

Chronic rhinosinusitis: Epidemiology and cost

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ABSTRACT

Chronic rhinosinusitis (CRS) is one of the most common chronic diseases and is associated with a high socioeconomic burden from direct and indirect costs. Its estimated prevalence ranges widely, from 2 to 16%. It is more common in female subjects, aged 18–64 years, and in southern and midwestern regions of the United States. CRS is more prevalent in patients with comorbid diseases such as asthma, chronic obstructive pulmonary disease, and environmental allergies. Few studies examine patient ethnicity, socioeconomic status, geographic location, and cultural factors in CRS populations. This article provides an overview of the epidemiology, racial variations, and economic burden of CRS.

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Chronic rhinosinusitis (CRS) is one of the most common diseases in the United States.^{1–4} It has substantial detriments on quality of life, rivaling congestive heart failure, angina, chronic obstructive pulmonary disease, and back pain.^{5,6} Moreover, CRS imposes a significant socioeconomic burden, in forms of direct and indirect costs.

In this article, we present a review of CRS, its prevalence, its variations according to demographic factors and comorbidities, and its socioeconomic burden.

PREVALENCE OF CRS

The estimated prevalence of CRS in the United States ranges from 2 to 16%^{4,7,8} (Table 1). This wide range reflects the lack of accuracy of CRS epidemiological data, which are confounded by multiple factors such as absence of a universal definition of CRS, variations in CRS diagnosis algorithms, variations in epidemiological study methodology, failure to thoroughly include data relevant to disease cofactors and comorbidities, and poor understanding of the natural history and rate of remission of CRS.

Despite its prevalence and socioeconomic burden, definitive diagnostic criteria for CRS remain transient and controversial. To foster effective treatment and research, several major expert panels have published standardized definitions and management guidelines for CRS, such as the Rhinosinusitis Task Force,⁹ European Position Paper on Rhinosinusitis and Nasal Polyps (EP3OS),³ and the Joint Task Force of Practice

Parameters¹⁰ and Clinical Practice Guidelines: Adult Sinusitis.¹¹ However, even the expert guidelines are not consistent in terms of defining CRS diagnosis by symptoms, signs, exam findings, or radiographic criteria. For example, the 1996 American Academy of Otolaryngology–Head and Neck Surgery Multidisciplinary Rhinosinusitis Task Force based their clinical definition of CRS on symptoms only.⁹ In 2003, the Sinus and Allergy Health Partnership Task Force amended the definition to require, in addition to 12 weeks of symptoms, physical findings of mucosal edema, polyps or purulent drainage on either anterior rhinoscopy or nasal endoscopy, or radiographic evidence of sinus disease (Waters view x ray for clinical definition of CRS and computer tomography scan for research definition of CRS).¹² In 2012, EP3OS defined clinical CRS by at least two symptoms, one of which has to be either nasal obstruction or discharge lasting >12 weeks as well as either endoscopic evidence of polyps and purulent secretions or radiological evidence by computer tomography.³ It should be noted that differences in diagnostic methodologies used over time, as well as variations among criteria used by different authors, may account for variations observed in many of the epidemiological parameters reviewed here.

The majority of primary care physicians do not have the training or equipment to perform nasal endoscopy and thus rely on symptoms alone for diagnosis, which likely leads to overdiagnosis.¹³ In addition, the dramatically different forms of rhinosinusitis, the numerous diagnoses that mimic the symptoms of CRS, and difference in training and experience of clinicians who diagnose CRS, all contribute to the variation of methodological definitions for CRS in epidemiological studies.

The higher U.S. prevalence estimates of 14–15.5% come from National Health Interview Survey (NHIS) studies.⁸ The 2006 NHIS sampled nearly 24,275 nationwide households with the objective of representing the

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Table 1 Presentation of available literature on CRS epidemiology

Author	Type	Prevalence	Location	Identifier Used
Pleis <i>et al.</i> ³⁶	Nationwide survey	14–16	United States	Patient self-report
Shashy <i>et al.</i> ⁷	Tertiary care center	2	Minnesota	ICD-9
Chen <i>et al.</i> ¹⁴	Nationwide survey	5.7 Females, 3.4 males	Canada	Patient self-report
Min <i>et al.</i> ¹⁶	Nationwide survey	1.01	Korea	2003 Task Force Definition
Kim <i>et al.</i> ¹⁷	Nationwide survey	6.95	Korea	*
Ahsan <i>et al.</i> ²⁸	Tertiary care center	9.6	North Scotland	ICD-9
Ahsan <i>et al.</i> ²⁸	Tertiary care center	9.3	Caribbean	ICD-9
Hastan <i>et al.</i> ²⁷	Nationwide survey	10.9	Europe	EP3OS criteria
Pilan <i>et al.</i> ⁵³	Nationwide survey	5.5	Sao Paulo	EP3OS criteria

*Nasal obstruction and discharge for at least 3 mo and positive nasal endoscopy.

