Social Determinants of Symptom Severity and Healthcare-Seeking in Acute Rhinosinusitis

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Introduction

Acute rhinosinusitis (ARS) is one of the most common upper respiratory conditions encountered in clinical practice, with approximately 20 million cases occurring annually costing three billion dollars in healthcare costs[1]. Typically starting as an upper respiratory infection, it is defined as the inflammation of the nasal sinus and paranasal sinuses, lasting less than four weeks. Despite its notable prevalence, ARS is a self resolving illness, with the majority of patients resolving symptoms without any pharmacologic interventions[2]. Some cases, however, can worsen and progress to acute bacterial rhinosinusitis, which may require medical treatment, and in some cases, can lead to serious orbital or intracranial complications[2,3]. Treatment falls into two categories: symptomatic management, including nasal irrigation and intranasal corticosteroids, and antibacterial therapy for patients with suspected bacterial infection[2]. Since most cases improve with conservative treatment care, early evaluation and proper management are important. However, accessing timely care can be easier for some patients than others depending on their social and economic conditions.

Recently, increasing attention has been directed toward the role of social determinants of health in shaping disease experiences. Factors such as income, educational attainment, insurance coverage, employment stability, access to healthcare resources, and race and ethnicity have been seen as important determinants on an individual's ability to access medical care[4,5]. Studies have shown that patients facing lower socioeconomic disadvantage frequently experience worse sinonasal symptoms and poorer quality of life outcomes, while also experiencing greater barriers to accessing routine medical care[4,5].

Among these factors, health insurance status represents a distinct variable affecting ARS healthcare utilization. Patients covered by public health insurance or lacking coverage have been repeatedly shown to rely on emergency departments for conditions including ARS[6,7]. Medicaid and uninsured individuals are about ten and nine times more likely, respectively, to seek emergency care for uncomplicated ARS compared to those with private coverage[6]. These differences are not because of varying disease presentation. Rather, it is explained by the difficulty that publicly insured and uninsured patients face in making timely appointments with their primary care providers, making the emergency

department the most accessible pathway for acute symptom management[6,8]. This pattern of delayed access is further supported by evidence showing that uninsured patients present with higher pain levels suggesting that symptom decline occurs due to lack of early clinical intervention[7].

Beyond the influence of insurance coverage, research in ARS has shown a pattern in which patients of lower socioeconomic status are more likely to experience delayed specialist presentation, less likely to maintain consistent follow up care, and more likely to live in environments with elevated levels of air pollution that worsen symptoms[4]. Patients from lower income and less educated communities are less likely to utilize specialty rhinology services and encounter additional barriers when navigating healthcare services including transportation challenges and limited healthcare literacy[9]. Educational attainment also plays an important role, as individuals from highly educated communities are substantially more likely to access specialized sinus care, possibly indicating that awareness of symptoms and familiarity with healthcare resources may affect when patients get evaluated. Such barriers are important as delayed presentation and management of sinonasal disease may allow symptoms to worsen over time. Studies of acute bacterial sinusitis have shown that children with Medicaid or no insurance are more likely to present with severe intracranial complications, supporting the possibility that limited access to timely care contributes to more advanced disease at presentation[10]. These findings suggest that socioeconomic factors may influence where patients seek care, how early they enter the healthcare system, and the severity of symptoms they experience when they present for evaluation.

Race and ethnicity have also been associated with differences in healthcare utilization and clinical outcomes among patients with ARS. Studies examining ARS have found that Black patients are significantly more likely to present to emergency departments for ARS, with one study reporting that Black patients were approximately six times more likely than White patients to present to an ED for uncomplicated ARS[6]. Research has also shown differences in symptom presentation across racial and ethnic groups. Hispanic patients were less likely to report classic sinonasal symptoms instead reporting facial pains and headaches, whereas Black patients were less likely to report sinonasal symptoms overall[6].

