The Association between Social Determinants of Health and Allergic Fungal Rhinosinusitis: A Systematic Review and Meta-Analysis

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INTRODUCTION

- Allergic fungal rhinosinusitis (AFRS) is a subset of chronic rhinosinusitis with nasal polyps (CRSwNP) characterized by eosinophilic mucus and a type I hypersensitivity reaction to fungal antigens.[1]
- Prevalence varies by region, but tends to be highest in the Southeastern United States.[2]
- Some previous studies have shown increased prevalence of AFRS among young, Black patients[3–9] with poor access to healthcare[3,5] as compared to CRS patients. However, other studies have failed to find a significant relationship between demographic or socioeconomic factors and AFRS.[10–12]
- Racial disparities in severity of presentation have additionally been described in the literature.[13,14]
- The purpose of this study was to conduct a systematic review of AFRS and potential social determinants of health, including socioeconomic status, housing, educational status, race, ethnicity, and access/affordability of care. Additionally, we aimed to meta-analyze race and insurance status in AFRS as compared to CRS and assess the impact of racial demographics on disease outcomes.

METHODS

This study was performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[16] A comprehensive search of PubMed (National Library of Medicine, National Institutes of Health), Scopus (Elsevier), and CINAHL (EBSCO) was performed to identify studies published from date of inception to September 29, 2022. The search strategies used a combination of subject headings (e.g., Medical Subject Headings [MeSH] in PubMed) and keywords such as allergic fungal rhinosinusitis, race, socioeconomic, insurance, social determinants of health. This was subsequently reformatted to search the other two databases.

Exclusion criteria were as follows:
- Non-English articles
- Non-human studies
- Review articles not presenting original data
- Case reports or case series
- Studies lacking an AFRS patient population

Two authors (JAG and FGD) independently screened titles and abstracts as well as full-text of articles to identify those that met inclusion criteria. These authors independently performed data extraction and compared results for accuracy. Risk of bias was assessed using the Risk of Bias in Non-Randomized Studies – of Interventions (ROBINS-I)[18] for included studies.

Statistical Methods: Meta-analysis of single means (mean, N for each study, and standard deviation) for age was performed by Comprehensive Meta-Analysis version 3 (Biostat Inc., Englewood, NJ, USA). Meta-analysis of proportions (race, gender, insurance status in patients with AFRS or CRS, rates of bone erosion in AFRS patients stratified by race) was performed using MedCalc 20.110 (MedCalc Software Ltd., Ostend, Belgium; https://www.medcalc.org; accessed on 2020) and were expressed as a percentage with 95% confidence intervals (CI). Each measure was weighted according to the number of patients affected. The weighted-summary proportion was calculated by the Freeman–Tukey transformation.[19] Heterogeneity among studies was assessed using χ^2 and I^2 statistics. $I^2 < 50\%$ indicated acceptable heterogeneity, and, therefore, the fixed-effects model was used. Otherwise, the random-effects model was performed. A comparison of weighted proportions was done to compare race, gender, and insurance status of patients with AFRS vs. CRS and rates of bone erosion among Black vs. White AFRS patients. Finally, funnel plots were performed to further assess the risk of publication bias.[20,21] In a funnel plot, the treatment effect is plotted on the horizontal axis, and the standard error is plotted on the vertical axis. The vertical line represents the summary estimated derived using a fixed-effect meta-analysis. Two diagonal lines represent (pseudo) 95% confidence limits (effect ± 1.96 SE) around the summary effect for each standard error on the vertical axis. These show the expected distribution of studies in the absence of heterogeneity or selection bias. In the absence of heterogeneity, 95% of the studies should lie within the funnel defined by these diagonal lines. Potential publication bias was evaluated by visual inspection of the funnel plot, as bias results in asymmetry of the funnel plot. A p-value of <0.05 was considered to indicate a statistically significant difference for all statistical tests.

