Der f*, with 951 individuals (39.9%) exhibiting sensitization. This was followed by oak (11.2%), birch (10.2%), ragweed (8.7%), cat epithelium (8.5%), Japanese hop (7.0%), and dog dander (7.0%) (**Fig. 1B**).

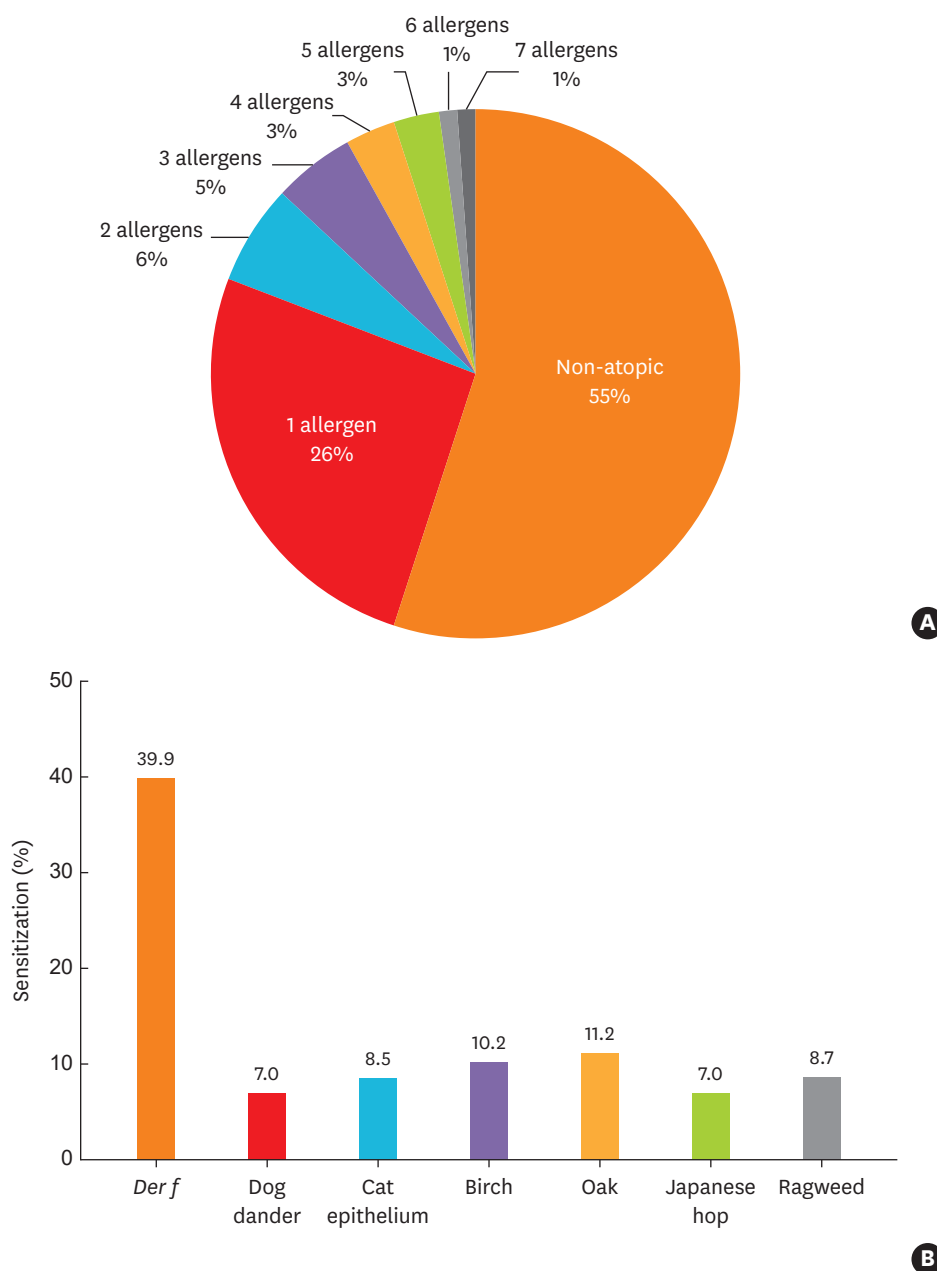


Fig. 1. Prevalence of allergen sensitization. (A) Distribution of study participants in terms of number of sensitized aeroallergens. (B) Specific allergen sensitization rate.