CRS = chronic rhinosinusitis.

civilian, noninstitutionalized population of the United States. The results are based on patient self-reporting of experiencing both acute and chronic sinus infection in the prior year, rather than physician diagnosis or objective medical identifiers, introducing recall bias and likely overestimation. On the other hand, the patient self-reported prevalence of CRS in Canada was lower, estimated at 3.4% in male patients and 5.7% in female patients *via* a national survey in which 73,364 participants were asked, "Do you have sinusitis diagnosed by health professional?"¹⁴

Estimates from studies based on physician-diagnosed CRS using International Classification of Disease 9 (ICD-9) data are much lower, with an estimated 2–2.3% prevalence in the United States.^{7,15} In Korea, the prevalence of CRS ranged between 1.01¹⁶ and 6.95%.¹⁷ This wide range in prevalence is attributed to the different study methodology and diagnostic criteria of CRS.

The reported overall prevalence of CRS in Europe by EP3OS criteria was 10.9% according to the Global Allergy and Asthma European Network study.³ This study used a validated moderately reliable survey for epidemiological diagnosis of CRS that is only based on symptoms but is reproducible and correlates with endoscopic findings, thereby facilitating large epidemiological studies.¹⁸ Although the epidemiological studies using symptom-based surveys are not specific and run the risk of overdiagnosis, studies with physician-diagnosed CRS are subject to selection bias, because subjects who do not seek medical attention are not included.

The ICD-9 codes and other billing databases are valuable data sources used frequently in research studies but may be another source of research error. Coding errors in these databases can lead to biased estimates of the frequency of visits and wrong prevalence of some medical conditions. A study comparing two emergency department electronic databases with patient

records manually abstracted from the emergency department log and medical records showed significant misclassification and omission of patient data in electronic databases.¹⁹ ICD coding errors may be unintentional because of coding entry mistakes, coders misinterpreting medical records, errors in diagnosis, errors in medical record documentation, and variability in clinical terminology or intentional coder errors.²⁰ The positive predictive value for 10 ICD-9 codes from emergency department visits was found to 74.4% and its efficiency in distinguishing types of emergency department visits varied across hospitals.²¹ Validating electronic data with another source of information such as medical records before being used for research purposes increases its accuracy and completeness but can be time-consuming and costly.¹⁹

CRS is a heterogeneous diagnosis with different subgroups (broadly, CRS with and without nasal polyps) that have different etiologies, course of disease, and burden of disease, as well as treatment. Most epidemiological studies do not stratify the different subgroups because of the diagnostic challenge of CRS with nasal polyps because endoscopy is needed for accurate diagnosis unless the polyps are large enough to be seen by anterior rhinoscopy. This limits population-wide epidemiological studies. A survey on 1387 adult Swedish population estimated 2.7% prevalence of nasal polyps, as well as higher frequency in men, elderly subjects, and asthmatic patients.²² In this same survey, 19 of 1862 patients without polyps had a previous physician diagnosis of nasal polyps. It is therefore postulated that surveys using population self-reported diagnosis of nasal polyps may overestimate the prevalence of the disease.³ Indeed, reported incidence of nasal polyps varies between 0.5%¹⁶ in Korea and 4.2%²³ in the United States. This difference, also, may be attributed to the different study methodology or population. Autopsy studies in Denmark revealed six patients with nasal polyps when screening of 300 autopsies using

anterior rhinoscopy (2%).²⁴ On the other hand, when the same group screened 69 autopsies using nasal endoscopy, 22 patients were found to have nasal polyps.²⁵

Furthermore, inaccurate classification of acute and recurrent rhinosinusitis and CRS also likely introduces error into epidemiological studies. Because patients with CRS may present to a wide range of clinicians from primary care to emergency, pulmonologists, allergists, otolaryngologists, and even intensivists and neurosurgeons when severe complications arise, variations in diagnostic coding in medical records likely exist.

