ORIGINAL RESEARCH

Exploring Sociodemographic Factors in Allergic Fungal Rhinosinusitis in a Northern California Patient Population

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Abstract

BACKGROUND: Allergic fungal rhinosinusitis (AFRS) is a subtype of chronic rhinosinusitis (CRS) that has previously been associated with younger age and Black patients. However, the role of demographic and socioeconomic factors in AFRS severity remains to be fully elucidated.

OBJECTIVE: The objective of this study was to determine whether demographic and socioeconomic factors are associated with incidence of AFRS, as well as with disease severity in Northern California.

METHODS: A retrospective cohort study was conducted of adult patients with AFRS and CRS from 2010 to 2019. AFRS was determined by the Bent and Kuhn criteria, and severity was assessed by radiographic evidence of cranioorbital invasion and other clinical parameters. Chi-square and t-test were used to assess demographic and socioeconomic differences between AFRS and CRS cohorts, and multivariable logistic regression was used to assess risk factors for severe AFRS.

RESULTS: Black patients represented 26.2% (55/210 patients) of the AFRS group and 4.9% (842/17,300 patients) of the CRS group, with pairwise comparison of race/ethnicity categories showing that the AFRS group had significantly higher proportions of Black race/ethnicity compared with other race/ethnicities ($p < 0.01$). AFRS and CRS groups differed significantly by age, with mean ages of 48.7 and 51.0 years, respectively ($p = 0.04$). There were no significant differences in gender, Medicaid status, comorbidities, and socioeconomic status measures. Multivariate logistic regression showed that Black patients had higher odds of having severe AFRS (adjusted odds ratio = 2.29; 95% confidence interval: 1.18–4.45).

CONCLUSION: AFRS has a unique predilection for Black patients, and severe disease is also more likely in this population.

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Introduction

Chronic rhinosinusitis (CRS) is a common condition with a prevalence of ~ 12% in the United States and is characterized by nasal discharge, sinus pain/discomfort, and sinonasal edema. Allergic fungal rhinosinusitis (AFRS) is a refractory subtype of CRS, encompassing 5% to 10% of CRS cases, and it accounts for 7% to 12% of CRS cases taken to surgery in the United States.[1–3] Clinical diagnosis of AFRS is defined by the Bent and Kuhn criteria, which includes type I immunoglobulin E (IgE)-mediated hypersensitivity, nasal polyposis, distinctive radiologic findings, eosinophilic mucin without fungal invasion, and a positive fungal stain.[4] However, there is a paucity of data on the epidemiology of the disease and the association of epidemiologic factors on disease severity.

First evaluated by Ferguson et al,[1] the unique demographic profile of AFRS was noted in patients living in the southeastern United States, where mold counts are notably high. AFRS was noted to develop primarily in young adults and adolescents, though all age groups could be affected.[5] Additional studies have shown that AFRS is associated with disadvantaged and vulnerable groups based on socioeconomic status and race. Wise et al reported a higher incidence of AFRS in Black patients and patients from lower socioeconomic areas, with up to 32% of patients in the southeastern United States undergoing surgical management for CRS reported to have AFRS.[6,7]

Disease severity for AFRS is assessed through several metrics, including the presence of comorbid conditions (eg, asthma, allergic rhinitis), Lund–Mckay computed tomography (CT) scan scores, immunologic markers, and number of sinus surgical procedures.[8] Bone erosion and orbitocranial complications in particular have been suggested to be associated with lower socioeconomic status.[6,8,9] However, through a retrospective review of 54 patients with AFRS, Ghegan et al demonstrated that although bone erosion was more prevalent in Black patients in the AFRS population, its presence was not associated with lower socioeconomic status.[10]

The present study aimed to further evaluate the predilection of AFRS for specific populations in Northern California in comparison to CRS and to determine if demographic and socioeconomic factors are not only associated with incidence of AFRS but also with disease severity. Accurate description of populations at risk of this disease would allow clinicians to more effectively identify patients requiring surgical intervention, ideally before the development of potential complications.

