

Prevalence and risk factors of chronic rhinosinusitis in Korea

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ABSTRACT

Background: Chronic rhinosinusitis (CRS) is one of the most common inflammatory diseases with multiple etiologies. Despite its high prevalence, risk factors influencing its prevalence have not been thoroughly revealed. Therefore, we investigated the prevalence and risk factors of CRS in Korea.

Methods: The 4098 subjects that participated in the Korea National Health and Nutrition Examination Survey were included in the study. Risk factors were categorized into sociodemographic and personal medical factors. Univariate and multivariate analyses were performed to identify significant risk factors of CRS. In addition, population attributable risks of the significant factors were calculated to estimate the effect on the population level.

Results: The prevalence of CRS in Korea was 6.95%. Among sociodemographic factors, male sex, old age, and heavy stress were significantly related with CRS. Influenza vaccination, septal deviation, and persistent allergic rhinitis were significant personal medical risk factors of CRS. Among these risk factors, persistent/moderate to severe allergic rhinitis was proven to be the most significant risk factor for CRS at the population level.

Conclusion: Although the prevalence and risk factors vary according to time, place, and diagnostic criteria, periodic epidemiological study on CRS is necessary to reduce socioeconomic expenditure and establish an improved national health care policy.

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Chronic rhinosinusitis (CRS) is a disease characterized by inflammation of the paranasal sinus mucosa of a duration at least 12 consecutive weeks.¹ Data from the National Health Interview Survey of the United States reported that CRS is one of the most frequently diagnosed chronic diseases affecting 14–16% of the population.^{2,3} Because of this high prevalence rate, the overall expenditure for CRS has been recognized as a socioeconomic burden. The direct cost estimated in 1996 was \$5.8 billion.⁴ The indirect cost caused by symptoms of CRS also appears to be staggering. The number of total restricted activity days caused by sinusitis rose from ~50 million/year in the period between 1986 and 1998 to 73 million/year between 1990 and 1992.⁵ In another aspect, CRS is a well-known aggravating factor in asthma and chronic lung diseases, which can also be an additional burden.⁶

Most studies on CRS mainly focused on the diagnosis and treatment of the condition, and relatively few researchers studied the epidemiology of CRS. Considering the fact that CRS is one of the most common chronic inflammatory diseases with significant socioeconomic burden, more accurate data about the prevalence and risk factors should be obtained through a population-based study to effectively reduce expenditures and establish an improved national health care policy on CRS. Therefore, we aimed to reveal the prevalence and risk factors of CRS using the Korea National Health and Nutrition Examination Survey.

MATERIALS AND METHODS

Subjects and Survey Methods

The present analysis was based on the data of the Population and Housing Census Report of Korea (Statistics Korea, 2005).⁷ A multi-stage clustered-stratified random method was used to sample the surveyed population. The total number of subjects was 4098 in 18 provinces, with 180 enumeration districts throughout Korea. The

survey was performed from January to December 2008. A visiting survey team was composed of four medical experts, including one otolaryngologist to perform clinical evaluations in a well-equipped mobile medical examination bus. The baseline information for each population was obtained using a structured questionnaire. Each participant ≥ 12 years of age was asked to answer the questionnaire. After finishing the questionnaire, the otolaryngologist asked questions regarding the patient's medical history and performed a physical examination.

Items on the Questionnaire

Information from a total of 12 sociodemographic factors was obtained by the questionnaire. The definitions and additional explanations of the factors are summarized in Table 1.

