Prevalence and Risk Factors of Chronic Rhinosinusitis, Allergic Rhinitis, and Nasal Septal Deviation
Results of the Korean National Health and Nutrition Survey 2008-2012

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IMPORTANCE Chronic rhinosinusitis (CRS), allergic rhinitis (AR), and nasal septal deviation (NSD) are frequent rhinologic diseases that consume considerable health care resources.

OBJECTIVE To determine the prevalence and risk factors of CRS, AR, and NSD in Korea.

DESIGN, SETTING, AND PARTICIPANTS This study analyzed 5-year cross-sectional data from the Korean National Health and Nutrition Examination Survey (KNHANES) 2008-2012. A total of 35,511 participants, who underwent an interview regarding nasal symptoms and a nasal examination, were enrolled and subsequently divided into 3 groups: children (aged 7-12 years), adolescents (aged 13-19 years), and adults (aged ≥20 years).

MAIN OUTCOMES AND MEASURES Adult CRS was classified into CRS with nasal polyps (CRSwNP) and CRS without nasal polyps (CRSsNP). Diagnosis of AR was based on symptoms and serum levels of specific IgE for 3 allergens, including Dermatophagoides farinae. The precise prevalence of AR was reestimated by multiplying the reciprocal of D. farinae frequency based on a conventional skin prick test. Nasal septal deviation was diagnosed via nasal endoscopy after nasal decongestion. This study estimated the association of the 3 diseases with demographic data, including sex, age, obesity, level of education, socioeconomic status, residence, smoking, and alcohol.

RESULTS The prevalence of CRSwNP and CRSsNP in 28,912 adults was 2.6% and 5.8%, respectively. An association was found between CRSwNP and age (odds ratio [OR], 1.03; 95% CI, 1.02-1.04; P < .001), lower level of education (OR, 1.40; 95% CI, 1.02-1.92; P = .04), and obesity (OR, 1.46; 95% CI, 1.16-1.84; P = .001). Symptom-based and allergy test result–based AR had a prevalence of 27.5% (n = 35,511) and 16.1% (n = 22,998), respectively. The reestimated prevalence of AR was 18.5% for all ages. Urban residence increased the risk of AR (OR, 1.21; 95% CI, 1.06-1.38; P = .005), but age was associated with a decreased risk (OR, 0.99; 95% CI, 0.98-0.99; P < .001). The prevalence of NSD was 48.0% and increased with age. In addition, NSD was a risk factor for CRSsNP (adjusted OR, 1.16; 95% CI, 1.02-1.32; P = .03) but not for CRSwNP.

CONCLUSIONS AND RELEVANCE In KNHANES 2008-2012, older age was associated with increased risk for CRSwNP and NSD but associated with a decreased risk for AR. Obesity was another risk factor for CRSwNP.

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he most frequently encountered diseases in the rhinology clinic are chronic rhinosinusitis (CRS), allergic rhinitis (AR), and nasal septal deviation (NSD).1,2 These diseases consume much of the health care resources in the rhinology clinic and cause a large financial burden.3,4 To provide medical resources to these patients, the accurate prevalence should be estimated with recent epidemiologic data. However, the precise prevalence has proved elusive to pinpoint in a nationwide survey without an accompanying otorhinolaryngologic examination because the diseases share similar nasal symptoms and multiple diseases sometimes co-exist. Nasal obstruction and discharge are the most common symptoms of almost all rhinologic diseases. Therefore, a survey without an otorhinolaryngologic examination would produce inaccurate predictions of prevalence. It was previously reported that symptom-based self-diagnosis without an otorhinolaryngologic examination frequently resulted in underdiagnosis.5

Chronic rhinosinusitis is a complex disease with various pathogenic and pathophysiologic features. Owing to diverse clinical characteristics, many diagnostic criteria have been published. The European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS) 2012 defined adult CRS based on corresponding symptoms and endoscopic or computed tomographic findings.3 To provide proper treatment and predict prognosis, EPOS 2012 emphasizes the classification of CRS into CRS with nasal polyps (CRSsNP) and without nasal polyps (CRSsSNP). Under this guideline, the prevalence of CRS in European countries was recently reported to be 6.9% to 27.1%.6

In the literature, the prevalence of AR varies from 2.9% to 54.1% according to race, age, and region.7 Even though a standard diagnosis of AR requires allergic nasal symptoms and corresponding allergic test results, many surveys have neglected the allergy test.8-10

The prevalence of NSD ranges from 34.0% to 89.2% depending on environment, race, age, and even classification method.11,12 Previous studies11,12 have examined participants without nasal decongestion. However, without decongestion, the entire septum could not be evaluated, consequently resulting in underdiagnosis. This study estimated the prevalence of CRS, AR, and NSD from the Korean National Health and Nutrition Examination Survey (KNHANES) 2008-2012 and investigated their correlation with demographic information.

