

Markers of disease severity and socioeconomic factors in allergic fungal rhinosinusitis

Justin D. Miller, BSPH, Allison M. Deal, MS, Kibwei A. McKinney, MD, Stanley W. McClurg, MD, Kenneth D. Rodriguez, MD, Brian D. Thorp, MD, Brent A. Senior, MD, Adam M. Zanation, MD and Charles S. Ebert Jr, MD, MPH

Background: Allergic fungal rhinosinusitis (AFRS) is a refractory subtype of chronic rhinosinusitis. There is a paucity of data investigating the association of epidemiologic markers of disease severity. The primary objective of this study is to evaluate components of disease severity with socioeconomic status and health care access.

Methods: A retrospective analysis was performed on patients diagnosed with AFRS by Bent and Kuhn criteria from 2000 to 2013. Severity of disease was measured by orbitocranial involvement, bone erosion, Lund-Mackay score, serum immunoglobulin E (IgE), and mold hypersensitivity. The North Carolina State Data Center provided county-specific socioeconomic and demographic data. Fisher's exact test, Wilcoxon rank sum test, Pearson correlations, and multivariable linear regression models were used to explore associations between variables.

Results: Of 93 patients, 58% were African American and 39% Caucasian with a male:female ratio of 1.4:1 and average age at presentation of 29 years. Race, age, insurance status, and gender were not associated with severity of dis-

ease. Bone erosion was correlated with residence in counties with lower income per capita ($p = 0.01$). Patients with orbitocranial involvement resided in more rural counties ($p = 0.01$) with less primary care providers per capita ($p = 0.02$). Residence in counties with older or poorer quality housing was associated with a higher prevalence of bone erosion ($p = 0.02$).

Conclusion: Within our cohort of patients residing in North Carolina, markers of disease severity (bone erosion and orbitocranial involvement) in AFRS were associated with lower income, rural counties, poor housing quality, and less health care access. © 2014 ARS-AAOA, LLC.

Key Words:

sinusitis; chronic rhinosinusitis; demography; epidemiology; allergy; mold; bone; race; gender

How to Cite this Article:

Miller JD, Deal AM, McKinney KA, et al. Markers of disease severity and socioeconomic factors in allergic fungal rhinosinusitis. *Int Forum Allergy Rhinol.* 2014;4:272-279.

Allergic fungal rhinosinusitis (AFRS) has remained a poorly understood disease since its first description as a paranasal manifestation of allergic bronchopulmonary aspergillosis by Millar et al.¹ in 1981. Soon after, Katzenstein et al.² described the retrieval of allergic mucin, Charcot-Leyden crystals, and fungal hyphae consistent with

Aspergillus from the paranasal sinuses of patients with chronic rhinosinusitis, coining the term "*Aspergillus* sinusitis." Later studies identified other types of fungi in diseased sinuses of patients with similar clinical presentations, necessitating the more apt name "allergic fungal sinusitis."^{3,4}

Since Millar et al.'s¹ original description, the exact pathophysiology of AFRS has remained elusive and controversial. A localized, immunoglobulin E (IgE)-mediated hypersensitivity reaction to fungi isolated to the paranasal sinuses⁵ is widely suspected; however, the role of fungal allergy in AFRS continues to be questioned.⁶ Despite controversy surrounding the immunopathology of AFRS, the disease has a well-defined constellation of pathologic findings. Bent and Kuhn⁷ described 5 criteria necessary for diagnosis of AFRS, which have remained the most widely accepted (type 1 hypersensitivity, sinonasal polyps, characteristic computed tomography [CT] scan findings, eosinophilic [allergic] mucin, and positive intraoperative fungal stain). Bone erosion is

Department of Otolaryngology-Head and Neck Surgery, University of North Carolina, Chapel Hill, NC

Correspondence to: Charles S. Ebert, Jr, MD, MPH, Department of Otolaryngology-Head and Neck Surgery, 170 Manning Drive, Physicians Office Building, Ground Floor, CB#7070, Chapel Hill, NC 27599; e-mail: charles_ebert@med.unc.edu

This work was performed at the University of North Carolina Hospitals, Chapel Hill, NC.

Potential conflict of interest: None provided.