Symptoms, Physical Examination, and Personal Medical History

During the examination, symptoms indicating rhinitis such as rhinorrhea, sneezing, itching sensation of nose, and indicating sinusitis such as anterior/posterior nasal drip, nasal obstruction, facial pain, anosmia, or hyposmia were checked. A physical examination using a 4-mm, 0° nasal endoscope was performed after checking the symptoms. "Positive for allergic rhinitis" was defined as a patient who had been diagnosed with the disease by a physician in the past before this survey. Also, the otolaryngologist evaluated the diagnosis and severity of allergic rhinitis based on the questionnaire and physical examination results following the Allergic Rhinitis and Its Impact on Asthma classification.^{8,9} Positive values of all other personal medical factors, including hypertension, diabetes mellitus, pulmonary tuberculosis, bronchial asthma, chronic obstructive pulmonary disease, allergic dermatitis, rheumatoid arthritis, temporomandibular joint (TMJ) disease, and influenza vaccination are defined by a history of diagnosis of the disease by a physician. Septal deviation, nasal polyp, characteristic of nasal discharge, and the condition of nasal mucosa were evaluated from every survey entrant. In this report, we defined CRS when the symptoms of both nasal obstruction and nasal discharge have been present for >3 months and, at the same time, intranasal endoscopic examination showed objective findings such as discolored nasal drainage in the nasal passage or nasal polyps. Survey participants who had undergone previous nasal surgery, such as endoscopic sinus surgery, intranasal antrostomy, Caldwell-Luc operation, septoplasty, or rhinoplasty were excluded.

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Table 1 Definitions of factors applied in the analysis

Variables	Definitions
Age	Old: age ≥ 65 yr Young: 12 to ≤ 65 yr
Family no.	The no. of family members living in same house
Income	The sum of earnings from all members of a family
Education	Low: graduated high/middle school High: attended or graduated college
Stress	Subjective opinions of population during daily life
Obesity	Obese: BMI ≥ 25 Nonobese: BMI < 25
Physical activity	At least, 1 hr of exercise done by study population
Alcohol consumption	Total number of days of drinking alcohol per week/month
Current smokers	Daily smokers at the time of survey (divided into three subgroups according to the amount of consumptions)
Non- and exsmokers	Participants not categorized into "current smokers"

BMI = body mass index.

Statistical Analysis

We first assigned risk factors as two groups: (1) sociodemographic factors and (2) personal medical factors. Then, we performed chi-square analysis to compare the factors between the normal and CRS groups. Accordingly, a two-stage analysis of risk factors for CRS was performed. Univariate analysis was performed to generate crude odds ratios with 95% confidence intervals (CIs). Considering the outcome values of univariate analysis, multiple logistic regression analysis was performed including variables with values of $p < 0.25$ in univariate analysis. Finally, population attributable risks (PARs) were calculated for risk factors that were proven to be significantly related with the prevalence in multivariate analysis. PAR was calculated using the method described by Bruzzi *et al.*¹⁰

RESULTS

Prevalence of CRS in Korea

The overall prevalence of CRS in Korea was 6.95% (Table 2). The difference between men and women in the incidence was significant. The incidence of CRS for men was 8.24% and that of women was 6.00%. The prevalence of CRS among different age groups also showed significant differences. An age from 19 to 29 years showed the lowest incidence (3.95%) and an age >70 years showed the highest incidence (10.16%).

Analysis of Risk Factors of CRS

First, univariate logistic regression was used to assess the independent effect of each factor on the prevalence of CRS. Among the sociodemographic factors, statistically significant factors are listed in Table 3. Other factors such as family number, income, sleeping hours, obesity, physical activity, alcohol consumption, and smoking were not related with CRS. Also, the personal medical factors showed significant positive correlation with CRS as mentioned in Table 4. However, pulmonary tuberculosis, chronic obstructive pulmonary disease, allergic dermatitis, rheumatoid arthritis, and temporomandibular joint problem did not show significant correlation with CRS.

Table 2 Prevalence of chronic rhinosinusitis (CRS) according to age and sex

Variables	No.	CRS	Prevalence (%)	Person's χ^2
Age (yr)				
12–18	466	28	6.01	
19–29	506	20	3.95	
30–39	720	41	5.69	
40–49	710	40	5.63	
50–59	616	50	8.11	
60–69	598	57	9.53	
≥ 70	482	49	10.16	
Total	4098	285	6.95	26.478 ($p = 0.000$)
Sex				
Male	1758	145	8.24	
Female	2340	140	6.00	
Total	4098	285	6.95	7.959 ($p = 0.000$)

Table 3 The univariate analysis of significant sociodemographic factors of chronic rhinosinusitis (CRS)

Variables	No.	CRS	Prevalence (%)	Crude OR	95% CI	p Value
Sex						
Female	2340	140	6.00	1		
Male	1758	145	8.24	1.414	1.110, 1.789	0.005
Age (yr)						
12–64	3299	209	6.33	1		
≥ 65	799	76	9.51	1.554	1.181, 2.046	0.002
Education						
High	881	45	5.10	1		
Low	3189	239	7.47	1.501	1.081, 2.082	0.015
Stress						
Light	2898	186	6.41	1		
Heavy	1186	97	8.17	1.129	1.006, 1.677	0.045

No. = numbers of study population; OR = odds ratio; CI = confidence intervals.