These differences in symptom presentation may influence how patients perceive their illness and when they choose to seek medical evaluation.

This study will investigate whether specific socioeconomic factors, including household income, insurance type, educational attainment, employment status, and race and ethnicity are associated with delayed healthcare-seeking behavior and greater symptom severity in patients presenting with acute rhinosinusitis. The primary outcome is symptom severity at presentation, measured using the baseline modified Sino-Nasal Outcome Test-16 (mSNOT-16) score. A secondary outcome is the duration of symptoms prior to presentation, measured as the number of days between symptom onset and enrollment as an indicator of delayed healthcare-seeking behavior. Building on previous literature, it is hypothesized that patients with lower household incomes, public or no health insurance, lower levels of educational attainment, unemployment or underemployment, and racial or ethnic minority backgrounds will experience longer delays between symptom onset and medical evaluation than patients with greater socioeconomic resources and improved access to healthcare. Additionally, these patients are expected to present with greater symptom severity at the time of evaluation, reflecting the compounded effects of reduced healthcare access. Identifying these relationships can offer ways for targeted interventions to be designed to prevent the cycle of delayed access and worsening disease that disadvantaged patients disproportionately experience.

Methods

Study Design and Population

This study will be a retrospective secondary analysis of data collected through the NOSES (Nasal Steroids, Irrigation, Oral Antibiotics and Subgroup Targeting for Effective Management of Sinusitis) trial. The NOSES study is a randomized clinical trial designed to evaluate treatment strategies for adults presenting with acute rhinosinusitis in primary care settings across the United States. Participants were enrolled through six Practice-Based Research Networks: Georgetown University, Penn State College of Medicine, University of California Los Angeles, University of Washington, University of

Wisconsin-Madison, and Virginia Commonwealth University. Data will be extracted from the study's REDCap database and will include demographic, socioeconomic, and clinical information collected at the enrollment visit.

Participants

The parent NOSES study enrolled adults aged 18 to 75 years old presenting to participating primary care, urgent care, or student health center clinics with signs and symptoms of ARS.

Inclusion and Exclusion Criteria

Eligible participants had symptoms lasting for 1 to 21 days without improvement or met the criteria for double sickening, where they had experienced improvement for 1 to 7 days followed by new or worsening symptoms. Symptoms that qualify for enrollment included facial pain or pressure, nasal obstruction, nasal discharge, reduced or no sense or smell, a fever greater than 39 degrees Celcius, headache, poor smelling breath, fatigue, ear pain or pressure, and dental pain. Exclusionary criteria included known allergy or intolerance to penicillin, received systemic antibiotic therapy in the prior four weeks, had prior sinus surgery for sinusitis, had complications of rhinosinusitis, were pregnant or breastfeeding, had a comorbidity or medication impairing immune response, were hospitalized in the prior five days, were unable to read, speak, or understand English or Spanish, or had been previously enrolled in the NOSES study. Participants using nasal corticosteroids in the two weeks prior to enrollment were also excluded unless they were willing to discontinue use 3 days prior to randomization.

The present secondary analysis includes all participants who completed the Demographics And General Health Patient Form at enrollment and for whom socioeconomic status (SES) data and at least one symptom severity measure was available.

Socioeconomic Indicators

Socioeconomic status is assessed using four self-reported indicators collected from the Demographics and General Health Patient Form administered at enrollment in REDCap. These indicators include:

1. Annual Household Income: This variable is reported across eight categories: less than $15,000; $15,000–$30,000; $30,001–$50,000; $50,001–$75,000; $75,001–$100,000; $100,001–$150,000; $150,001–$200,000; and more than $200,000. Analyses will retain this structure.
2. Educational Attainment: This variable is reported across eight distinct categories, ranging from some high school through a professional or doctoral degree.
3. Health Insurance Status: Participants initially indicate their coverage via a binary yes/no question, followed by selecting their specific insurance type (private, Medicare, Medicaid, self-insured, uninsured, or other).
4. Employment Status: Reported across ten categories, which capture diverse statuses including full-time or part-time employment, self-employment, unemployment, student status, retirement, and stay-at-home caregiving.
5. Race: Race is reported across seven categories: American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, Black or African American, White, More than one race, and Other.
6. Ethnicity: Ethnicity is reported as Hispanic or Latino, Not Hispanic or Latino, or Prefer not to answer.