Received: 14 August 2013; Revised: 7 November 2013; Accepted: 26 November 2013

DOI: 10.1002/alr.21292

View this article online at wileyonlinelibrary.com.

also often seen on CT imaging due to mucinous expansion and local inflammation, occurring in 20% to 93%^{8–10} of AFRS cases. This bony erosion and expansion commonly leads to proptosis and vision deficits in AFRS, with reports of proptosis ranging from 9%⁸ in adults and 22% to 50%^{8,11} in children. Additionally, IgE levels are frequently elevated in AFRS when compared to other forms of chronic rhinosinusitis, and total serum IgE levels have been found to predict the need for repeat surgical intervention.^{12–14}

Ferguson et al.¹⁵ first studied the unique demographic profile of AFRS, finding an increased prevalence of AFRS in the southeastern United States, where mold counts are notably high. Wise et al.¹⁶ reported a higher incidence of AFRS in African Americans and patients from lower socioeconomic areas. Bone erosion was also found to be more prevalent in the African American AFRS population; however, its presence has not been associated with lower socioeconomic status.¹⁷ The current study was designed to further examine the unique predilection of AFRS for a specific population and determine if demographic factors are associated with not only the incidence of AFRS, but disease severity. Identifying demographic predictors of disease severity could lead to earlier diagnosis and more aggressive treatment in select groups, avoiding the serious and morbid complications of severe AFRS. We hypothesized that severity of disease measured by orbitocranial involvement, serum IgE, mold hypersensitivity, and bone erosion on CT would be associated with lower socioeconomic status and less access to primary medical care.

Patients and methods

After approval by the University of North Carolina Institutional Review Board, a retrospective chart review was conducted on functional endoscopic sinus surgery patients from January 2000 to April 2013. One hundred and nine patients were found to meet at least 3 out of 5 criteria for allergic fungal rhinosinusitis according to Bent and Kuhn criteria.⁷ Prior studies have used between 3 and 5 criteria for diagnosis. Melroy et al.¹⁸ found a significant delay between the time of initial presentation and the diagnosis of AFRS when using Bent and Kuhn⁷ criteria. Melroy et al.¹⁸ found an average time to diagnosis of 11 months and that characteristic CT findings (65%) and fungal stains (19%) were the most commonly missing criteria. It is likely that many of our study's patients presented during the evolution of their disease, before reaching 5 of 5 criteria. Therefore, we included patients meeting at least 3 of 5 Bent and Kuhn⁷ criteria. We found that fungal stain was the most commonly missing criteria (12%), largely due to the fact that intraoperative fungal stains were not routinely ordered during the earlier years of our data collection. Full criteria were met by 77% of patients and all patients were diagnosed with AFRS by the Charles S. Ebert (CSE). Additionally, preoperative CT scans were reviewed by the senior author and 93 patients were determined to have definitive CT characteristics of AFRS^{7,10} and subsequently retained in the study.

Patients who were immunocompromised or resided outside of North Carolina were excluded from the study.

Demographic factors including patient age, race, age at diagnosis, and county of residence were collected from medical records. Insurance status was collected and stratified by uninsured or subsidized insurance, Medicare, military insurance, and private insurance. Uninsured patients and patients with Medicare or other subsidize insurance were combined to aid the comparability of our study with 2 prior works examining the demographics of AFRS (Wise et al.¹⁶ and Geghan et al.¹⁷), both of which used the same insurance criteria. Additionally, our intent was to use insurance status as a direct measure of socioeconomic status, rather than healthcare access, which is best measured by combining uninsured patients and those with subsidized insurance. Place of residence was stratified by both county and North Carolina Health Service Area (HSA). North Carolina is divided into 6 HSAs defined by the National Center for Health Statistics, with boundaries designed with respect to geographic features, population, and health resources. County and HSA demographic data were collected from the Log Into North Carolina Database provided by the North Carolina Data Center. The database was explored for categories representing patients' income levels, living conditions, and access to healthcare. The following parameters were included in our data analysis: income per capita, rural population per capita, primary care physicians (PCPs) per capita, occupied housing units over 30 years old per capita, and occupied housing units designated overcrowded at last inspection per capita.