Methods

STUDY DESIGN

This study was approved by the Kaiser Permanente Institutional Review Board with a waiver of written informed consent. A retrospective cohort study was performed for all adult (≥ 18-year-old) patients with a diagnosis of AFRS or CRS in the electronic medical record (EMR) between January 1, 2010, and December 31, 2019. Patients with CRS were identified with International Classification of Diseases, 9th Revision (CD-9) and/or ICD-10 codes (J32.9, J33.9, J32.4, 471.9, 473.9, 473.8) and inclusion required at least two diagnoses within the study period made by an otolaryngology–head and neck surgery practitioner at an in-person ambulatory visit. AFRS patients were identified with at least one ICD-9 and/or ICD-10 diagnosis code specific for AFRS (B49, J30.89, J32.9, 477.8, 473.9, 117.9) made by an otolaryngology–head and neck surgery practitioner at an in-person ambulatory visit during the study period and additionally validated through chart review. Additionally, patients with at least two specific diagnosis descriptions of "CRS, unspecified" or "CRS," as well as "fungal sinusitis" or "AFRS" mentioned in progress notes in the EMR for the same encounter, were manually reviewed by the investigators for inclusion into the AFRS group based on meeting at least 3 of 5 Bent and Kuhn criteria defined as type I IgE-mediated hypersensitivity, nasal polyposis, distinctive radiologic findings, eosinophilic mucin without fungal invasion, and a positive fungal stain.[4] Patients were excluded if they had previous sinus surgery, an AFRS diagnosis prior to the study start date, or a diagnosis of invasive fungal sinusitis.

Demographic variables, such as age, race, gender, and Medicaid status, were obtained from the patient EMR, whereas socioeconomic variables, such as neighborhood median education, neighborhood median household income, and the neighborhood deprivation index (NDI), were obtained using census data. IgE and eosinophil count and percentage were

sourced from laboratory databases. Comorbidity data, such as the presence of allergic rhinitis and asthma, were electronically extracted utilizing a 1-year look-back from the date of AFRS diagnosis to search for ICD-9 and/or ICD-10 diagnoses for the comorbid conditions. Smoking status was obtained by patient self-reported data in the EMR. Data are available upon request. Readers may contact the corresponding author to request underlying data.

The outcome of disease severity was assessed by chart review only for the AFRS cohort. Disease severity as a dichotomous outcome variable was defined by the presence of ≥ 1 major criteria (M1: CT scan with bony erosion; M2: CT scan with orbitocranial extension), or ≥ 2 minor criteria (m1: Lund–Mackay score of 12 for unilateral disease; m2: Lund–Mackay score of 24 for bilateral disease; m3: ≥ 2 sinus surgical procedures; m4: ≥ 3 courses of oral corticosteroids).

STATISTICAL ANALYSIS

For both the AFRS and CRS groups, demographic and clinical characteristics were summarized descriptively (frequencies, proportions, means, and medians). Bivariate analysis was used to assess demographic and socioeconomic differences between AFRS and CRS patients, as well as to evaluate sociodemographic and clinical characteristics of patients with differing levels of disease severity among patients with AFRS. Fisher's exact tests and Pearson's Chi-square test were used to assess associations in categorical variables (eg, race/ethnicity, gender, socioeconomic status). The Student's t-test was used for comparison of normally distributed continuous variables, whereas for continuous nonnormally distributed variables, the Mann-Whitney test was used to test for differences between those with AFRS and those with CRS, as well as to test for severe and non-severe disease among the AFRS cohort. We performed multivariable logistic regression analyses to obtain adjusted odds ratios (ORs) for severe AFRS disease [along with accompanying 95% confidence intervals (CIs)], controlling for sociodemographic (ie, age, sex, race/ethnicity) and clinical characteristics (history of asthma, history of allergic rhinitis, smoking status). These analyses were performed using SAS 9.4 statistical software (SAS Institute Inc., Cary, NC). A significance level of alpha = 0.05 was used.

Results

The cohort included 210 patients with AFRS. Comparison of the AFRS cohort was made with a CRS cohort of 17,300 patients, and the summary comparisons are shown in Table 1. There was a statistically significant difference in race/ethnicity between the AFRS and CRS groups ($p < 0.01$). Black patients represented 26.2% (55/210) of the AFRS group and 4.9% (842/17,300) of the CRS group, and pairwise comparison of race/ethnicity categories showed that Black race/ethnicity was significantly higher in the AFRS group compared with other race/ethnicities ($p < 0.01$ using the Bonferroni correction, not shown in Table 1). Additionally, there were statistically significant differences in the age at presentation between the groups, with a mean age of 48.7 years [standard deviation (SD) of 15.8] in the AFRS group and a mean age of 51.0 (15.8) years in the CRS group ($p = 0.04$). However, when age was assessed as a categorical variable, there was no statistically significant difference between the AFRS and the CRS groups. Similarly, the neighborhood median household income for the AFRS group was lower, with a median of $92,116 [quartile 1 (Q1)–Q3: $70,919–$126,028] compared with $100,437 (Q1–Q3: $75,385–$130,213) for the CRS group ($p = 0.04$), but there was no statistically significant association between neighborhood median household income and CRS/AFRS subtypes when categorizing neighborhood median household income into quartiles. There were no statistically significant differences in gender, Medicaid status, NDI, healthy places index, and social vulnerability index between the AFRS and CRS groups.