Methods

Study Design and Population

This study analyzed the 5-year cross-sectional survey data of KNHANES 2008-2012 conducted by the Korean Society of Otorhinolaryngology-Head and Neck Surgery and the Korean Center for Disease Control and Prevention. KNHANES sampled the population using a complex sampling design (stratified clustering methods). After stratification of the geographic areas (16 provinces of South Korea), sex, 26 age groups, and 24 land and housing classes, the primary sampling units (ie, meaningful clusters of population elements) were formed, and 20 families were randomly sampled in each primary sampling unit. After participants provided written informed consent, the survey was conducted for every member in the sampled family. A total of 45,811 participants were included in KNHANES (Figure), which included an otorhinolaryngologic interview and nasal endoscopy performed by approximately 200 otorhinolaryngologists. For the nasal endoscopy, a 4-mm, 0°-angled rigid endoscope was used. Nasal endoscopy was performed before and after nasal application of the decongestant xylometazoline (Zycomb; Takeda Pharmaceutical Company). The details of KNHANES can be accessed online at https://knhanes.cdc.go.kr/knhanes.

This study enrolled 35,511 participants who were at least 7 years of age: 3,421 children (aged 7-12 years), 3,178 adolescents (aged 13-19 years), and 28,912 adults (aged ≥20 years) (Figure). The prevalence of CRS was estimated in the adults based on symptoms and/or nasal endoscopic findings according to adult criteria of the EPOS 2012 guideline.3 The prevalence of AR was evaluated in the 3 age groups based on symptoms and allergy test results. The prevalence of NSD was investigated in the adolescent and adult groups. Protocols of this study were approved by the institutional review board of Seoul National University Bundang Hospital.

Chronic Rhinosinusitis

The surveyed CRS symptoms included 4 nasal attributes: nasal discharge (anterior or posterior), nasal obstruction, facial pain, and sneezing. The prevalence of CRS was estimated by using symptom combinations (CRSsNP). Under this guideline, the prevalence of CRS in European countries was recently reported to be 6.9% to 27.1%.6

Figure. Study Enrollment
pain or pressure, and olfactory dysfunction lasting for 3 months. After nasal decongestion, nasal endoscopy was used to check for nasal polyps and purulent discharge. On the basis of the symptoms and endoscopic findings, a participant was diagnosed as having CRS if at least 2 of the 4 nasal symptoms (including nasal discharge or obstruction) and/or at least 1 of the 2 endoscopic findings were evident. A focus on nasal polyps during endoscopy classified CRS into CRSwNP and CRSSNP.

### Allergic Rhinitis

Allergic rhinitis was assessed on the basis of 2 different methods: symptom and allergy test results. The symptom-based diagnosis was defined using only AR symptoms (sneezing, rhinorrhea, nasal obstruction, and nasal itching) lasting for several days regardless of a common cold in the last 12 months. The allergy test result-based diagnosis was defined using both AR symptoms and an allergy test result positive for sensitization. KNHANES 2010 conducted the allergy test by measuring the serum level of specific IgE for 3 allergens: Dematophagoïdes farinae, cockroach, and dog dander. The specific IgE was measured using an immunoradiometric assay with ImmunoCAP 100 (Phadia Laboratory Systems) and a 1470 WIZARD gamma-Counter (PerkinElmer Inc) with a cutoff value of 0.35 kU/L. Among the enrollees, 2298 participants took the allergy test (Figure). Allergic rhinitis was divided into (1) seasonal or perennial AR according to symptom seasonality and (2) intermittent mild or intermittent moderate to severe, persistent mild, or persistent moderate to severe AR according to the Allergic Rhinitis and its Impact on Asthma (ARIA) guideline.

To improve the accuracy of AR prevalence, we used a previous study concerning the allergen frequency in a skin prick test. *Dematophagoïdes farinae* has the highest frequency in Korean allergy patients: 83.8% for those aged 7 to 12 years, 78.5% for those aged 13 to 19 years, 91.5% for those aged 20 to 29 years, 80.7% for those aged 30 to 39 years, 66.9% for those aged 40 to 49 years, 58.8% for those aged 50 to 59 years, 55.3% for those aged 60 to 69 years, and 58.8% for those older than 70 years. The precise prevalence of AR was reestimated using the *D. farinae* sensitized AR prevalence multiplied by the reciprocal of the *D. farinae* frequency for each age group.