Medical records were also reviewed for markers of disease severity. Preoperative CT images and respective radiology reports by The University of North Carolina Department of Radiology were reviewed for evidence of bony erosion of the skull base, orbital walls or sinuses. Medical records and CT scans were reviewed for proptosis, diplopia, and vision loss to screen for orbitocranial involvement. When available, radioallergosorbent testing (RAST) and mold allergy classes (range, 0–6) were retrieved. Total serum IgE levels were also obtained when available.

Severity of disease was additionally quantified using the novel Ebert-Zanation (EZ) Allergic Fungal Rhinosinusitis Severity Scoring System (Table 1). Preoperative sinus CT scans were reviewed by 2 rhinologists and graded by the Lund-Mackay CT scoring system.¹⁹ Disease severity was subdivided into innate and radiographic factors. Innate score included serum IgE (0 = <100; 1 = 100–600; 2 = >600) and RAST (0 = < class 4; 1 = ≥ class 4). Radiographic score included bone erosion (0 = No; 1 = Yes), orbitocranial involvement (0 = No; 1 = Yes), and Lund-Mackay score (1 = 0–6; 2 = 7–18; 3 = 19–24). Innate and radiographic scores were totaled with a maximum total score of 6.

Fisher's exact tests were used to compare percentages between groups, and Wilcoxon rank sum and Kruskal-Wallis tests were used to compare continuous variables. Pearson correlation coefficients are reported to describe the

TABLE 1. EZ AFRS Severity Scoring System

	Points		
	0	1	2
Innate			
IgE (IU/mL)	<100	100–600	>600
RAST class	<4	≥4	–
Radiographic			
Bone erosion	No	Yes	–
Orbitocranial	No	Yes	–
Lund-Mackay	≤6	7–18	>18

AFRS = allergic fungal rhinosinusitis; EZ = Ebert-Zanation; IgE = immunoglobulin E; RAST = radioallergosorbent testing.

magnitude of correlation between continuous variables. Univariate and multivariate linear regression modeling was used to evaluate associations between patient demographics and disease severity measured by the EZ AFRS Severity Scoring System. Additionally, associations were explored between radiographic and innate factors to determine if IgE and RAST allergy class were predictors of objective disease severity when measured by bone erosion, orbitocranial involvement, and Lund-Mackay score.

Results

Demographics

Of 93 patients, the mean age of presentation was 29 (range, 10–75) years. The cohort consisted of 53 (58%) males and 39 (42%) females, and 54 (58%) of patients were African American, 33 (36%) Caucasian, and 4 (4%) Hispanic. Twenty-nine patients (32%) were uninsured or had subsidized insurance and 51 (55%) of patients had private insurance. A majority of patients resided within 3 HSAs in central and eastern North Carolina, with 50% of patients residing in the 2 coastal HSAs (5 and 6), and 37% of patients residing within HSA 4 in central North Carolina (Fig. 1).

Disease severity

Bone erosion was observed in 59 (65%) of patients with a slightly higher prevalence in males (70% vs 57%; $p = 0.26$) and an equal prevalence in African Americans and Caucasians (65%). Additionally, similar rates of bone erosion were observed with uninsured/subsidized insurance and private insurance groups (68% vs 62%, respectively; $p = 0.91$). Orbitocranial involvement occurred in 33 (36%) of patients with slightly higher prevalence in Caucasians (43%) than African Americans (32%; $p = 0.27$) and with uninsured/subsidized insurance (46%) than private insurance (32%; $p = 0.46$). Males and females had equal rates of orbitocranial involvement (36% vs 35%, respectively). The average Lund-Mackay scores were 15.6 (95% confidence interval [CI], ± 1.05) and 15.9 (95% CI, ± 1.07) ($p =$

0.753), and did not differ by race, gender, or insurance status. Total serum IgE levels were available for 55 patients, with a mean IgE of 1030 IU/mL, median of 622 IU/mL, and range of 14 IU/mL to 6866 IU/mL. Radioallergosorbent testing was available for 49 patients, 39% of which had a class 4 or greater allergy to at least 1 mold. Caucasians were noted to have a higher incidence of class 4 or greater mold allergy than African Americans (61% vs 26%; $p = 0.03$). The patient-specific demographics for disease severity are included in Table 2. Geographic location was not found to be associated with disease severity.