The distribution of sensitization based on the number of allergens was as follows: 632 individuals (26.5%) were sensitized to 1 allergen, 142 (6.0%) to 2 allergens, 119 (5.0%) to 3 allergens, 59 (2.5%) to 4 allergens, 73 (3.1%) to 5 allergens, 33 (1.4%) to 6 allergens, and 19 (0.8%) to 7 allergens (**Fig. 1A**).

Age-specific patterns for allergen sensitization in Koreans

Age-specific rates for allergen sensitization showed significant differences ($P < 0.001$), with a decreasing trend in sensitization rates with an increase in age (P value for trend < 0.001 ; **Fig. 2A**) as follows: 10–19 years (56.4%), 20–29 years (57.1%), 30–39 years (48.1%), 40–49 years (41.8%), 50–59 years (36.9%), 60–69 years (35.6%), and ≥ 70 years (27.3%). Regarding the rates of sensitization to individual allergens according to age, perennial allergens such as *Der f*, dog dander, and cat epithelium showed higher sensitization rates for the 10- to 19- and 20- to 29-year age groups, and a decreasing trend with an increase in age (**Fig. 2B**). Particularly for *Der f*, there was a significant difference in sensitization rates between the 10- to 19-year age group (51.7%) and ≥ 70 -year group (22.7%), showing a significant decrease with increasing age ($P < 0.001$, P value for trend < 0.001). Similar results were observed regarding dog dander and cat epithelium ($P < 0.001$, P value for trend < 0.001). However, for seasonal allergens such as oak, birch, ragweed, and Japanese hop, the highest sensitization rate was observed for the 60- to 69-year age group (**Fig. 2C**). Particularly for oak and ragweed, statistically significant differences in sensitization rates were observed across different age groups ($P = 0.022$ and $P = 0.024$, respectively).

Clinical characteristics according to allergen sensitization

A total of 2,386 participants were classified into non-atopic ($n = 1,309$) and atopic ($n = 1,077$) groups based on their allergen sensitization status. Age, sex, income, residential type, level of education, comorbidities, white blood cell count, hemoglobin level, alanine aminotransferase level, and pulmonary function test results were analyzed and compared between the 2 groups (**Table 1**).

The average age of the non-atopic and atopic groups was 44.08 ± 19.07 and 36.79 ± 17.82 years, respectively, which showed a statistically significant difference ($P < 0.001$). The proportion of men in the non-atopic and atopic groups was 44.2% and 56.7%, respectively ($P < 0.001$). There were no significant differences in body mass index, income level categorized by quartiles, residential type, and residential area between the 2 groups. However, the atopic group had a higher proportion of individuals with higher education than the non-atopic group ($P = 0.049$). This difference remained statistically significant even after adjusting for age and sex ($P = 0.032$). After adjusting for age and sex, no significant differences were observed in the blood and pulmonary function test results between the 2 groups ($P > 0.05$).

Correlation between allergen sensitization and allergic diseases

The prevalence of allergic diseases according to allergen sensitization status was compared between the atopic and non-atopic groups (**Table 2**). For the atopic group, the prevalence of allergic rhinitis was 26.6% compared to 10.1% for the non-atopic group (OR, 3.075; 95% CI, 2.426–3.897; $P < 0.001$). The prevalence of otitis media was 11.5% for the atopic group in comparison to 6.5% for the non-atopic group (OR, 1.481; 95% CI, 1.092–2.007; $P = 0.011$). Atopic dermatitis was prevalent in 8.4% of the atopic group in comparison to 2.7% of the non-atopic group (OR, 2.559; 95% CI, 1.689–3.878; $P < 0.001$). However, there was no significant correlation between the allergen sensitization status and prevalence of sinusitis and asthma.