### Nasal Septal Deviation

Nasal septal deviation was assessed via nasal endoscopy after decongestion and was defined as an asymmetric septal protrusion in the right and/or left nasal cavities. In addition, symptomatic NSD was defined as NSD with nasal obstructive symptoms for more than 3 months.

### Demographic Information

This study analyzed several items of demographic information, including sex, age, residence (urban or rural), level of education (middle school or below or high school or above), family income (lower or higher than the average income of the general population), occupation (white collar or blue collar job), history of smoking (<5 or ≥5 pack-years) and alcohol consumption (less than twice a week or twice a week or more), and comorbid asthma. This study used body mass index (BMI; calculated as weight in kilograms divided by height in meters squared) to evaluate obesity (BMI ≥25). Adult participants provided all demographic information, but children and adolescents provided only limited information, such as sex, age, residence, and family income. The history of alcohol consumption was surveyed for both adolescent and adult participants.

### Statistical Analysis

The prevalence of CRS, AR, and NSD was calculated based on complex sampling analysis using SPSS statistical software, version 18 (SPSS Inc) because KNHANES 2008-2012 adopted a stratified cluster sampling method to select participants. The difference in prevalence across demographic factors (eg, sex, age, residence, family income, level of education, occupation, BMI, history of smoking and alcohol consumption, and comorbid asthma) was analyzed using the complex sampling method of the univariable χ² test. To estimate the odds ratio (OR), the complex sampling method of binary logistic regression was used to conduct multivariable analyses for the factors with P < .20 in the univariable test. In this study, statistical significance was defined as a P < .05.

### Results

#### Chronic Rhinosinusitis

To evaluate adult CRS, this study included 28,912 adult participants (Figure). The prevalence of adult CRS was 8.4%: 2.6% for CRSwNP and 5.8% for CRSSNP (eTable 1 in the Supplement). A predominance of male sex and asthma was observed in CRSwNP and CRSSNP (eTable 1 in the Supplement). With increasing age, the prevalence of CRSwNP increased, with the highest prevalence of 4.1% in the seventh decade of life. On the other hand, the prevalence of CRSSNP decreased and then increased again, with the lowest prevalence of 5.2% in the fifth decade of life (eTable 1 in the Supplement). Chronic rhinosinusitis with nasal polyps was more prevalent in rural areas and with a lower level of education, obesity, increased amounts of smoking and alcohol consumption, and comorbid asthma (eTable 1 in the Supplement). Blue collar occupation elevated the prevalence of CRSwNP and CRSSNP (eTable 1 in the Supplement). Multivariable regression found that male sex and asthma were common risk factors for CRSwNP and CRSSNP (OR, 1.48; 95% CI, 1.08-2.01; and OR, 1.27; 95% CI, 1.05-1.53, respectively, for male sex and asthma). Aging, lower level of education, and obesity were risk factors only for CRSSNP (OR, 1.03; 95% CI, 1.02-1.04; OR, 1.40; 95% CI, 1.02-1.92; and OR, 1.46; 95% CI, 1.16-1.84, respectively) (Table 1).

#### Allergic Rhinitis

Symptom-based and allergy test result-based AR had a prevalence of 27.5% and 16.1%, respectively (eTable 2 in the Supplement). Male sex had a higher prevalence in the symptom-based AR than female sex (eTable 2 in the Supplement). On the basis of age groups, the prevalence of symptom-based AR was 30.2% in children, 32.9% in adolescents, and 26.6% in adults,
whereas allergy test result–based AR was 19.1%, 23.7%, and 14.9%, respectively. Urban residence and higher family income had a higher prevalence of symptom-based AR (eTable 2 in the Supplement). Multivariable analysis revealed that urban residence was the only risk factor for symptom-based AR (OR, 1.21; 95% CI, 1.08-1.34) (Table 2). Aging has a protective effect against both symptom-based and allergy test result–based AR (OR, 0.99; 95% CI, 0.98-0.99 and OR, 0.98; 95% CI, 0.97-0.99, respectively).

According to symptom seasonality, seasonal AR was approximately twice as prevalent in both symptom-based and allergy test result–based AR (eTable 3 in the Supplement). Using the ARIA classification, intermittent mild AR was the most prevalent in both symptom-based and allergy test result–based AR followed by intermittent moderate to severe AR (eTable 3 in the Supplement).