The mean radiographic, innate, and total EZ AFRS Disease Severity scores for the cohort were 2.3, 1.9, and 4.2, respectively. A weak association was identified between female gender and high innate ($p = 0.096$) and total ($p = 0.07$) scores (Fig. 2). When insurance status was stratified into uninsured/subsidized vs insured groups, the univariate analysis revealed a trend toward association between uninsured/subsidized payment method and higher radiographic ($p = 0.09$) and total ($p = 0.06$) disease severity scores. Caucasians had higher innate scores than African Americans (mean 2.3 vs 1.7; $p = 0.07$). Table 3 presents average EZ AFRS Disease Severity Scores stratified by patient demographics.

No univariate associations were observed between radiographic and innate measures of disease severity when analyzed individually by Fisher's exact test. Multivariate regression models also explored the association of race, gender, IgE, and mold allergy with radiographic factors and found no associations.

County data

County-specific socioeconomic data were analyzed for associations with severity of disease (Table 4). By Wilcoxon signed-rank testing, there was a statistically significant association between bone erosion and residing in a county with lower income per capita ($p = 0.01$) and a higher number of houses greater than 30 years old per capita ($p = 0.02$). A statistically significant association was also observed between orbitocranial involvement and residing in a county with fewer PCPs per capita ($p = 0.02$) and a larger rural population per capita ($p = 0.01$). Lower income per capita and overcrowded housing approached significance with the presence of orbitocranial involvement ($p = 0.06$; $p = 0.07$, respectively). Additionally, residing in a county with fewer PCPs per capita approached significance with higher Lund-Mackay scores ($r = 0.19$; $p = 0.09$). Using the EZ AFRS Severity Scoring System, higher radiographic scores were associated with residing in a county with lower income per capita ($r = -0.24$; $p = 0.03$). No statistically significant associations were observed with total severity scores and county-specific demographics.

Multivariable regression identified a significant association between radiographic score and residing in a county with lower income per capita ($p = 0.045$) when controlled for race, gender, age at diagnosis, insurance status, and PCPs per capita.

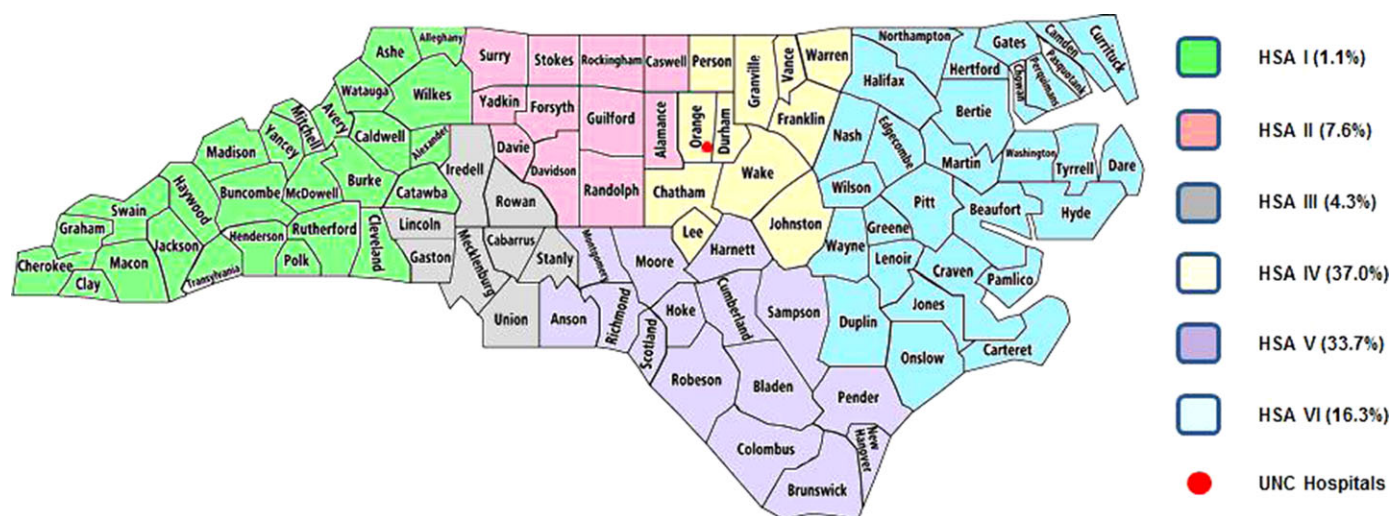


FIGURE 1. North Carolina HSAs with respective distribution of patients with AFRS. AFRS = allergic fungal rhinosinusitis; HSA = Health Service Areas.