RESULTS

A total of 21 studies were included for qualitative review with a total of 16 studies included for meta-analysis (Figure 1). Critical appraisal of studies indicated an acceptably low risk of bias for the majority of included studies (Figure 2). A funnel plot showed that all studies lie inside the funnel with little asymmetry suggesting little publication bias (Figure 3).

A total of 1,612 patients were included, including 719 with a diagnosis of AFRS, 628 with a diagnosis of Chronic Rhinosinusitis with Nasal Polyps (CRSwNP), and 265 with a diagnosis of Chronic Rhinosinusitis without Nasal Polyps (CRSsNP).

The proportion of Black patients among AFRS, CRSwNP, and CRSsNP groups was 58.0% [45.3% to 70.1%], 23.8% [14.1% to 35.2%], and 13.0% [5.1% to 24.0%] respectively (Figure 4A, 4B, 4C). This was significantly higher among the AFRS population compared to both the CRSwNP population (difference 34.2% [28.4% to 39.6%], $p < 0.0001$) and the CRSsNP population (difference 44.9% [38.4% to 50.6%], $p < 0.0001$).

The proportion of bone erosion at presentation among Black and White patients was 64.0% [56.0% to 71.4%] and 45.4% [24.9% to 66.7%] respectively (Figure 4A, 4B). A significantly higher proportion of Black patients in included studies presented with bone erosion (difference 18.6% [6.3% to 30.2%], $p = 0.0029$).

The proportion of patients who were either uninsured or covered by Medicaid among the AFRS, CRSwNP, and CRSsNP populations was 31.5% [25.4% to 38.1%], 8.6% [0.7% to 23.8%], and 5.0% [0.3% to 14.8%] respectively. This was significantly higher among the AFRS group than the CRSwNP group (difference 22.9% [15.3% to 31.1%], $p < 0.0001$) and the CRSsNP group (difference 26.5% [19.1% to 33.4%], $p < 0.0001$).