Finally, the prevalence of CRS can not be accurately estimated without understanding the natural history of the disease. Are the patients cured or do they just reach remission? Unfortunately, there are no data supporting complete cure of CRS. The goal of CRS treatment is to achieve and maintain clinical control of disease defined as (1) patient does not have symptoms or the symptoms are not bothersome, (2) patient has healthy or almost healthy mucosa, and (3) patient only needs local medication.³ Furthermore, research on the cost of CRS shows that, despite decrease in physician visits and antibiotic cost, the average cost of anti-inflammatory medications remained relatively unchanged after endoscopic sinus surgery.¹⁵ This evidence supports the chronic inflammatory nature of the disease that may reach remission rather than cure.

VARIATIONS ACCORDING TO SEX, AGE, GEOGRAPHY, AND COMORBIDITIES

The 1992, 1997, and 2007 NHIS⁸ results consistently show CRS to be more common in female subjects (59%) than in male subjects in the United States. Similar results were reported in the Canadian survey.¹⁴ A German prospective study administered the German Adapted Version of the Sino-Nasal Outcome test 20 to 202 patients with CRS before and 3 months after endoscopic sinus surgery to evaluate the impact of gender, age, and comorbidities and showed that women had significantly lower quality of life scores than men despite similar disease-specific symptoms scores.²⁶ However, the Global Allergy and Asthma European Network²⁷ reported no significant variations in CRS prevalence by gender. Although there was no difference in CRS prevalence according to age in a study from Germany,²⁶ CRS prevalence is reportedly higher in adults of aged 18–64 years in the United States⁸ and Europe²⁷ and is most prevalent in the United States between the age of 40 and 64 years.² The survey by Chen *et al.* on the Canadian population describes a mean prevalence of CRS from 2.7% in the age group 20–29 years that increases with age until it reaches 6.6% in the age group 50–59 years and finally levels off

at 4.7% after the age of 60 years. The two Korean epidemiology studies described previously present conflicting results on gender and age association with CRS that makes drawing definitive conclusions challenging. Although the 1996 Korean study reported no statistically significant difference in CRS with respect to gender and age,¹⁶ the 2011 study revealed significantly higher prevalence in male gender.¹⁷ These apparent contradictions illustrate the potential impact of differences in study methodology or sampling.

CRS is geographically more common in the Midwest and the South of the United States than in the Northeast and is least common in the West.⁸ The lower incidence of CRS in Canada is consistent with these data and supports the hypothesis of North–South gradient whereby CRS seems to be less prevalent in cooler countries.¹⁴ Similar lower prevalence in cooler areas is seen in Scandinavian counties versus a higher prevalence in the more humid weather of Amsterdam and Poland.²⁷ Interestingly, a comparative study between North Scotland and South Caribbean showed no difference in the prevalence of CRS in these two countries despite the difference in climates.²⁸

The relationship between smoking and CRS is inconsistent. Although smoking did not correlate with CRS diagnosis in some studies,²⁹ other studies showed significant association between CRS and smoking^{27,30} and worse endoscopic sinus surgery outcomes in smokers.²⁹ Analysis of data of 20,050 adults aged ≥ 17 years from the Third National Health and Nutrition Examination Survey between 1988 and 1994 showed active smokers have high prevalence of sinus problems and passive smokers do not.³⁰ In a review of the literature, Reh *et al.* found evidence that smoking exposure contributes to CRS. They also correlated the decrease in incidence of physician-reported diagnoses of sinusitis in adults between 1997 and 2007 to a decrease in secondhand smoke exposure.³¹

CRS is more prevalent in patients with asthma, chronic obstructive pulmonary disease, and allergies.^{32,33} The prevalence of sinusitis in patients with asthma is estimated between 18 and 40%^{32,34} and is associated with an increase in health care use and expenditure as well as lost workdays.³⁴ Other studies comparing CRS with and without polyposis groups suggested similar prevalence rates of chronic inflammatory disease and inflammatory bowel disease in both groups. The frequency of CRS patients exhibiting the nasal polyp phenotype, however, was significantly greater in patients with asthma ($p < 0.0001$), inflammatory bowel disease ($p = 0.033$), and atopic dermatitis ($p = 0.049$).³⁴