Discussion

The predilection of AFRS for certain populations was not well described until 2004, when Wise et al.²⁰ found African American ethnicity to be a statistically significant predictor of bone erosion in AFRS. Further epidemiologic work by Wise et al.¹⁶ demonstrated that AFRS patients were significantly younger than those with chronic rhinosinusitis and had a higher likelihood of being uninsured or covered by Medicaid. Additionally, African Americans comprised a statistically significant percentage of the AFRS patient population when compared to a cohort of chronic rhinosinusitis patients. Wise et al.²⁰ hypothesized that the disease's unique epidemiologic profile was due to either late presentation secondary to socioeconomic factors, a genetic predisposition in African Americans, or an increased exposure to fungal allergens in African Americans. However, little work has been done to further describe the predilection of AFRS for specific demographic groups and explore demographic associations with disease severity.

Prior to this study, bony erosion and Lund-Mackay score had been the only measurements used to explore associations of AFRS disease severity with patient demographics. Again, the demographics of bone erosion were first described in 2004 by Wise et al.,²⁰ who studied a cohort of 47 AFRS patients and found that African American race was a statistically significant predictor of bone erosion. In 2007, Ghegan et al.¹⁷ studied a slightly larger cohort of 57 AFRS patients and subsequently found no correlation between bone erosion and race, insurance status, or age; however, they did find a statistically significant association between male gender and bone erosion. In 2010, Champagne et al.²¹ described significantly higher preoperative Lund-Mackay scores in African Americans compared to Caucasians. Our study did not find any correlations of bone erosion or Lund-Mackay score with race, age at diagnosis, gender, or insurance status. However, we did observe a higher incidence of bone erosion in males than females

(70% vs 57%; $p = 0.26$). Also, there was a suggested association between female gender and total disease severity score ($p = 0.07$), likely driven by higher female than male innate scores (mean 2.16 vs 1.70; $p = 0.096$). Although previous studies have demonstrated a significantly higher incidence of bone erosion in males,^{17,20,22} these data suggest that the gender discrepancy may be diminished in larger cohorts, and that whereas there may be a slightly higher prevalence of bone erosion in males, this may not be translatable to increased overall disease severity.

Additionally, our study found significant associations between bone erosion and residing in a county with lower income per capita and older housing. Ghegan et al.¹⁷ also stratified data by county, but found no statistically significant associations between bone erosion and demographic data, including: percentage of county residents below the poverty level, median household income, number of physicians per 1000 persons, and percentage of African American residents in the county.

Our study examined additional measures of disease severity beyond bone erosion, including: orbitocranial involvement, Lund-Mackay score, total serum IgE, and mold allergy. When these measures of disease severity were analyzed against county demographics, we found several significant associations. Our data suggest that lower income, decreased access to care, and older or poorer quality housing lead to worse disease. When assessed individually, our data suggest that residing in poorer, rural counties and counties with decreased access to healthcare increases the likelihood of more severe radiographic measures of AFRS. Residing in counties with older, poorer quality housing appears to increase the likelihood of bone erosion and orbitocranial involvement. Radiographic indications of disease severity appeared to have the strongest correlations with county demographics. Even when controlling for age, race, gender, insurance status, and PCPs per capita, residing in a lower income county was found to be significantly associated with

TABLE 2. Demographic associations with disease severity measures

	Bone erosion	OC involvement	LM > 18	RAST ≥ 4	IgE > 600 IU/mL
Age, years (mean Y, N)	27, 31	28, 29	26, 29	24, 27	26, 22
Race, n (%)					
African American	35 (65)	17 (32)	17 (34)	8 (26) ^a	19 (51)
Caucasian	24 (65)	16 (43)	10 (29)	11 (61) ^a	9 (50)
Gender, n (%)					
Male	37 (70)	19 (36)	14 (29)	9 (33)	14 (44)
Female	21 (57)	13 (35)	13 (37)	10 (46)	14 (61)
Insurance status, n (%)					
Unins/Subs	19 (68)	13 (46)	10 (39)	7 (41)	10 (48)
Private	31 (62)	16 (32)	15 (33)	9 (36)	13 (52)
Medicare	1 (50)	0 (0)	0 (0)	1 (50)	2 (100)
Military	7 (70)	3 (30)	2 (22)	2 (40)	3 (43)
HSA, n (%)					
1	1 (100)	0 (100)	1 (100)	0 (0)	1 (100)
2	5 (71)	3 (43)	1 (14)	1 (100)	0 (0)
3	2 (50)	2 (50)	1 (33)	0 (0)	0 (0)
4	18 (56)	7 (22)	13 (42)	7 (35)	12 (50)
5	21 (68)	14 (45)	8 (28)	9 (50)	11 (61)
6	11 (73)	6 (40)	3 (25)	2 (22)	4 (40)