After screening the potential risk factors using univariate logistic regression, multiple logistic regressions were performed to evaluate the influence of each risk factor by controlling the effects of other covariates. In this analysis, sex, age, and stress were significant sociodemographic risk factors of CRS (Table 5). The adjusted odds ratio for the male group versus the female group was 1.525 versus 1 (95% CI, 1.189–1.956). The older age group showed an odds ratio of 1.446 compared with the younger age group. The heavy stress group was significantly associated with CRS, which the odds ratio was 1.376. Among the personal medical factors, three factors were significantly related with CRS (Table 6). The group that had influenza vaccination showed an odds ratio of 1.581. Persistent allergic rhinitis and septal deviation showed definite correlation with CRS. Finally, PARs of significant risk factors were calculated. Among the factors, moderate to severe, persistent allergic rhinitis was proven to be the most attributing factor for CRS at the population level (Table 7).

DISCUSSION

Only few reports have evaluated its epidemiology and risk factors, especially in Asian countries, although the influence of the CRS on the population was significant. In Korea, the first epidemiological study on CRS based on a nationwide survey was reported in 1996.¹¹ In our report, the prevalence of CRS was 6.95%, and in a previous report was CRS prevalence was 1.01%.¹¹ This difference can be explained in two ways. First, in defining the CRS, the previous report adjusted more

Table 4 The univariate analysis of significant personal medical factors chronic rhinosinusitis (CRS)

Variables	No.	CRS	Prevalence (%)	Crude OR	95% CI	p value
Hypertension						
(-)	3853	264	6.85	1		
(+)	118	11	9.32	1.483	1.110, 1.982	0.008
Diabetes mellitus						
(-)	3829	251	6.55	1		
(+)	269	34	12.6	2.062	1.408, 3.021	0.000
Bronchial asthma						
(-)	3951	263	6.65	1		
(+)	147	22	14.9	2.468	1.542, 3.949	0.000
Influenza vaccination						
(-)	2641	159	6.02	1		
(+)	1452	126	8.67	1.483	1.163, 1.891	0.001
Septal deviation						
(-)	4067	200	4.91	1		
(+)	142	81	57.0	24.732	17.23, 35.50	0.000
Allergic rhinitis						
(-)	3063	111	3.62	1		
(+)	1035	171	16.5	3.649	2.573, 4.677	0.000
ARIA classification						
I/mild	587	50	8.52	1		
I/moderate-severe	199	27	13.5	1.686	1.024, 2.776	0.040
P/Mild	115	31	26.9	3.964	2.395, 6.559	0.000
P/moderate-severe	134	63	47.0	9.350	6.100, 14.89	0.000

ARIA = Allergic Rhinitis and Its Impact on Asthma; OR = odds ratio; CI = confidence intervals; I = intermittent; P = persistent.

Table 5 Multiple logistic regression of selected sociodemographic risk factors of chronic rhinosinusitis

Variables	Adjusted OR	95% CI	p Value
Sex			
Female	1		
Male	1.525	1.189, 1.956	0.001*
Age (yr)			
12-64	1		
≥65	1.446	1.078, 1.940	0.014*
Income			
≤\$3000/mo	1		
>\$3000/mo	0.865	0.671, 1.115	0.263
Education			
High	1		
Low	1.359	0.967, 1.910	0.077
Stress			
Light	1		
Heavy	1.376	1.059, 1.787	0.017*

*Value of $p < 0.05$ with 95% CIs.