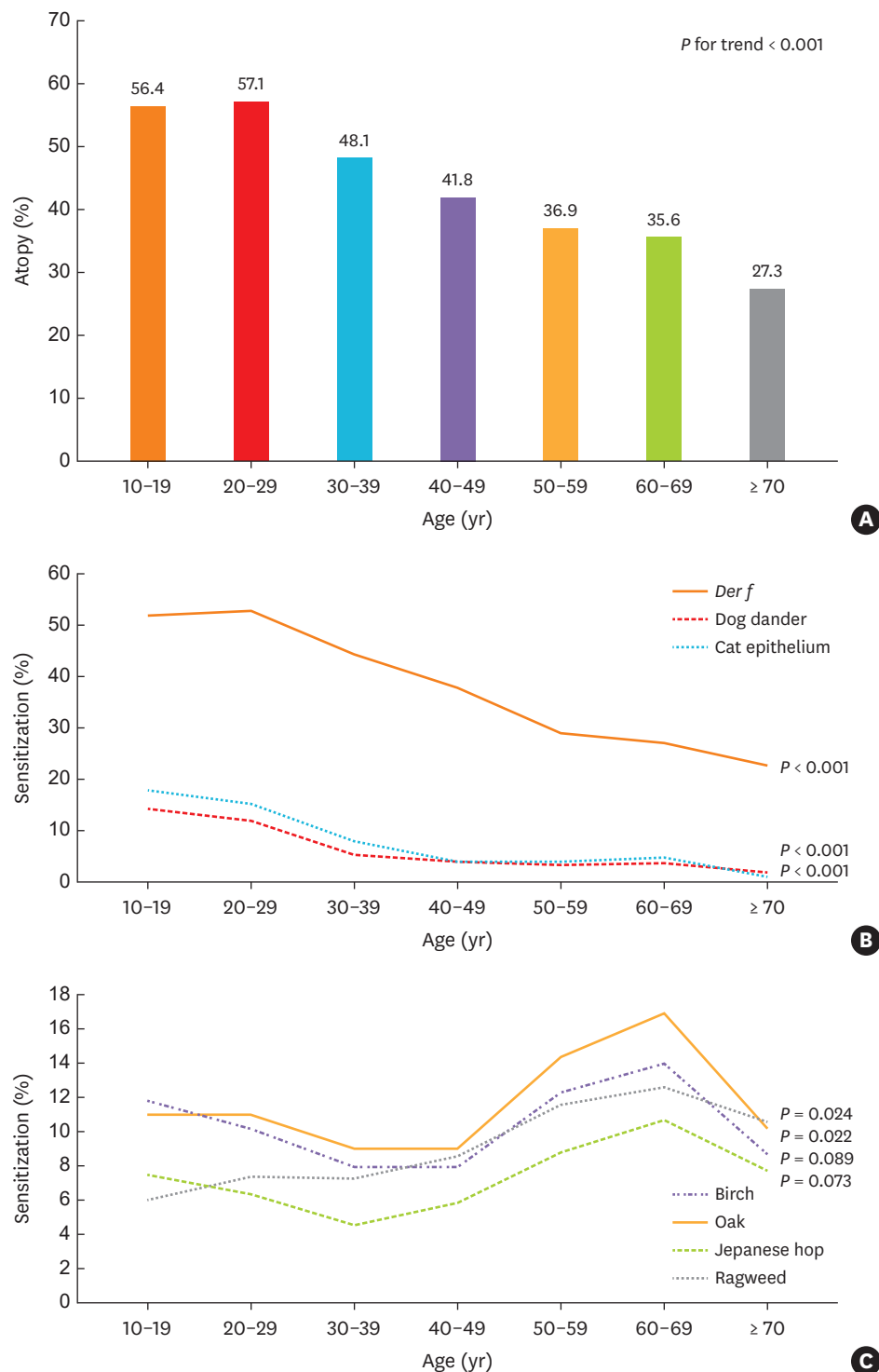


Fig. 2. Specific sensitization rate of aeroallergens by age groups. (A) Prevalence of allergen sensitization by age group. (B) Indoor/Perennial allergen sensitization rate. (C) Outdoor/Seasonal allergen sensitization rate.

Correlation between allergen sensitization and symptoms of rhinitis

A questionnaire was administered to the participants to assess the presence of rhinitis symptoms in the past 12 months. A total of 570 individuals were randomly selected to answer the questionnaire: 358 from the non-atopic group and 212 from the atopic group. Among

Table 1. Clinical characteristics of the study participants according to the presence of allergen sensitization

Characteristics	Total	Non-atopic group	Atopic group	P value	P value*
No. of participants	2,386 (100.0)	1,309 (54.9)	1,077 (45.1)		
Age (yr)	40.79 ± 18.87	44.08 ± 19.07	36.79 ± 17.82	< 0.001	
Male sex	1,189 (49.8)	578 (44.2)	611 (56.7)	< 0.001	
Body mass index	23.53 ± 4.03	23.50 ± 3.95	23.58 ± 4.13	0.613	0.157
Household income				0.791	0.368
Lowest quartile	342 (14.3)	193 (14.8)	149 (13.9)		
Lower-middle quartile	633 (26.5)	352 (27.0)	281 (26.2)		
Upper-middle quartile	648 (27.2)	356 (27.3)	292 (27.2)		