Of the 210 AFRS patients, 116 were identified as having non-severe disease and 94 were identified as having severe disease. Comparison of the non-severe and severe AFRS cases are summarized in Table 2. With race/ethnicity categorized as Black vs non-Black, 60% (33/55) of Black patients vs 39% (61/155) of non-Black patients had severe disease, and 40% (22/55) of Black patients vs 60% (94/155) of non-Black patients had non-severe AFRS ($p = 0.01$). There were no statistically significant differences between the non-severe and severe disease AFRS cases based on age, gender, Medicaid status, neighborhood median household income, NDI, healthy places index, and social vulnerability index. Additional patient variables of asthma, allergic rhinitis, and smoking status did not show any statistically significant differences in the bivariate analysis.

The multivariate logistic regression model showed that Black patients had 2.29 times the odds of having severe AFRS compared to non-Black patients ($p = 0.01$). Table 3 shows the variables in

Patient characteristic	Overall N = 17,510 (100%)	CRS subtype		Chi-square p value
		AFRS N = 210 (1.2%)	CRS N = 17,300 (98.8%)	
Age at index, mean (SD)	50.9 (15.8)	48.7 (15.8)	51.0 (15.8)	0.04[a]
Age at index, median (Q1–Q3)	51 (38–63)	49 (35–60)	51 (39–63)	0.06[b]
Age at index, n (%)				
18–35	3380 (19.3)	54 (25.7)	3326 (19.2)	0.09
36–50	5145 (29.4)	58 (27.6)	5087 (29.4)	
51–65	5622 (32.1)	66 (31.4)	5556 (32.1)	
≥ 65	3363 (19.2)	32 (15.2)	3331 (19.3)	
Age at index, n (%)				
18–40	5049 (28.8)	64 (30.5)	4985 (28.8)	0.6
≥ 41	12,461 (71.2)	146 (69.5)	12,315 (71.2)	
Gender, n (%)				
Female	7992 (45.6)	105 (50.0)	7887 (45.6)	0.2
Male	9518 (54.4)	105 (50.0)	9413 (54.4)	
Race/Ethnicity, n (%)				
Non-Hispanic White	10,306 (58.9)	100 (47.6)	10,206 (59.0)	< 0.01
Black	897 (5.1)	55 (26.2)	842 (4.9)	
Asian	2921 (16.7)	21 (10.0)	2900 (16.8)	
Hispanic	2306 (13.2)	21 (10.0)	2285 (13.2)	
Other	1080 (6.2)	13 (6.2)	1067 (6.2)	
Medicaid status, n (%)				
Yes	557 (3.2)	10 (4.8)	547 (3.2)	0.23
No	16,953 (96.8)	200 (95.2)	16,753 (96.8)	
Neighborhood median household income, median (Q1–Q3)	100,375 (75,363–130,050)	92,116 (70,919–126,028)	100,437 (75,385–130,213)	0.04[b]
Neighborhood median household income, n (%)				
< $75,000	4303 (24.6)	61 (29.1)	4242 (24.5)	0.23
$75,000–$99,999	4406 (25.2)	58 (27.6)	4348 (25.1)	
$100,000–$129,999	4417 (25.2)	45 (21.4)	4372 (25.3)	
> $130,000	4380 (25.0)	46 (21.9)	4334 (25.1)	
Neighborhood median education, n (%)				
High school and below	1273 (7.3)	15 97.1)	1258 (7.3)	0.94
Some college and above	16,237 (92.7)	195 (92.9)	16,042 (92.7)	
NDI, n (%)				
Q1 (least deprived)	7441 (42.5)	75 (35.7)	7366 (42.6)	0.26
Q2	4253 (24.3)	52 (24.8)	4201 (24.3)	
Q3	24.9 (14.2)	33 (15.7)	2457 (14.2)	
Q4	2017 (11.5)	30 (14.3)	1987 (11.5)	
Q5 (most deprived)	1309 (7.5)	20 (9.5)	1289 (7.5)	
Healthy places index, n (%)				
Q1 (least advantaged)	759 (4.4)	12 (5.7)	747 (4.3)	0.09
Q2	1721 (9.9)	27 (12.9)	1694 (9.8)	
Q3	3099 (17.8)	43 (20.6)	3056 (17.8)	
Q4	4804 (27.6)	61 (29.2)	4743 (27.6)	
Q5 (most advantaged)	7033 (40.4)	66 (31.6)	6967 (40.5)	
Social vulnerability index, n (%)				