RACIAL AND ETHNIC DIFFERENCES

Racial and ethnic factors may impact the presentation and natural history of CRS. Unfortunately, studies on CRS reporting race and ethnicity are scarce because analysis by race and ethnicity on a national scale only became routine in 1997. In that year, the United States Office of Management and Budget issued revised standards for all federal statistical systems regarding collection, tabulation, and presentation of data on race and ethnicity.³⁵

Analysis of the 2009 NHIS exposed perspectives on the relationship between CRS diagnosis, race, and ethnicity: African American adults had the highest frequency of sinusitis (13.8%) and highest rates of absenteeism (23%) whereas Asian adults had the least reported diagnosis of CRS. Furthermore, white non-Hispanic female and black female subjects are more likely to report diagnosis with CRS.³⁶

Whether these disparities are true biological differences or are artifacts of confounding socioeconomic variables is difficult to answer. It remains unclear whether the apparent delay in seeking appropriate medical attention is caused by low socioeconomic status, genetic differences in disease progression, or cultural factors.

The medical literature has been rich in reports over the last few decades concerning disparities in health outcomes among different racial and ethnic groups that were attributed to socioeconomic inequalities that impact health, health behavior, and access to health care resources.³⁷ In fact, an investigation of 2009 NHIS data showed differences in insurance status, specialist visits, and treatments between CRS patients of different racial and ethnic groups³⁸ whereby African American along with Hispanic subjects, were more likely to delay medical care because of cost-related concerns than were other groups.³⁶ Another study using the 2006 National Ambulatory Medical Care Survey and National Hospital Ambulatory Medical Care Survey data to tally patient visits to nonfederal physicians, emergency departments, and outpatient department care facilities, revealed highest emergency department use among African Americans and highest use of the outpatient office and private insurance among non-Hispanic white populations.³⁸ Early release estimates of the NHIS 2011 reveal that more than one-third of Hispanic subjects were uninsured in the past year and that Hispanic subjects are more likely to be uninsured than people that are black, white, or Asian populations.³⁹

It also remains possible that genetic and/or cultural forces impact the patient's perceived severity of his/her condition. This is elucidated in a cohort study using the rhinosinusitis disability instrument controlling for socioeconomic status; in this study a lower

quality of life was observed among Hispanic compared with African Americans and non-Hispanic white populations despite similar disease burden on computer tomography and endoscopy. The authors attributed this finding to one of two possibilities: (1) Hispanic subjects presenting to the physician after symptoms had reached a more severe threshold or (2) a cultural and language trait where they express their perceived impact on quality of life more aggressively.³⁸ A systematic literature review of PubMed citations from the years 1944–2011 analyzed 26 studies using experimental pain stimuli to assess pain sensitivity across multiple ethnic groups and concluded lower pain tolerance among African American subjects when compared with non-Hispanic white subjects.⁴⁰ Other investigations have observed lower pain threshold among Asian subjects when compared with non-Hispanic white subjects⁴¹ and in African Americans and Hispanic subjects when compared with non-Hispanic white subjects.⁴⁰ These findings, along with socioeconomic status, may contribute to greater emergency department use in African American populations, although socioeconomic factors remain a significant factor.

A good example of the complex interplay of the different confounding factors of socioeconomic status and race is allergic fungal rhinosinusitis (AFRS). Accumulating evidence supports the observation that AFRS is both more common and more aggressive in African American male subjects.⁴² In a study by Ghegan *et al.* African American male subjects were 15 times more likely to develop AFRS with bone erosion than African American female and white subjects.⁴³ African American patients tended to present at significantly younger age and with greater associated bone erosion, suggesting a more aggressive disease course. When controlling for other socioeconomic variables, AFRS was more prevalent in the uninsured and Medicaid populations.⁴⁴ When compared with patients with nonpolyp-forming CRS, the AFRS patient group contained significantly more uninsured or Medicaid patients, resided in counties with a higher percentage of patients below the poverty level, and had lower mean household income, again suggesting lower socioeconomic status and less access to health care among AFRS patients.⁴⁴ The more aggressive nature of AFRS in African American patients, as measured by the incidence of bone erosion, may be explained by late presentation to health care. Nonetheless, it does appear there is a higher incidence of AFRS in African American patients after adjusting for socioeconomic factors such as insurance, education, and income.⁴⁴ Interestingly, association of AFRS with low socioeconomic status was also reported in a recent report of 20 cases in Pakistan,⁴⁵ underscoring that both race and socioeconomic status are risk factors in this disease process.

