



Letter

Living in lower income zip codes is associated with more severe chronic rhinosinusitis

Chronic rhinosinusitis (CRS) is a chronic inflammatory condition afflicting the upper airways. In 2014, approximately 29.4 million adults reported being told by a doctor or other health professional in the past 12 months that they had sinusitis.¹ The pathogenesis of CRS is multifactorial, likely due to a combination of host and environmental factors.² Determining whether the host factors are due to nonmodifiable, such as race, or modifiable risk variables is important. Previous analyses of the effect of socioeconomic status on CRS have yielded conflicting results. All earlier studies were limited due to small sample sizes. More recently, our group has shown that, in Chicago, African Americans have a higher frequency of nasal polypsis, hyposmia, and worse disease on imaging.³ What is uncertain is whether this effect is due to the socioeconomic status of African Americans or other undiscovered factors specific to this group. The purpose of this study was to determine the effect of socioeconomic status in CRS patients in Chicago.

We analyzed a large, retrospective cohort of CRS patients managed at the Rush University Medical Center (RUMC) Allergy/Immunology and Otolaryngology clinics, as previously described.^{3,4} For this study we included CRS patients seen between 2005 and 2015 who had at least 2 visits to the RUMC and had a residential address documented at the time of the last visit. Patients with comorbid cystic fibrosis, primary ciliary dyskinesia, or eosinophilic granulomatosis with polyangiitis were not included. The diagnosis of CRS was based on 12 weeks of continuous sinonasal symptoms with objective findings documented by endoscopic exam and/or sinus computed tomography (CT) scan.³

Socioeconomic status was estimated by the mean household income for the patient's zip code using United States Census data from 2006 to 2010.⁵ The patients were categorized based on their residential zip codes' mean household incomes, which were divided into 4 groups based on federal classifications for tax brackets averaged for the years 2005–2015. The first group consisted of individuals living in zip codes with a mean household income below the first income bracket cutoff for families, which is slightly above the poverty threshold for these years—mean household incomes of below \$37,450. The second group included individuals with mean income in the next tax bracket, between \$37,450 and \$75,900. The third group was the next higher tax bracket, from \$75,900 to \$115,200, whereas the fourth group was from a zip code with a mean income of over \$115,200.

Several predictors from the cohort were used for this study, including patients' characteristics of sex, race, and body mass index

(BMI). In addition, clinical predictors related to CRS, including presence of nasal polyp, comorbid conditions, duration of CRS, number of CRS surgeries, sinus CT score, and Lund-Mackay score (LMS), were also analyzed. We used insurance type as the indicator for access to care. Insurance data were retrieved from the charts for this study and were classified as private, Medicaid, Medicare, or no insurance.

We first analyzed the associations among zip code groups with demographic factors and BMI using analysis of variance or χ^2 test, as appropriate. Associations between the independent zip code groups, demographics, and clinical phenotype variables were then evaluated using multinomial logistic regression adjusting for race, BMI, and insurance. All statistical analyses were performed using SPSS version 21 (IBM SPSS, Inc, Armonk, New York).

Our cohort consisted of 1,102 cases with confirmed diagnosis of CRS who were evaluated at the RUMC. These CRS patients were categorized into the 4 household income groups described previously. There were 38, 541, 435, and 87 patients in groups 1, 2, 3, and 4, respectively. Compared with the higher income group (group 4), group 1 patients (the lowest income group) had a higher BMI and higher percentage of African Americans. Group 2 had a higher percentage of African Americans and Latinos compared with group 4 (Table 1). Furthermore, group 1 had a higher rate of cases covered by Medicaid insurance. Among the study group, 869 had sinus CT scan images to calculate LMS.

The association of different income zip code groups with CRS-related variables detailed earlier was analyzed using a multinomial regression model adjusting for race, insurance, and BMI. Compared with group 4, group 1 had a significantly higher LMS but a similar rate of CRS with nasal polyp and a comparable duration of CRS, and had undergone a similar number of surgeries. There were no statistical differences among the different groups in terms of comorbid asthma, allergic rhinitis, aspirin-exacerbated respiratory disease, and eczema.⁶