OR = odds ratio; CI = confidence interval.

strict diagnostic criteria of CRS as the presence of at least three major symptoms persisting for >3 months with endoscopic findings of a nasal polyp and/or mucopurulent rhinorrhea in the middle meatus.¹¹ In our report, CRS was defined as the presence of only two major symptoms persisting >3 months.¹ Because of this difference, the previous report was presumed to have underestimated the prevalence. Second, the age of participants in each study can be another factor affecting the prevalence difference. Previously, 1303 participants aged from 0 to 10 years were included in the analysis, which was 14.5% of the total study population. In contrast, we only included individuals >12 years of age, which we assumed to be the minimum age to undergo an accurate physical examination and complete the

Table 6 Multiple logistic regression of selected personal medical factors of chronic rhinosinusitis

Variables	Adjusted OR	95% CI	p Value
Hypertension			
(-)	1		
(+)	1.139	0.629, 2.063	0.667
Diabetes mellitus			
(-)	1		
(+)	2.035	0.996, 4.156	0.051
Bronchial asthma			
(-)	1		
(+)	1.912	0.803, 4.553	0.143
Influenza vaccination			
(-)	1		
(+)	1.646	1.041, 2.605	0.033*
Septal deviation			
(-)	1		
(+)	13.516	7.578, 24.11	0.000*
Allergic rhinitis			
(-)	1		
(+)	1.389	0.871, 2.217	0.168
ARIA classification			
I/mild	1		
I/moderate-severe	1.612	0.865, 3.002	0.133
P/mild	2.576	1.320, 5.028	0.006*
P/moderate-severe	8.236	4.701, 14.43	0.000*

*Value of $p < 0.05$ with 95% CIs.

ARIA = Allergic Rhinitis and Its Impact on Asthma; OR = odds ratio; CI = confidence interval; I = intermittent; P = persistent.

questionnaire.² Although age <2 years could be included in an epidemiological study for more comprehensive representation of the whole population, because of the inability to recognize their health

Table 7 Population attributable risk (PAR) of significant risk factors of chronic rhinosinusitis (CRS)

Risk Factors of CRS	PAR
Sex: Male	0.176
Age: ≥ 65 yr	0.083
Stress: Heavy	0.094
Influenza vaccination: (+)	0.163
Septal deviation	0.234
ARIA classification: P/mild	0.159
ARIA classification: P/moderate-severe	0.490

ARIA = Allergic Rhinitis and Its Impact on Asthma; P = persistent.

conditions objectively and the difficulties in examining their nasal cavities, we excluded them to obtain more accurate results. The prevalence of CRS was reported to be 14–16% in the United States, which is higher than our data.^{12,13} This may be explained by the difference in methods for diagnosing CRS. Studies performed in United States relied on participants' self-reporting. A trained interviewer asked participants to recall the history of being diagnosed with CRS. The participants who had CRS in the distant past but have been resolved may still report CRS on the survey in this method. Therefore, the prevalence of CRS in the United States might have been overestimated.^{3,12,13}

A higher incidence of CRS among male participants was consistent with the previous study (1.06% versus 0.95%).¹¹ The percentage of current smokers in men may explain their higher prevalence of CRS. The percentage of "current smokers" in men was 47.7% and in women was 7.3% ($p < 0.05$, result not shown). Although smoking was not a significant risk factor in our results, indirect effects of smoking on the prevalence could not be ruled out completely.¹⁴ The relationship between age and CRS has been inconsistent among past reports.^{1,2,11} Higher prevalence in proportion to the increment with age can be explained by the change in mucociliary function. Ho *et al.* found that ciliary beat frequency decreases and more definite defects of central microtubulus of cilia develop as people get older.¹⁵ The third factor that showed a significant correlation was stress. Among the sinusitis epidemiological studies, this is the first report to evaluate stress as a risk factor of CRS. In the case of a related respiratory disease, bronchial asthma, emotional stress was proven to be a triggering factor of the disease.¹⁶ Although stress is not a factor that can be objectively measured and quantified, our report elucidated the correlation between CRS and stress, a common risk factor for various diseases.