^a*p* < 0.05.

HSA = Health Service Area; IgE = immunoglobulin E; OC = orbitocranial; RAST: radioallergosorbent test; Unins/Subs = uninsured or subsidized insurance.

a higher radiographic score in our multivariate model. The county-specific demographic domains we chose for analysis are highly interrelated; however, the Linked Into North Carolina database was extensively searched and the data points were determined to be the best proxies of income, healthcare access, and housing quality.

Patient-specific data are more reliable measures of socioeconomic status; however, these data are difficult to collect in retrospective studies. Our study examined patient's insurance status in order to better delineate the role of socioeconomic factors with a more individualized analysis. Wise et al.¹⁶ found that AFRS patients were less likely to be insured than non-AFRS chronic rhinosinusitis patients, and Thahim et al.²³ studied a cohort of 20 AFRS patients in Pakistan, finding that 80% were of low socioeconomic status. However, no study to date has identified an association between patient-specific measures of socioeconomic status and disease severity in the United States. Although our study did not find any statistically significant associations between patient-specific demographics and disease severity, our data did suggest a relationship between unin-

TABLE 3. Average EZ AFRS Severity Scoring System values

	Radiographic	Innate	Total
Race			
African American	2.3	1.7 ^a	4.1
Caucasian	2.3	2.3 ^a	4.5
Gender			
Male	2.3	1.7 ^a	3.9 ^a
Female	2.2	2.2 ^a	4.6 ^a
Insurance status			
Unins/Subs	2.5	1.9	4.7
Private	2.2	1.8	3.9
Medicare	1.5	2.5	4.0
Military	2.1	1.8	4.0
HSA code			
1	3.0	2.0	5.0
2	2.1	2.0	4.0
3	2.3	0	0
4	2.1	1.9	4.2
5	2.4	2.1	4.3
6	2.3	1.4	3.9

^a*p* < 0.10.

AFRS = allergic fungal rhinosinusitis; EZ = Ebert-Zanation; HSA = Health Service Area; Unins/Subs = uninsured or subsidized insurance.

sured status and increased radiographic measures of AFRS severity (*p* = 0.06). This finding further supports our county data, suggesting that lower socioeconomic status is related to more extensive disease upon presentation.

Several theories have been proposed to explain increased prevalence and extent of disease seen in certain groups. The commonly accepted role of type I hypersensitivity to ubiquitous fungi in the pathophysiology of AFRS has recently been challenged²⁴⁻²⁶; however, it is still considered an integral component to the disease's pathophysiology. Subsequently, certain populations may be exposed to higher fungal loads, resulting in more severe disease or faster disease progression. Mold counts vary by geographic location, and prior studies have found that fungi species recovered from AFRS patients intraoperatively vary by geographic location.^{8,12,27,28} Gehgan et al.¹⁷ found no variation in disease severity by geographic region, and we found no associations between geographic area and disease extent when measured by HSA; however, both studies were confined to small geographic areas within North and South Carolina. Lower socioeconomic status with subsequent poor quality housing may also lead to increased exposure to molds within the household. Although we did find significant associations between disease severity and measures of housing