SOCIOECONOMIC BURDEN

Total expenditures attributed to CRS were estimated to be \$8.6 billion in 2007.⁴⁶ Several factors contribute to the high economic burden of this disease.

It is a chronic condition with ill-defined remission and a natural history of frequent acute exacerbations requiring medical intervention, in addition to the chronic baseline symptoms. The expenses of CRS can be divided into direct costs of medical visits, diagnostic expenses, medical therapy, and surgical cost, as well as indirect costs of lost productivity and work absenteeism. Its chronic nature with recurrent exacerbations often entails multiple visits to primary care physicians, the emergency room, and to specialists. A National Ambulatory Medical Care Survey/National Hospital Ambulatory Medical Care Survey reported that CRS accounted for an estimated 20.3 million of 902 million (2.3%) total physician visits, 1.2 million emergency department visits of 119.2 (1%), and 2.3 million visits to an outpatient department of 102.2 million (2.3%) in 2006.³⁸ NHIS data over a 10-year period indicate that >25% of patients with CRS visited emergency rooms, 33% saw a medical specialist, and more than half spent \$500/yr on health care.¹ Adjusting for patient demographics and Charlson comorbidity index adds ~3.5 additional office visits and 5.5 additional prescription fills, as well as an overall incremental increase of \$772/person per year in total health care expenditures for patients with CRS when compared with those without.⁴⁶

The diagnosis and follow-up also involves expensive diagnostic procedures such as computed tomography scans, cultures, and endoscopies. Antibiotic cost alone for CRS may surmount \$150 million a year.⁴⁷ Medication cost breakdown for an episode of CRS exacerbation typically includes 3 weeks of antibiotics, 1 month of nasal corticosteroids, and/or a 15-day prednisone taper, which are estimated to cost around \$300, \$75, and \$11, respectively.⁴⁸ Cost of antihistamines, anticholinergic agents, decongestants, irrigating solutions, mucolytics, oral steroids, and leukotriene modifiers surpass the cost of antibiotic therapy directed toward treatment of CRS.¹⁵

Numerous studies have shown the effectiveness of surgery in improving quality of life of CRS patients.^{15,49,50} A prospective nonrandomized multi-institution cohort followed patients refractory to medical therapy electing to undergo endoscopic sinus surgery over 1 year and found significantly greater levels of improvement in multiple quality of life outcomes compared with patients managed by medication alone.⁴⁹ An estimated 257,000 patients undergo ambulatory sinus surgery per year.⁵¹ Overall, 46% of CRS patients undergo primary sinus surgery within 4.7 months of diagnosis, and the rate of

revision surgeries is 8.7%.¹⁵ Bhattacharyya *et al.* estimated an average cost of \$7726 for endoscopic sinus surgery and procedure-related follow-up (two postoperative visits).¹⁵ In patients who did have endoscopic sinus surgery, there is a significant decrease in average health care costs related to physician visits, diagnostic procedures, and antibiotics. However, the average cost of anti-inflammatory medications remained relatively unchanged in the 1st and 2nd year after the procedure at \$537 and \$556, respectively,¹⁵ hallmarking the chronic nature of the underlying disease process.

Other expenses that impact the economic burden of the disease include absenteeism from work or school, decreased productivity related to poor quality of life ("presenteeism"), and expenses related to additional therapies patients seek to achieve relief such as acupuncture and alternative medicine. CRS has been shown to cause significant activity, work, and social limitations.⁵² A cost benefit breakeven analysis based on literature review constructed a productivity model for absenteeism and presenteeism secondary to recurrent acute rhinosinusitis.⁴⁸ Although the authors studied recurrent acute rhinosinusitis, the estimated 1.7 days of absenteeism per episode, 0.66 days for 3–5 days of presenteeism (partial productivity) per episode, and \$193.47 lost for each day of missed work can be extrapolated to quantify the estimated loss in CRS.⁴⁸

CONCLUSION

CRS is a prevalent disease with an enormous health cost burden. Although medicine and surgery have advanced in control of symptoms and exacerbation of CRS, preventing this chronic disease is evidently a good idea. Despite active research in tertiary care settings, the understanding of CRS etiology, natural history, and geographic and racial variation requires thorough data entry at the level of primary care settings, emergency departments, and otolaryngologists. Only by the use of validated universal definitions for CRS, well-defined methodology in epidemiological research, and accurate entry of disease variables will it be possible to obtain epidemiological data on the natural evolution of the disease and its socioeconomic factors and thereby make advances toward disease prevention.

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