Table 1: Patient demographics and clinical characteristics by CRS subtype (N = 17,510) (*Continued*)

Table 1: *Continued*

Patient characteristic	Overall N = 17,510 (100%)	CRS subtype		Chi-square p value
		AFRS N = 210 (1.2%)	CRS N = 17,300 (98.8%)	
Q1 (least vulnerable)	4733 (27.0)	50 (23.8)	4683 (27.1)	0.27
Q2	5464 (31.2)	62 (29.5)	5402 (31.2)	
Q3	4686 (26.8)	57 (27.1)	4629 (26.8)	
Q4 (most vulnerable)	2627 (15.0)	41 (19.5)	2586 (15.0)	

[a]p Value calculated using the Student's t-test.

[b]p Value calculated using the Mann-Whitney test.

AFRS = allergic fungal rhinosinusitis; CRS = chronic rhinosinusitis; NDI = neighborhood deprivation index; Q = quartile; SD = standard deviation.

the multivariate logistic regression model for severe AFRS. Other model factors, including age, gender, asthma, allergic rhinitis, and smoking status, were not statistically significant. When including NDI into the model, the adjusted OR for having severe AFRS was 2.00 for Black patients when comparing to non-Black patients (p = 0.03).

Discussion

AFRS stands out as a unique subset of CRS in its epidemiology, diagnosis, and treatment. Although CRS is common, affecting > 30 million Americans, precise epidemiological characteristics are not well understood.[11–15] Analysis of multiple national health surveys by Soler et al demonstrated CRS as a significant health condition for all major racial/ethnic groups in the United States, with differences based on insurance status, work absenteeism, and resource use.[14] Conversely, AFRS has been shown through multiple studies to have higher prevalence in Black Americans.[6,8–10,16,17] The present study corroborated these findings and showed significantly increased prevalence of AFRS among Black patients, representing 26.2% of the AFRS cohort.

Severity of disease has also been analyzed with respect to race/ethnicity, with conflicting results. After the report from Wise et al in 2004,[17] which demonstrated Black patients developed bone erosion at a higher rates, studies from Ghegan et al, Miller et al, and Champagne et al did not corroborate these findings.[9,10,16] Interestingly, both Ghegan et al and Miller et al did find increased rate of bone erosion in males, and Champagne et al showed increased Lund–Mackay scores in Black patients.[9,10,16] However, Miller et al described increased rate of bone erosion in patients residing in counties with lower per-capita income, suggesting that increased disease severity may be secondary to socioeconomic factors, such as poor health care access and delayed presentation.[9] The present study's findings suggest Black patients have higher odds of progressing to severe AFRS, defined by major and minor criteria, as detailed above. Additionally, as the largest cohort of AFRS patients, this study adds to the body of evidence from the aforementioned studies showing an association between AFRS disease severity and race/ethnicity. However, this study's findings differ from those of Miller et al in that no significant association was found between socioeconomic status (as represented by NDI) and disease severity in this study. Of note, this patient population exclusively contains insured patients who are part of the authors' integrated health care system, possibly reducing the burden of socioeconomic factors affecting access to health care. Differences seen in previous studies may, instead, highlight other facets of health care disparities that likely do not exist in this cohort. Whether Black race is a predictor or a proxy of another social determinant of health in AFRS disease epidemiology needs to be further explored.

The propensity of AFRS for certain groups is not fully elucidated, but various environmental and host factors have been examined. The role of innate immunity and type I hypersensitivity to environmental fungus mediated by IgE has been classically viewed as a critical factor in AFRS pathophysiology.[18] It is possible that when exposed to higher fungal loads based on geographic factors, these sensitive populations may have surpassed the threshold of fungal load to trigger development of AFRS. Certain geographic locations vary by mold count and fungal species cultured in AFRS patients,[9,19,20] yet studies focused on small areas in North and South Carolina have not demonstrated association between geography and disease severity.[9,10] Larger studies with national geographic analysis would provide useful information in examining the association of geography and AFRS disease severity. Additionally, there may be genetic predisposition to AFRS, with > 3000 uniquely expressed genes in patients with AFRS compared to CRS, and