The *D. farinae* sensitized AR had a prevalence of 14.0% in participants who had undergone the allergy test. Results were 19.1% for those aged 7 through 12 years, 20.8% for those aged 13 through 19 years, 20.8% for those aged 20 through 29 years, 19.7% for those aged 30 through 39 years, 9.1% for those aged 40 through 49 years, 9.4% for those aged 50 through 59 years, 5.3% for those aged 60 through 69 years, and 5.9% for those older than 70 years. After multiplication of the reciprocal of the *D. farinae* frequency, the reestimated precise prevalence of AR was 18.5%.

**Nasal Septal Deviation**

For evaluation of NSD, this study included 3178 adolescent and 28,912 adult participants (Figure). The prevalence of NSD and symptomatic NSD was 48.0% and 3.8%, respectively (eTable 4 in the Supplement). The male prevalence was higher than the female prevalence at 57.1% and 38.9%, respectively, for NSD and 5.6% and 2.1%, respectively, for symptomatic NSD (eTable 4 in the Supplement). The highest prevalence of 51.6% for NSD was achieved in the sixth decade of life, but no pattern of prevalence was observed with aging (eTable 4 in the Supplement). However, symptomatic NSD decreased with aging (eTable 4 in the Supplement). Greater alcohol consumption was positively related with NSD and symptomatic NSD (eTable 4 in the Supplement). In the multivariate regression, male sex, aging, and greater alcohol consumption were risk factors for NSD (OR, 2.11; 95% CI, 1.90-2.14; OR, 1.00; 95% CI, 1.00-1.01; and OR, 1.16; 95% CI, 1.08-1.24, respectively), but male sex and aging were risk and protective factors, respectively, for symptomatic NSD (OR, 2.64; 95% CI, 2.23-3.14 and OR, 0.99; 95% CI, 0.98-0.99) (Table 3).

**NSD as a Risk Factor for CRS**

The prevalence of NSD combined with CRS was 4.3%, with 1.2% for CRSwNP and 3.1% for CRSsNP. After adjusting for risk factors of adult CRSsNP, NSD still increased the risk of CRSsNP (adjusted OR, 1.16; 95% CI, 1.02-1.32) (Table 4). However, after adjusting the risk factors of adult CRSwNP, NSD did not increase the risk of CRSwNP (Table 4).

**Discussion**

This study presents 2 types of important outcomes. First, the study used several distinctive methods to find the precise prevalence, including nasal endoscopy and an allergy test for the diagnosis, subtyping CRS into CRSwNP and CRSsNP, and reestimating AR prevalence with the allergen-specific frequency. Second, individual risk factors were found for CRSwNP and CRSsNP: aging, lower level of education, and obesity were risk factors for CRSwNP, whereas NSD was a risk factor for CRSsNP.

Approximately 200 otolaryngologists participating in KNHANES 2008-2012 produced reliable medical histories
and physical findings through interview and nasal endoscopy. Nasal endoscopy is a valuable tool by which CRS is classified into CRSwNP and CRSsNP having different pathophysiologic features, treatments, and responses to treatment.3 Our results revealed that the prevalence of CRSwNP in Korean adults was almost half that of CRSsNP. However, the absence of sinus imaging in KNHANES is a limitation of our results. A sinus image might help improve the accuracy of the diagnosis of CRS.

Approximately 10% of the difference in prevalence between symptom-based and allergy test result–based AR implies that the usual reported prevalence based on AR symptoms might be overestimated. However, the allergy test result–based diagnosis of AR in our study is limited by untested responsiveness to pollen and fungal allergens. To overcome this limitation and improve accuracy, this study reestimated the prevalence of AR by multiplying it with the reciprocal of the D. farinae frequency, which is the best choice to improve accuracy because it has the highest frequency (76.4%) among all indoor and outdoor allergens in Korea.13 The prevalence was slightly elevated to 18.5% on reestimation but was still much lower than the symptom-based prevalence of 27.6%. This reestimated prevalence still has a limited value because KNHANES measured specific IgE, yet the frequency was calculated using the skin prick test. Despite the small sample size and limited numbers of tested allergens, the reestimated prevalence may represent the actual prevalence of AR in the general population.

The development of CRS and nasal polyps is influenced by genetic and environmental factors.14-16 In the literature, several etiologic and risk factors of CRS and nasal polyps have been reported; male sex (especially in Asian populations), asthma, and aspirin sensitivity for CRS and male sex, aging, and asthma for nasal polyps.17-21 Among them, a predominance of male sex and asthma in patients with CRSwNP and CRSsNP was also verified in our results. Aging was also a certain risk factor only for CRSwNP. Our study found that a lower level of education and obesity were additional risk factors for CRSwNP.