Highest quartile	755 (31.6)	404 (31.0)	351 (32.7)		
Type of residence				0.281	0.082
House	1,047 (43.9)	561 (42.9)	486 (45.1)		
Apartment	1,339 (56.1)	748 (57.1)	591 (54.9)		
Residence district				0.323	0.589
Urban	1,984 (83.4)	1,079 (82.4)	905 (84.0)		
Suburban/rural	402 (16.8)	230 (17.6)	172 (16.0)		
Level of education				0.049	0.032
≤ Elementary school	433 (18.1)	261 (20.7)	172 (16.7)		
≤ Middle school	264 (11.1)	147 (11.7)	117 (11.4)		
≤ High school	727 (30.5)	377 (30.0)	350 (34.0)		
≥ College	864 (36.2)	473 (37.6)	350 (38.0)		
WBC (/uL)	6,369.30 ± 1,745.13	6,246.86 ± 1,698.35	6,518.12 ± 1,810.12	< 0.001	0.054
Hemoglobin (/uL)	14.18 ± 1.60	14.00 ± 1.58	14.40 ± 1.61	< 0.001	0.063
Creatinine (mg/dL)	0.80 ± 0.20	0.79 ± 0.21	0.80 ± 0.20	0.185	0.982
ALT (IU/L)	22.91 ± 20.12	22.51 ± 19.84	23.40 ± 20.46	0.281	0.786
FEV1 (%)	87.56 ± 12.78	87.76 ± 13.29	87.21 ± 11.89	0.489	0.919
FVC (%)	88.10 ± 12.34	87.96 ± 12.53	88.33 ± 12.02	0.635	0.741
FEV1/FVC %	77.60 ± 6.62	77.66 ± 6.66	77.42 ± 6.57	0.571	0.473

Values are presented as mean ± standard deviation or number (%).

WBC, white blood cell count; ALT, alanine aminotransferase; FEV1, forced expiratory volume in 1 second; FVC, forced vital capacity.

*Adjusted for age and sex.