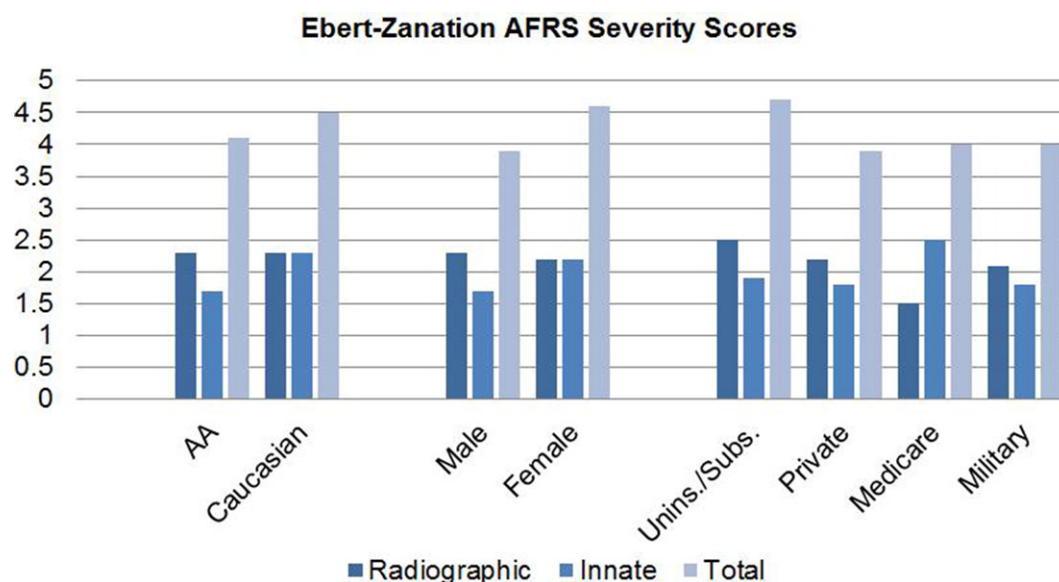


FIGURE 2. Ebert-Zanation AFRS Severity Scores for race, gender, and insurance subgroups. AA = African American; AFRS = allergic fungal rhinosinusitis; Unins./Subs. = uninsured or subsidized insurance.

quality by county, this theory would be better supported by patient-specific exposure data.

Another proposed explanation for the increased disease severity in select populations is a genetic susceptibility to AFRS.²⁹ Previous studies have suggested that this genetic susceptibility may also explain faster disease progression in some groups; namely African Americans. As mentioned, numerous studies have demonstrated that AFRS disproportionately affects African Americans compared to Caucasians,^{16,17,20–22} and our cohort was comprised of 58% African Americans and only 36% Caucasians. However, unlike Wise et al.,²⁰ who found an increased incidence of bone erosion in African Americans, our study identified an equal prevalence of bone erosion between African Americans and Caucasians (65%), and found no associations of race with disease severity. Even when controlled for insurance status, gender, and county parameters, race was not an indicator of disease severity. Therefore, whereas race may play a significant role in the prevalence of AFRS, our study, which is the largest AFRS severity study to date, suggests that the disease's severity or progression may be based more on patients' socioeconomic status.

A driving factor for this study's results may be that lower socioeconomic status leads to decreased access to care, which in turn leads to later presentation to a healthcare provider and more extensive disease. Multivariate regression did not find any associations between innate measure of disease severity (IgE and RAST) and bone erosion, orbitocranial involvement, or Lund-Mackay score as was expected. However, total serum IgE and mold allergy have been found to correlate with AFRS clinical severity. Schubert and Goetz¹⁴ found that a 10% or greater increase in IgE postoperatively was found to have a statistically significant predictive value for repeat surgery and Stewart

and Hunsaker¹³ noted that higher RAST classes to molds were associated with increased polyp severity class in AFRS patients. Therefore, our radiographic measures of disease severity may be measures of disease progression, more so than disease severity, and future studies are necessary to validate measures of AFRS severity.

Our study was additionally limited by its retrospective nature. As mentioned, our only patient-specific measure of socioeconomic status was insurance status. Additional studies using prospectively collected patient data including personal income, having a PCP, and housing conditions are needed. For better distinction between actual disease severity and delay in presentation, the number of repeat surgeries and the time from symptom onset to first presentation to an otolaryngologist should be recorded. This study was conducted at a large public tertiary care otolaryngology-head and neck surgery practice that largely serves residents of North Carolina. Additionally, patients residing outside of North Carolina were excluded from the study because no county data was available. Therefore, this study may be biased by our institution's patient population. Finally, our study is limited by its sample size and our results may not be applicable to larger groups. Although our cohort's demographic profile is similar to that from other AFRS studies out of South Carolina and Georgia, our results may not be applicable to other parts of the country. The incidence of AFRS is certainly lower in other areas of the country, and it is unclear if the disease portrays the same demographic profile and associations with socioeconomic status outside of the Southeast. Despite these limitations, our cohort is the largest of any prior study examining AFRS severity and patient demographics, and is the first study to demonstrate a link between patient socioeconomic status and AFRS severity. Furthermore, intraoperative mucosal