Figure 1: PRISMA Flow Diagram

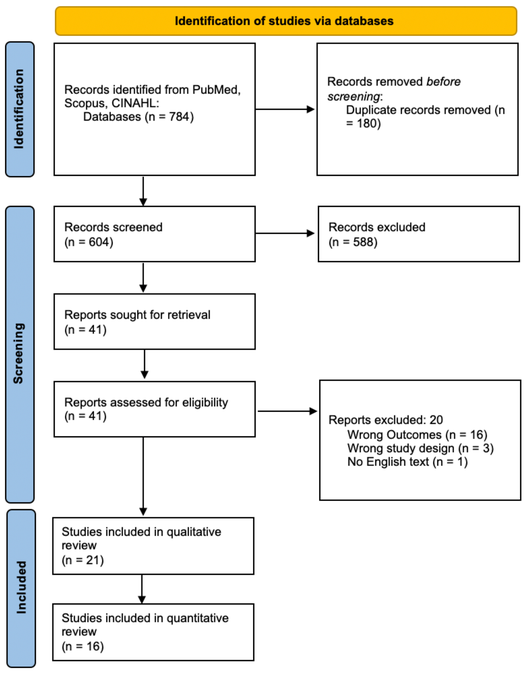

Figure 2: Risk of bias for included studies

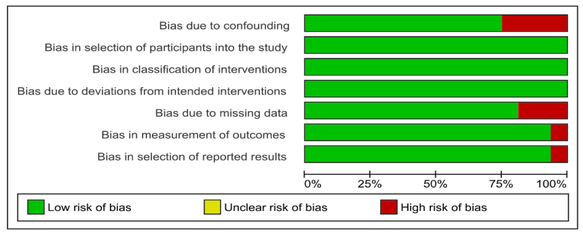

Figure 3: Funnel Plot of Included Studies

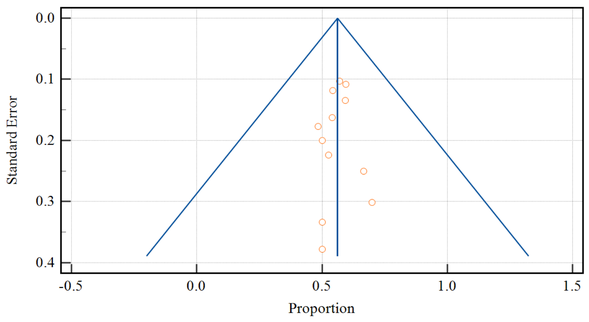

Table 1: Association between Socioeconomic Factors and AFRS

Author	Total Patients	CRS Subtypes Analyzed	Outcomes
Ghegan 2007	54	AFRS	• Presence vs. absence of bone erosion was not associated with percentage of county residents below poverty level, median household income, African Americans residing in specified county
Miller 2014	87	AFRS	• Living in county with lower income per capita associated with bone erosion on presentation and worse radiographic score • Living in county with lower income per capita was not significantly associated with presence of orbitocranial involvement at presentation
Lu-Myers 2015	186	AFRS, CRSwNP, CRSsNP	• AFRS patients lived in counties with significantly lower income per capita than CRSwNP and CRSsNP
Rowan 2020	70	AFRS, CRSwNP	• AFRS more likely to have lower household income • AFRS less likely to own home
Thahim 2007	20	AFRS	• 80% of patients came from low socioeconomic background
Wise 2008	169	AFRS, CRSwNP, CRSsNP	• AFRS patients lived in counties with significantly higher percentage of patients below poverty line than those with CRSsNP (not significant in CRSwNP) • AFRS patients lived in counties with lower median household income than those with CRSsNP (not significant in CRSwNP)

Table 2: Association between Access to Care and AFRS

Author	Total Patients	CRS Subtypes Analyzed	Outcomes
Ghegan 2007	54	AFRS	• Presence vs. absence of bone erosion was not associated with number of physicians per 1,000 residents
Miller 2014	87	AFRS	• Living in county with fewer primary care providers per capita associated with orbitocranial involvement on presentation • Living in county with fewer primary care providers per capita not associated with higher Lund-Mackay scores (approached but did not reach statistical significance)
Lu-Myers 2015	186	AFRS, CRSwNP, CRSsNP	• AFRS patients lived in counties with fewer primary care providers per 100 residents than CRS patients
Wise 2008	169	AFRS, CRSwNP, CRSsNP	• No difference in number of physicians per 1,000 county residents between groups

Table 3: Association between Housing and AFRS

Author	Total Patients	CRS Subtypes Analyzed	Outcomes
Miller 2014	87	AFRS	• Living in county with higher number of houses > 30 years old per capita associated with bone erosion at presentation • Living in county with larger rural population per capita associated with orbitocranial involvement at presentation • Living in county with more overcrowded housing per capita not associated with orbitocranial involvement at presentation (approached but did not reach statistical significance)
Lu-Myers 2015	186	AFRS, CRSwNP, CRSsNP	• No difference in county-based proportion of overcrowded housing residents, residents in > 30 year old housing units, rural population
Rowan 2020	70	AFRS, CRSwNP	• No difference in proportion of patients seeing mold in home, flooding near home • No difference in type of residence, age of home, material home made from between groups • No difference in fungal counts of home samples

CONCLUSIONS

- AFRS patients are more likely to be young, Black, and either uninsured or on subsidized insurance than their CRS counterparts.
- Given that the vast majority of studies used in this meta-analysis were conducted in the Southern United States, the role of social determinants of health in other geographic locations is one worth further investigation and may provide clarity as to why certain individuals develop this disease. The relationship between race and health disparities in the Southern United States is incredibly complex due to a number of social and economic barriers to medical care rooted in structural inequities.
- There are early signs that some social determinants of health may play a role in the development of AFRS; however, significantly more research with an emphasis on uniformity of outcome measurements is required before making any sort of definitive conclusion

ABSTRACT

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REFERENCES

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