Table 2. Comorbidities of the study participants according to presence of allergen sensitization

Variables	Non-atopic group	Atopic group	OR	95% CI	P value*
No. of participants	1,309 (54.9%)	1,077 (45.1%)			
Allergic rhinitis	127 (10.1%)	274 (26.6%)	3.075	2.426–3.897	< 0.001
Maxillary sinusitis	87 (6.9%)	89 (8.6%)	1.226	0.894–1.682	0.207
Otitis media	2 (6.5%)	119 (11.5%)	1.481	1.092–2.007	0.011
Atopic dermatitis	34 (2.7%)	87 (8.4%)	2.559	1.689–3.878	< 0.001
Asthma	25 (2.0%)	32 (3.1%)	1.523	0.884–2.624	0.130

OR, odds ratio; CI, confidence interval.

*Binary logistic regression adjusted for age and sex.

them, 213 participants (37.3%) reported experiencing symptoms of rhinitis in the past 12 months. There was a statistically significant difference between the non-atopic and atopic groups, with 31.8% (114/358) of the non-atopic group and 46.7% (99/212) of the atopic group reporting symptoms of rhinitis ($P < 0.001$). The diagnostic rate of allergic rhinitis based on objective tests was also significantly higher for the atopic group at 10.3% (22/212), in comparison to 4.5% (16/358) for the non-atopic group ($P = 0.009$).

An additional questionnaire was administered to 213 individuals who reported experiencing symptoms of rhinitis within the past 12 months. The questionnaire included questions regarding perennial/seasonal symptoms, symptoms lasting for more than 4 days per week, symptoms lasting for more than 4 consecutive weeks, and the impact of rhinitis symptoms on daily life. Compared to the non-atopic group, the atopic group suffered more impairments in daily life due to the symptoms of rhinitis (25.4% vs. 39.4%, $P = 0.039$). No significant differences were observed between the 2 groups in any other items of the questionnaire (**Table 3**).

Table 3. Findings of the questionnaire on symptoms of rhinitis according to presence of allergen sensitization that was administered to participants who experienced rhinitis symptoms in the past 12 months (n = 213)

Variables	Non-atopic group (n = 114)	Atopic group (n = 99)	P value
Duration of rhinitis symptoms			0.073
All year round	57 (50%)	62 (62.6%)	
Seasonally	57 (50%)	37 (37.4%)	
≥ 4 days/week	47 (41.2%)	52 (52.5%)	0.130
≥ 4 weeks/episode	35 (30.7%)	26 (26.3%)	0.544
Disruption of daily life due to rhinitis symptoms	29 (25.4%)	39 (39.4%)	0.039

Among the 213 individuals who experienced symptoms of rhinitis in the past 12 months, the severity of their symptoms was analyzed based on the presence of allergen sensitization. There was no difference in the severity of symptoms related to perennial allergens (*Derf*, dog dander, and cat epithelium). However, for seasonal allergens (birch, oak, Japanese hop, and ragweed), the proportion of individuals experiencing impairment in daily life due to symptoms of rhinitis was higher among those who were sensitized to the allergens compared to those who were not; birch, 50.0% vs. 28.7% ($P = 0.017$); oak, 47.1% vs. 29.1% ($P = 0.039$); Japanese hop, 60.0% vs. 29.0% ($P = 0.005$); and ragweed, 55.6% vs. 28.5% ($P = 0.005$) (**Fig. 3A**). Among individuals sensitized to Japanese hop and ragweed, the proportion of individuals experiencing symptoms for more than 4 days per week was approximately 1.5 times higher compared to those who were not sensitized to these allergens: Japanese hop, 70.0% vs. 44.0% ($P = 0.034$), and ragweed 66.7% vs. 43.5% ($P = 0.020$) (**Fig. 3B**).