TABLE 4. County-specific associations with disease severity

	Radiographic										Innate						
	Bone erosion			OC involvement			Lund-Mackay score ^a				RAST			IgE (IU/mL) ^a			
	No	Yes	<i>p</i>	No	Yes	<i>p</i>	≤6	6–17	≥18	<i>r</i> (81); <i>p</i>	<4	≥4	<i>p</i>	<100	100–600	>600	<i>r</i> (53); <i>p</i>
Per capita income (\$)	26909	22285	0.01 ^a	26000	22371	0.06 ^b	26267	22285	24591	0.05; 0.68	23173	23909	0.74	27439	22437	26051	0.23; 0.09 ^b
PCPs per 100 people	0.09	0.07	0.37	0.09	0.07	0.02 ^a	0.1	0.08	0.09	0.19; 0.09 ^b	0.08	0.09	0.77	0.09	0.08	0.09	0.07; 0.61
Rural population per capita	0.13	0.29	0.30	0.13	0.32	0.01 ^a	0.16	0.13	0.31	–0.01; 0.93	0.13	0.13	0.58	0.12	0.13	0.13	0.04; 0.77
Overcrowded housing units per capita	0.01	0.02	0.24	0.02	0.02	0.07 ^b	0.01	0.02	0.01	0.15; 0.19	0.02	0.01	0.26	0.01	0.02	0.01	–0.16; 0.25
Occupied units >30 years old per capita	0.1	0.11	0.02 ^a	0.11	0.11	0.10	0.11	0.11	0.11	0.01; 0.96	0.11	0.11	0.34	0.10	0.13	0.11	–0.29; 0.03 ^a

Medians are presented for each group, and *p* values comparing the distribution, with *r* (df) representing correlation coefficients and degrees of freedom when appropriate. Values of *p* represent continuous dataset analysis with Pearson correlation.

^a*p* < 0.05.

^b*p* < 0.10.

IgE = immunoglobulin E; OC = orbitocranial; PCP = primary care physicians; per capita = per person; RAST = radioallergosorbent test.

tissue samples have been collected from many of the patients in our database, and demographic factors will be compared against a genetic analysis of patient tissues to further describe the role of race, genetics, and socioeconomic factors in AFRS pathogenesis.

The reason for an association of Caucasian race with mold allergy (*p* = 0.03) and high innate score (*p* = 0.07) is unclear at this time. Futures studies are needed to investigate these findings.

The EZ AFRS Severity Scoring System was designed to quantitatively standardize the severity of AFRS, which can be a difficult task considering the disease's unclear pathophysiology and presentation. Although the internal validity of the scoring system is unknown at this time, we selected evidence-supported parameters that have been described in previous literature to create the scoring criteria. Total IgE and RAST class were chosen because they have been found to be predictors of recurrent surgical intervention and degree of polyp extension, respectively; true measures of severity rather than disease progression.^{13,14} Similarly, Lund-Mackay score has long been described as a gold standard for measuring radiographic sinusitis severity.¹⁹ We

anticipate that the scoring system will be integral to classifying our own AFRS patients to optimize referral and treatment, and avoid the destructive progression of AFRS.

Conclusion

Select demographic groups may have a predilection for increased severity of allergic fungal rhinosinusitis. In this study, disease severity was associated with lower income, rural counties, poor housing quality, and less health care access. This cohort's racial and socioeconomic profile is similar to others published in the southeastern United States. However, unlike prior studies with smaller cohorts, we found disease severity to be associated with lower socioeconomic status by county level, suggesting that the disease's predilection for a certain population may be secondary to healthcare accessibility or living conditions rather than race, has been as suggested previously. Prospective studies are needed to collect patient-specific demographic measures and better define at risk groups, allowing tailored diagnoses and treatment to prevent the devastating effects of severe AFRS. 

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