No report has previously evaluated the vaccination for influenza virus as a risk factor of CRS. CRS is known as one of the most common complications of influenza infection. The fact that vaccination is a significant preventive modality to reduce complications has been proven.¹⁶ However, our analysis showed that vaccinated population was more vulnerable to CRS. This conflicting result can be explained in several aspects. First, the population diagnosed with chronic cardiopulmonary disease and diabetes mellitus might comprise a relatively larger proportion of vaccinated population in high-risk groups of CRS, such as age > 65 years. According to the guideline of the Korea Center for Disease Control and Prevention, high-risk groups were required to be vaccinated in a community health center.¹⁷ Second, the protection provided by the vaccination might have been inconsistent because of the difference between selected vaccine strains and circulating epidemic strains in the year of this survey.¹⁶

The direct roles of allergic rhinitis in CRS etiology have been largely anecdotal, although a large number of studies seem to suggest this relationship.^{1,11,14,18,19} For further analysis, we classified individuals according to the Allergic Rhinitis and Its Impact on Asthma criteria to elucidate the correlation between the symptom severity of allergic rhinitis and CRS. In our result, people who complained about persis-

tent symptoms showed higher odds ratios for CRS. Although the exact mechanism through which allergic rhinitis can predispose patients to CRS remains unknown, several previous studies suggest potential pathogenic factors. Maurizi *et al.* evaluated 20 patients with allergic rhinitis on ciliary ultrastructure and mucociliary clearance.²⁰ All patients showed decreased ciliary clearance and at least an alteration of the normal structure of cilia. Pelikan *et al.* conducted a provocation study by nasal instillation of an antigen to evaluate whether the exposure would exacerbate the symptoms of CRS.²¹ Among 37 patients, 29 showed symptom exacerbations and changes in radiographic findings, which can be also a possible explanation for the relationship between CRS and allergic reaction.

Among the factors, septal deviation was the most definite risk factor for CRS. Mechanical obstruction caused by deviation is generally known to be a predisposing factor of CRS. Despite the general recognition, previous studies presented inconsistent results regarding the relationship.^{22–25} Collet *et al.* reviewed 25 previously published articles and concluded that it was not possible to establish a definite role of septal deviation in pathogenesis of CRS.²² However, septal deviation was shown to have adverse effects on mucociliary clearance of the nasal mucosa and to cause mechanical obstruction of the sinus ostia.²⁶ The discrepancy may also be related to the manner of diagnosing septal deviation. The degree of deviation is a subjective finding and, therefore, the diagnosis can be varied among physicians. Thus, further functional studies should be performed to fully understand the relationship between the two pathological conditions.

Odds ratios explain a greater CRS risk for a person exposed to that specific risk factor, whereas the PAR explains the portion of the specific risk factor at the population level.¹⁰ Because of the conceptual differences, it is valuable to calculate the PAR in a nationwide study to reflect this result to health care policy. In accordance with the results of multivariate analysis, persistent/moderate to severe allergic rhinitis and septal deviation showed the highest attributing proportion in the study population (Table 7). This result of PAR means that 49 and 23.4% of CRS would be prevented by eliminating each risk factor, respectively. In this study, a large number of study populations selected from all districts of the country are sufficient to represent the whole Korean population. Moreover, the physical findings obtained by well-trained otolaryngologists with > 3 years of experience can be another advantage. One of the main purposes of an epidemiological study is to evaluate the potential impacts of identifiable risk factors on population. In that respect, calculating PAR was appropriate and valuable.

The limitation of our study is mainly derived from the definition of CRS. In defining CRS, the criteria are mainly based on common symptoms that can also be the manifestations of other sinonasal conditions. Also, there is no international consensus on the definition of CRS. This lack of specificity and consensus can cause confusion and result in inconsistent results between CRS studies. Another major weakness of our study is the lack of radiological confirmation in the diagnosis of CRS and the confirmative test of allergic rhinitis. Previously, Stankiewicz *et al.* actually reported the discrepancy between CRS diagnoses based on symptoms and CRS evidently detected by computed tomography.²⁷ Although endoscopic findings obtained by physical examination can support the accuracy of this study, future studies should include additional diagnostic tools to make a more exact diagnosis.

CONCLUSION

The prevalence of CRS in Korea was 6.95%. Male sex, age > 65 years, and heavy daily stress were significant sociodemographic risk factors of CRS. Personal medical factors such as influenza vaccination, allergic rhinitis, and septal deviation were also risk factors of CRS. Although the prevalence and risk factors vary according to time, place, and diagnostic criteria, periodic epidemiological studies on CRS are necessary to reduce socioeconomic expenditure and establish an improved national health care policy.

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