Correlation between allergen sensitization and symptoms of sinusitis

A questionnaire was administered to 571 individuals enquiring about symptoms of sinusitis lasting for more than 3 months. The questionnaire included questions on nasal discharge or postnasal drip, nasal congestion, facial pain or pressure, and olfactory dysfunction. There was no significant correlation between allergen sensitization status and symptoms of nasal discharge or postnasal drip and facial pain or pressure. However, nasal congestion was significantly more common in the atopic group than in the non-atopic group (8.0% vs. 3.4%, $P = 0.018$). Moreover, olfactory dysfunction was approximately 3 times more common in the atopic group than in the non-atopic group (6.6% vs. 2.2%, $P = 0.013$) (**Table 4**). However, no statistically significant differences were observed in the symptoms based on the type of allergen sensitization.

DISCUSSION

The KNHANES is conducted annually to produce statistically representative and reliable data on health status, health behaviors, and food and nutrient intake of the Korean population at national and regional levels. This study analyzed the status of allergen sensitization for the general Korean population, and its association with allergic diseases, based on the 2019 KNHANES data. In a previous KNHANES conducted in 2010, specific IgE measurements were obtained for house dust mites (HDM), cockroaches, and dog allergens.⁹ The current study is significant due to the fact that it analyzed the types of allergen sensitization by measuring IgE levels for both indoor and outdoor allergens. Although stemming from different items and thus not directly comparable, compared with 2010 KNHANES data, the sensitization rates to HDM or dog allergens showed no notable differences: *Derf* (40.09% vs. 39.86%, $P = 0.882$), dog (6.15% vs. 6.96%, $P = 0.265$).