Patient characteristic	Overall N = 210 (100%)	Severity of AFRS[a]		Chi-square p value
		Non-severe N = 116 (55.2%)	Severe N = 94 (44.8%)	
Age at index, mean (SD)	48.7 (15.8)	50.3 (15.3)	46.7 (16.3)	0.11[b]
Age at index, median (Q1–Q3)	49 (35, 60)	50.5 (39, 62)	46.5 (33, 59)	0.11[c]
Age at index, n (%)				
18–35	54 (25.7)	23 (19.8)	31 (33.0)	0.19
36–50	58 (27.6)	35 (30.2)	23 (24.5)	
51–65	66 (31.4)	39 (33.6)	27 (28.7)	
≥ 65	32 (15.2)	19 (16.4)	13 (13.8)	
Age at index, n (%)				
18–40	64 (30.5)	30 (25.9)	34 (36.2)	0.11
≥ 41	146 (69.5)	86 (74.1)	60 (63.8)	
Gender, n (%)				
Female	105 (50.0)	54 (46.6)	51 (54.3)	0.27
Male	105 (50.0)	62 (53.5)	43 (45.7)	
Race/Ethnicity, n (%)				
Non-Hispanic White	100 (47.6)	61 (52.6)	39 (41.5)	0.13
Black	55 (26.2)	22 (19.0)	33 (35.1)	
Asian	21 (10.0)	12 (10.3)	9 (9.6)	
Hispanic	21 (10.0)	13 (11.2)	8 (8.5)	
Other	13 (6.2)	8 (6.9)	5 (5.3)	
Medicaid status, n (%)				
Yes	10 (4.8)	3 (2.6)	7 (7.5)	0.11
No	200 (95.2)	113 (97.4)	87 (92.6)	
Neighborhood median household income, median (Q1–Q3)	92,116 (70,919–126,028)	96,801 (75,184.5–130,283.5)	90,619 (60,643–117,745)	0.14[c]
Neighborhood median household income, n (%)				
< $75,000	61 (29.1)	28 (24.1)	33 (35.1)	0.27
$75,000–$99,999	58 (27.6)	35 (30.2)	23 (24.5)	
$100,000–$129,999	45 (21.4)	24 (20.7)	21 (22.3)	
> $130,000	46 (21.9)	29 (25.0)	17 (18.1)	
Neighborhood median education, n (%)				
High school and below	15 (7.1)	7 (6.0)	8 (8.5)	0.49
Some college and above	195 (92.9)	109 (94.0)	86 (91.5)	
NDI, n (%)				
Q1 (least deprived)	75 (25.7)	48 (41.4)	27 (28.7)	0.09
Q2	52 (24.8)	31 (26.7)	21 (22.3)	
Q3	33 (15.7)	17 (14.7)	16 (17.0)	
Q4	30 (14.3)	13 (11.2)	17 (18.1)	
Q5 (most deprived)	20 (9.5)	7 (6.0)	13 (13.9)	
Healthy places index, n (%)				
Q1 (least advantaged)	12 (5.7)	6 (5.2)	6 (6.4)	0.11
Q2	27 (12.9)	11 (9.6)	16 (17.0)	
Q3	43 (20.6)	19 (16.5)	24 (25.5)	
Q4	61 (29.2)	40 (34.8)	21 (22.3)	
Q5 (most advantaged)	66 (31.6)	39 (33.9)	27 (28.7)	
Social vulnerability index, n (%)				

Table 2: Patient demographics and clinical characteristics by AFRS disease severity (N = 210) (*Continued*)