Our study has presented some novel findings. Individuals from lower income neighborhoods were more likely to be African American, have a higher BMI, and have Medicaid insurance. After adjusting for these variables, individuals from a low-income zip code (group 1) had more severe CRS, indicating that the link between higher LMS and poor income is not explained by race, insurance type, or BMI. One of the factors that can impact the LMS in CRS is the presence of nasal polyp; in general, CRS patients with nasal polyp have higher LMSs than patients with CRS without nasal polyps. To test whether the presence of nasal polyp impacted our results, we ran the multinomial regression test again and added nasal polyp as a covariable in the model, but this did not change the results. The odds ratio for LMS comparing group 4 with group 1, adjusting for polyp, BMI, insurance, and race, was 1.10 (95% confidence interval, 1.02–1.21; $P = .013$). Two groups of factors linked to lower income zip codes

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Table 1
Patients' Characteristics and Clinical Predictors

Zip code group	Group 1: from zip codes with mean annual household salary <\$37,450	Group 2: from zip codes with mean annual household salary \$37,450–\$75,900	Group 3: from zip codes with mean annual household salary \$75,900–\$115,200	Group 4: from zip codes with mean annual household salary >\$115,200
Number of patients	39	541	435	87
Insurance				
Medicaid	26.3%	15.0%	2.4%	2.8%
Regression coefficient (95% CI) ^a	4.15 (0.78–22.04) P = .094	3.49 (0.81–15.08) P = .093	0.64 (0.13–3.02) P = .57	Reference
Medicare	13.2%	19.8%	18.7%	26.4%
Odds ratio (95% CI)	0.52 (0.16–1.66) P = .27	0.78 (0.43–1.41) P = .41	0.63 (0.13–3.02) P = .57	Reference
Private	55.3%	62.8%	76.7%	68.1%
Odds ratio (95% CI)	0.87 (0.13–2.34) P = .76	0.89 (0.34–1.47) P = .81	1.21 (0.56–2.89) P = .78	Reference
Noninsured	5.3%	2.4%	2.2%	2.8%
Odds ratio (95% CI)	1.34 (0.14–12.28) P = .79	0.71 (0.14–3.48) P = .67	0.57 (0.12–2.74) P = .48	Reference
Age (years), mean (SD)	50.82 (15.72)	48.99 (17.27)	49.84 (17.88)	53.63 (19.11)
Odds ratios (95% CI) ^b	0.92 (0.84–1.02) P = .12	0.99 (0.96–1.02) P = .34	0.98 (0.96–1.01) P = .09	Reference
Gender male (%)	73.7%	60.3%	57.6%	59.7%
Odds ratios (95% CI)	1.21 (0.48–3.21) P = .19	1.15 (0.45–2.90) P = .76	0.91 (0.55–1.53) P = .74	Reference
Race				
African American (%)	84.2%	34.8%	8.9%	4.2%
Odds ratio (95% CI)	15.69 (2.47–80.82) P < .0001	13.08 (4.02–42.56) P < .001	2.56 (0.76–8.57) P = .12	Reference
White (%)	7.9%	47.0%	78.0%	88.9%
Odds ratio (95% CI)	0.065 (0.007–0.64) P = .02	0.42 (0.15–3.23) P = .96	0.64 (0.14–2.89) P = .56	Reference
Latino (%)	2.6%	15.0%	6.7%	4.2%
Odds ratio (95% CI)	6.3 (0.47–77.27) P = .17	6.23 (1.89–20.51) P = .003	1.77 (0.52–5.99) P = .13	Reference
Other (%)	5.3%	2.6%	3.8%	2.8%
Odds ratio (95% CI)	5.42 (1.54–15.6) P = .20	1.37 (0.29–6.33) P = .68	1.54 (0.34–6.91) P = .57	Reference
BMI, mean (SD)	34.48 (0.29)	29.56 (9.03)	25.85 (7.47)	26.25 (4.77)
Odds ratio (95% CI)	1.08 (1.03–1.15) P = .003	1.03 (1.00–1.07) P = .02	0.99 (0.96–1.02) P = .66	Reference
Lund-Mackay score, mean (SD)	7.76 (7.15)	5.15 (5.99)	4.69 (5.66)	4.29 (5.31)
Odds ratio (95% CI)	1.09 (1.01–1.16) P = .015	1.02 (0.975–1.07) P = .36	1.01 (0.97–1.06) P = .62	Reference
Number of FESS surgeries, mean (SD)	0.76 (1.07)	0.68 (1.24)	0.74 (1.26)	0.60 (0.74)
Odds ratio (95% CI)	1.24 (0.87–1.76) P = .23	1.13 (0.87–1.47) P = .34	1.15 (0.89–1.48) P = .28	Reference
Duration of CRS, mean (SD)	6.92 (6.27)	7.19 (8.55)	5.17 (7.51)	5.82 (7.57)
Odds ratio (95% CI)	1.02 (0.96–1.07) P = .46	1.01 (0.98–1.05) P = .24	0.98 (0.95–1.02) P = .48	Reference
Cases with polyp	44.7%	32.9%	35.1%	27.8%
Odds ratio (95% CI)	1.89 (0.78–4.54) P = .15	1.26 (0.71–2.22) P = .41	1.41 (0.81–2.46) P = .22	Reference
Cases with asthma	36.8%	30.2%	32.7%	18.1%
Odds ratio (95% CI)	1.69 (0.65–4.34) P = .28	1.62 (0.85–3.12) P = .14	2.27 (0.96–4.23) P = .063	Reference
Cases with AR	31.6%	29.8%	32.9%	31.9%
Odds ratio (95% CI)	0.88 (0.34–2.26) P = .79	0.92 (0.52–1.63) P = .79	1.08 (0.62–1.89) P = .76	Reference
Cases with eczema	5.3%	7.6%	8.2%	11.7%
Odds ratio (95% CI)	0.19 (0.007–3.31) P = .32	0.21 (0.02–1.91) P = .16	0.16 (0.02–1.3) P = .10	Reference