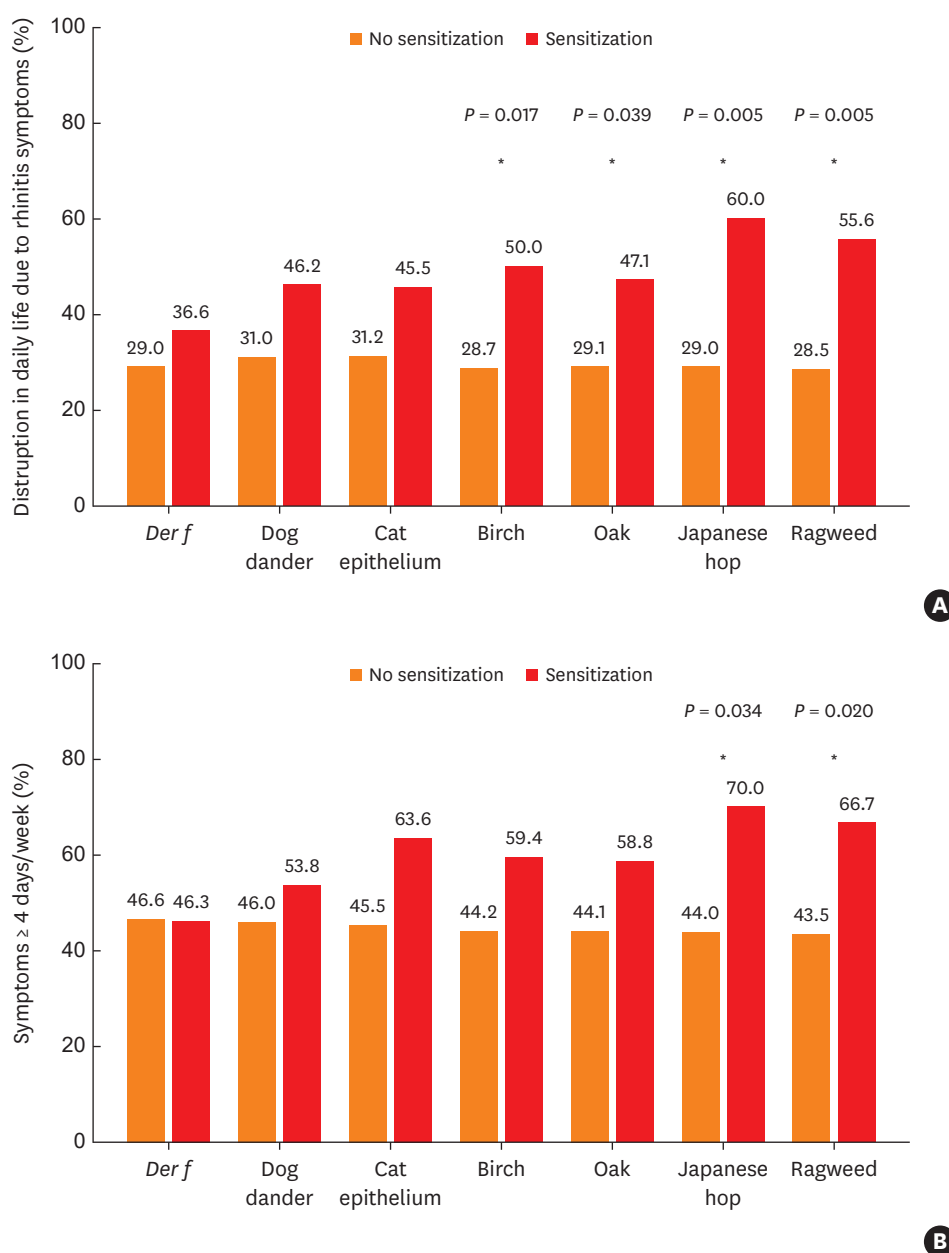


Fig. 3. Severity of symptoms in accordance with allergen sensitization in patients with symptoms of rhinitis in the past 12 months. (A) Proportion of disruption in daily life due to symptoms of rhinitis. (B) Proportion of symptoms lasting more than 4 days per week.

Table 4. Findings of the questionnaire on sinusitis symptoms according to the presence of allergen sensitization (n = 571)

Variables	Non-atopic group (n = 358)	Atopic group (n = 213)	P value
Anterior/posterior nasal drip for ≥ 3 mon	21 (5.9%)	14 (6.6%)	0.722
Stuffy nose for ≥ 3 mon	12 (3.4%)	17 (8.0%)	0.018
Facial pain or fullness for ≥ 3 mon	2 (0.6%)	4 (1.9%)	0.203
Anosmia or hyposmia for ≥ 3 mon	8 (2.2%)	14 (6.6%)	0.013

Outdoor allergens classified as seasonal allergens include pollen allergens from trees and weeds. Pollen is a major cause of seasonal allergen sensitization, and it is necessary to continuously track the sensitization rate of pollen allergens as well as ecological changes in plants to manage and treat allergic diseases.¹⁰ In Korea, the 4 distinct seasons result in diverse types of plant growth, with tree pollen being more prevalent in spring and weed pollen in autumn.^{11,12} However, continuous changes in the global environment due to global warming and climate crises have led to ecological changes in plants. Therefore, the Korea Meteorological Administration has developed and distributed pollen calendars for 8 cities in Korea. A previous single-hospital study in Korea that examined the changes in types of allergen sensitization using skin prick tests reported that the sensitization rates for seasonal allergens in 2010-2011 were as follows: birch (14.36%), oak (13.57%), ragweed (15.18%), and Japanese hop (11.01%).¹³ Contrarily, in the current study, lower sensitization rates were observed for birch (11.2%), oak (10.2%), ragweed (8.7%), and Japanese hop (7.0%). The previous study targeted symptomatic individuals who visited the hospital, however, the current study used data from the KHNES, which included asymptomatic individuals from the general population. It can be contemplated that the differences between the populations of the 2 studies resulted in differences in sensitization rates.