Table 2: *Continued*

		Severity of AFRS[a]		
Patient characteristic	**Overall N = 210 (100%)**	**Non-severe N = 116 (55.2%)**	**Severe N = 94 (44.8%)**	**Chi-square p value**
Q1 (least vulnerable)	50 (23.8)	25 (21.6)	25 (26.6)	0.26
Q2	62 (29.5)	40 (34.5)	22 (23.4)	
Q3	57 (27.1)	32 (27.6)	25 (26.6)	
Q4 (most vulnerable)	41 (19.5)	19 (16.4)	22 (23.4)	
Asthma, n (%)				
Yes	89 (42.4)	55 (47.4)	34 (36.2)	0.1
No	121 (57.6)	61 (52.6)	60 (63.8)	
Allergic rhinitis, n (%)				
Yes	115 (54.8)	64 (55.2)	51 (54.3)	0.89
No	95 (45.2)	52 (44.8)	43 (45.7)	
IgE (count), n (range)[d]	258 (55–803)	277 (53–997)	216.5 (66–779)	0.6
Eosinophil (count), n (range)[e]	396 (152–975)	398 (143.5–879.5)	360 (216–1302)	0.66
Eosinophil (%), n (range)[f]	4 (2–8)	4 (2–8)	4 (2–7)	0.73
Smoking, n (%)				
Current smoker	8 (3.8)	4 (3.5)	4 (4.3)	1.00
Nonsmoker	159 (75.7)	88 (75.9)	71 (75.5)	
Former smoker	43 (20.5)	24 (20.7)	19 (20.2)	

[a]Disease severity defined by the presence of ≥ 1 major criteria (CT scan with bony erosion; CT scan with orbitocranial extension), or ≥ 2 minor criteria (Lund–Mackay score of 12 for unilateral disease; Lund–Mackay score of 24 for bilateral disease; ≥ 2 sinus surgical procedures; ≥ 3 courses of oral corticosteroids).

[b]p Value calculated using the Student's t-test.

[c]p Value calculated using the Mann-Whitney test.

[d]113 patients missing IgE values.

[e]187 patients missing eosinophil count.

[f]13 patients missing eosinophil count.

AFRS = allergic fungal rhinosinusitis; CT = computed tomography; IgE = immunoglobulin E; NDI = neighborhood deprivation index; Q = quartile; SD = standard deviation.

> 30 overexpressed genes compared to eosinophilic mucin rhinosinusitis.[18,21] Gene pathway analysis reveal these genetic variations to be strongly associated with the T helper-2 inflammatory pathway and the innate immune system. Taken together, interactions between environmental and host factors contribute to the epidemiologic presentation of AFRS.

Characteristic	**Adjusted OR**	**95% CI**	**p value**
Age	0.98	(0.97–1.01)	0.09
Gender			
Male	Ref	Ref	0.21
Female	1.43	(0.81–2.52)	
Race/ethnicity			
Non-Black	Ref	Ref	0.01
Black	2.29	(1.18–4.45)	
Asthma	0.64	(0.36–1.14)	0.13
Allergic rhinitis	0.75	(0.40–1.39)	0.36
Smoking			
Nonsmoker	Ref	Ref	0.95
Current/former smoker	1.02	(0.51–2.04)	

Table 3: Adjusted ORs for severe AFRS in patients with AFRS (n = 210)

AFRS = allergic fungal rhinosinusitis; CI = confidence interval; OR = odds ratio; Ref = reference.

The study is limited by an inherent selection bias in its cohort of insured patients who are part of an integrated health care system. Moreover, this study's patients may not be representative of socioeconomic and health associations throughout other parts of the country. However, insight into how disease prevalence and severity can change under these circumstances provides useful information. For example, understanding that equitable access to care can eliminate health care disparities in certain diseases can help support positive changes to policies or health care systems. Other limitations are related to the information bias inherent in a retrospective chart review. Manual review for diagnostic criteria of AFRS and review of CT scans (for Lund–Mackay scores and bony remodeling/expansion) is subject to some subjective interpretation. A systematic method for each chart review was developed and multiple reviewers were employed to minimize this potential bias. Additionally, AFRS may have been coded incorrectly by some

practitioners. Multiple broad ICD-10 diagnosis codes that included fungal sinusitis, as well as key search terms, were used in the algorithm to capture AFRS as widely as possible to account for this limitation. In the authors' analysis, possible confounding variables of socioeconomic status, income, and Medicaid status were accounted for. However, there may be other confounders in AFRS disease etiology that have yet to be identified. This study's results are generalizable to the population of patients in the authors' integrated health care system in Northern California. Future research should aim to broaden the population analysis to larger geographic regions, which may reveal trends that local analysis may not be able to capture.

Conclusion

AFRS stands out as a unique subset of CRS in its epidemiology, diagnosis, and treatment. Although AFRS has a unique predilection for Black patients, there is conflicting data regarding the epidemiology of AFRS disease severity. This study confirmed AFRS is more prevalent in Black patients and severe disease is more likely in this population. Other studied socioeconomic factors were not found to contribute to chance of severe disease. Understanding this association between race and disease can help practitioners and scientists better understand the pathophysiology of disease and can help patients and communities better understand the social risk factors afflicting vulnerable populations.

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