A lower level of education might be related to low socioeconomic status, leading to a delay in seeking timely medical attention and subsequently leading to chronic inflammation.22,23 Delayed medical attention and proinflammatory condition could cause medically refractory CRSwNP. However, a lower level of education did not raise the risk of CRSsNP in our results; contemporary medical treatments, such as nasal irrigation with saline, topical corticosteroid, and antibiotics, might still provide a chance to cure overstayed CRS without nasal polyps hampering the nasal irrigation and topical medication.

An interesting finding is the association between CRSwNP and obesity. Eastern and western studies report obesity as a risk factor of CRS.24,25 However, a search of the MEDLINE database did not find any clinical studies reporting a direct correlation between obesity and nasal polyps in the general population. One British study26 on asthma reported that obesity had an inverse correlation with nasal polyps in patients with severe asthma. However, the inverse correlation could not be generalized from the patients with severe asthma to the general population. Our study emphasizes that obesity is a risk factor for CRSwNP rather than for CRSsNP. In addition, the risk is also independent of comorbid asthma. A proinflammatory condition secondary to excessive adipose tissue in an obese person27 might provoke the development of CRSwNP, but further study is necessary to verify the correlation and the associated mechanisms.

In our study, AR prevalence decreased with age and had the highest prevalence in adolescents and younger adults. This age-related tendency is concordant with the finding of previous reports.27 Like many studies that report residence in a rural area as a protective factor for AR,28 our study also found that urban residence was a risk factor for symptom-based AR. Unlike symptom-based AR, allergy test result–based AR might not be affected by urban residence because pollen and fungal allergens were not tested in our study. Physicians usually treat more patients with AR with persistent and severe symptoms than with intermittent or mild symptoms. However, a nationwide survey found the highest prevalence of intermittent mild AR under the ARIA classification, which might be caused by the fact that patients with persistent and/or severe symptoms visit the clinic more frequently than those with intermittent and/or mild symptoms.

### Table 3. Association of Participant General Characteristics and Nasal Septal Deviation

<table>
<thead>
<tr>
<th>Patient Group</th>
<th>OR (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No NSD</td>
<td>1.00 (1.00-1.01)</td>
<td>.03</td>
</tr>
<tr>
<td>NSD</td>
<td>1.16 (1.08-1.24)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

### Table 4. Adjusted ORs of NSD in Adults With CRSwNP and CRSsNP

<table>
<thead>
<tr>
<th>Patient Group</th>
<th>OR (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRSwNP</td>
<td>2.5 (0.2)</td>
<td>.85 (0.70-1.03)</td>
</tr>
<tr>
<td>No NSD</td>
<td>2.7 (0.2)</td>
<td>... b</td>
</tr>
<tr>
<td>CRSsNP</td>
<td>6.3 (0.3)</td>
<td>1.16 (1.02-1.32)</td>
</tr>
<tr>
<td>No NSD</td>
<td>5.3 (0.3)</td>
<td>... b</td>
</tr>
</tbody>
</table>

Abbreviations: CRSNP, chronic rhinosinusitis with nasal polyps; NSD, nasal septal deviation; OR, odds ratio.

* Adjusted for sex, age, level of education, and body mass index.

b Ellipses indicate data not applicable.

Adjusted for sex.
Similar to a previously reported study,12 our study found that male sex increases the risk of NSD. In addition, aging and alcohol consumption were risk factors for NSD. An increased chance of nasal trauma, which causes secondary NSD, in older and/or drunken persons can explain the risk. Of interest, this study found that NSD elevates the risk of adult CRSsNP. In the literature, a predisposing effect of NSD on CRS has long been debated and remains to be settled.29,30 Our finding that NSD was not a risk factor for CRSwNP but was a risk factor for CRSsNP might be a clue regarding the controversial results. However, even if NSD is a risk factor for CRSsNP, surgical correction for NSD should be carefully applied because 92.3% of those with NSD did not have nasal obstructive symptoms.

Conclusions

This extensive, nationwide epidemiologic study of CRS, AR, and NSD using an otorhinolaryngologic interview and nasal endoscopy produced an updated national prevalence for Koreans of 2.6%, 5.8%, 18.5%, and 48.0% for CRSwNP, CRSsNP, AR, and NSD, respectively. In addition, we determined the risk and protective factors for the diseases: (1) male sex was a risk factor for CRS and NSD, (2) aging was a risk factor for CRSwNP but a protective factor for AR, (3) a lower level of education and obesity were risk factors for CRSwNP, (4) urban residence was a risk factor for AR, and (5) NSD was a risk factor for CRSNP.