Several studies have revealed differences in the patterns of allergen sensitization based on the age, country, and region.^{14,17} The diversity of sensitization to major allergens has been associated with several intrinsic factors, including genetic susceptibility and environmental factors such as increased antigen exposure or changes in absolute antigen distribution. Aging is associated with alterations in the immune system, which are defined as immunosenescence. In other words, immune function declines with age, leading to decreased allergic sensitization.¹⁸ In the current study, it was observed that the sensitization rate was highest among teens and individuals belonging to the 20- to 29-year age group, and thereafter, gradually decreased for older groups. Indoor allergens predominantly sensitized children and adolescents, whereas outdoor allergens showed higher sensitization rates among the older individuals. Although the exact causes of age-related differences in the types of sensitized allergens have not been fully elucidated, it is speculated that reduced outdoor activities during childhood and adolescence may be a contributing factor. For outdoor allergens, because of repeated exposure seasonally, sensitization may be increased through a repetitive immune response process despite aging. According to several Korean studies, apart from age of patients, regional differences in the timing of plant flowering also lead to variations in the patterns of seasonal allergen sensitization,^{15,19} and the sensitization patterns for perennial allergens change with the life environment.

Allergen sensitization is an important risk factor for allergic diseases. Patients with allergic diseases exhibit increased IgE levels in response to 1 or more specific allergens.²⁰ In this study, the group sensitized to 1 or more allergens had a higher prevalence of allergic rhinitis, otitis media, and atopic dermatitis. Inhaled allergens, in particular, have been associated with the prediction of respiratory allergic diseases and severity of symptoms.²¹ Atopic dermatitis in adolescents and adults is influenced by allergens such as HDM, dog dander and cat epithelium, and pollen.²² In this study, the prevalence of allergic rhinitis and atopic dermatitis increased more than 3 and 2.5 times, respectively, in cases with allergen sensitization. However, no association was found between allergen sensitization and prevalence of asthma, which is in concordance with a European study conducted on the general population.²³ More than 30% of pediatric patients diagnosed with asthma also have type 2 inflammation, and their condition improves before reaching the age of 1 year. However, the target participants of the KHNES were aged ≥ 10 years, which may have resulted in limitations in causality evaluation.

Allergic rhinitis is an IgE-mediated inflammatory reaction in the mucous membranes following exposure to inhaled allergens, and it is important to perform tests to confirm allergen sensitization for diagnosis.²⁴ Several studies have reported associations between allergen sensitization and severity of allergic rhinitis, exacerbating factors, and prognosis.^{23,25,26} In the current study, patients in the atopic group had a significantly higher incidence of allergic rhinitis symptoms. Some studies have reported that the relationship between severity of sinusitis and allergen sensitization is not clear.^{27,28} However, in the current study, the incidence of chronic sinusitis symptoms, such as nasal congestion and olfactory dysfunction, was more than 3 times higher for the atopic group. This suggests that allergen sensitization can be a risk factor for reduced quality of life. Therefore, it is important to continuously monitor the changes in the types of allergen sensitization and identify the major causative allergens that affect allergic diseases. In addition, for patients exhibiting symptoms of allergic rhinitis and sinusitis, it would be helpful to identify the causative allergens using skin and IgE tests, to avoid allergens. The active application of allergen immunotherapy may aid in treatment.

This study had a few limitations. First, the KNHANES dataset is a cross-sectional dataset, which restricts the evaluation of causality between allergic diseases and allergen sensitization. Secondly, the assessment of a limited number of inhalant allergens restricts the representation of the overall atopic status. Thirdly, relying on self-report surveys for symptoms and diagnostic information could lead to recall bias. The questionnaire was administered to individuals with symptoms of rhinitis and sinusitis. Despite its limitations, this study is one of the few to have investigated allergen sensitization for both indoor and outdoor allergens for the general Korean population, which could contribute to the prevention and management of allergic diseases.

In conclusion, the study findings confirm that allergen sensitization affects approximately half of the general population in South Korea, and is associated with the prevalence and severity of allergic diseases. Therefore, actively identifying the underlying allergens during the diagnosis and treatment of allergic diseases would improve disease prognosis and enhance the patients' quality of life.

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