Abbreviations: AR, allergic rhinosinusitis; BMI, body mass index; CI, confidence interval; CRS, chronic rhinitis; FESS, functional endoscopic sinus surgery.

^aThe reported regression coefficients (95% CI) for all numeric variables were calculated in comparison to the highest income group (group 4) using multinomial logistic regression adjusting for race, insurance, and BMI.^bThe reported odds ratio (95% CI) for all categorical variables were calculated in comparison to the highest income group (group 4) using multinomial logistic regression adjusting for race, insurance, and BMI.

could explain this association: environmental factors and socioeconomic factors. The zip codes with low income were primarily located in the inner-city, polluted neighborhoods of Chicago, whereas the higher income zip codes were mainly close to Lake Michigan or suburbs further away from major roads and highways in the city, and thus potentially in areas with less pollution. The effect of air pollution on CRS has been suggested in previous reports, but the current state of the literature is not strong enough

to draw definitive conclusions in this regard.⁷ Other possible environmental factors include the possible increased exposure to first- or second-hand smoking that is known to affect CRS,⁸ or increased in-house aeroallergens, such as mice or dust mites, in these neighborhoods.

The effect of socioeconomic status on CRS is poorly understood. One small study on 93 CRS patients from North Carolina showed that socioeconomic status, based on patients' residential

county health service area, was not associated with CRS severity.⁶ The lack of an association in that study could be due to the small sample size or the significant variability of socioeconomic status in each county, which covered a relatively large geographic area with multiple zip codes. In a small study from Canada, lower education level and income were associated with increased subjective CRS symptoms, but no association was found with LMS.⁹ The sample size of that study and the fact that it was performed in a country with global health care access could be the reason for their negative result.

Our finding that patients living in a low-income zip code have more severe disease despite similar duration of CRS could suggest that these patients have more rapid progression of disease. Also, our finding that these patients have a similar number of surgeries despite higher LMSs may suggest that some of them needed to undergo sinus surgery, but did not, due to health disparity issues. We found that the type of insurance was not linked to LMS; however, insurance type (private vs Medicaid or Medicare) is not the only factor affecting health-care access, and other factors, such as co-pay amounts and distance from health-care facilities or networks, can impact the care and result in health-care disparity. Therefore, the barrier to accessing referral care centers for patients of lower socioeconomic status who live in lower income zip codes could be higher than for those living in higher income neighborhoods. It is possible that patients from lower income zip codes do not present to a referral center on time and only those with more severe symptoms, as reflected by higher LMS, make it to tertiary-care centers. Further study is needed to determine whether our findings represent an environmental or health disparity mechanism.

The main study limitations include the retrospective design and that our findings are from a single tertiary-care urban academic hospital. As a limitation embedded in retrospective studies we could not trace changes of address in our patient population and used the single address documented in the chart at the time of the visit. In addition, there were uneven numbers of cases in different zip code categories; however, our analyses did show that we had a power of 82% to detect any differences at a significance of greater than .05, despite the lower number of cases in groups 1 and 4. The strengths of this study are the size of the cohort and the diverse patient population.

In conclusion, we have shown that low-income zip code is associated with more severe CRS, as demonstrated by increased LMSs.

Further research is necessary to determine the underlying cause of this association.

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