Participants who selected 'Prefer not to answer' or 'Don't Know' for any SES indicator will be treated as missing for that variable.

Outcome Measures

The primary outcome of this study will be symptom severity at presentation, measured using the modified Sino-Nasal Outcome Test-16 (mSNOT-16) score recorded at Day 0. The mSNOT-16 is a validated patient-reported outcome measure used to assess symptom burden and disease-specific quality

of life in adults with acute rhinosinusitis[11,12]. Higher mSNOT-16 scores indicate greater symptom severity and poorer quality of life. The mSNOT-16 score will be analyzed as a continuous variable. Secondary outcomes will include symptom duration at presentation, measured as the number of days elapsed between symptom onset and enrollment, as recorded in the Study Eligibility Form in REDCap. This variable will be analyzed as a continuous measure, with larger values indicating a longer duration of symptoms prior to seeking medical evaluation.

Delayed Healthcare-Seeking Behavior

Delayed healthcare-seeking behavior is measured as the number of days elapsed between symptom onset and the enrollment visit, as recorded in the Study Eligibility Form in REDCap. This variable is recorded as a continuous integer representing the symptom day at presentation (e.g., a patient presenting on their fifth day of symptoms receives a value of 5). Larger values indicate a longer duration of symptoms prior to seeking medical evaluation and are interpreted as reflecting greater delays in healthcare-seeking behavior. Days from symptom onset to presentation will be analyzed as a continuous variable and compared across socioeconomic and demographic groups, including income, insurance status, educational attainment, employment status, and race and ethnicity.

Symptom Severity

Symptom severity is measured using the modified Sino-Nasal Outcome Test-16 (mSNOT-16), a validated patient-reported outcome instrument that assesses symptom burden and disease-specific quality of life in adults with ARS. Higher mSNOT-16 scores indicate greater symptom severity and poorer quality of life. The mSNOT-16 score used in this analysis is drawn from the daily symptom diary entry recorded on the day of presentation. This examines how a patient's timing in seeking care relates to their symptom severity, looking closely at whether lower SES correlates with greater symptom burden at presentation. The mSNOT-16 score is analyzed as a continuous variable.

mSNOT-16 Calculation [ADD]

Statistical Analysis [FILL IN]

For variables with more than two categories, the ANOVA p-value indicates whether at least one pair of group means differs significantly; it does not imply that all categories differ from one another or that the variable shows a uniform association with the outcome. Significant pairwise differences were therefore identified using Bonferroni-adjusted post hoc comparisons not shown in this paper.

Results

A total of 1632 participants were analyzed in the study. Of the 1632 participants, 1194 participants were enrolled in Phase 1 of the NOSES study, while 438 were directly randomized to Phase 2. The study population was relatively young, with 42% of participants aged 18-29 years and 25% aged 30-44 years, while 18% were 45-59 years of age and 12% were 60 years or older. Females comprised the majority of the cohort (63%). The cohort was predominantly White (57%), followed by Asian (13%) and Black or African American (12%) participants. Most participants identified as non-Hispanic or Latino (80%), whereas 15% identified as Hispanic or Latino. Complete demographic and socioeconomic characteristics of the study population are presented in Table 1.

Symptom Severity at Presentation

Baseline mSNOT-16 scores were generally similar across the socioeconomic and demographic groups examined, and no consistent pattern of symptom severity was observed when examining annual household income, insurance status, insurance type, or ethnicity (Table 2). Mean baseline mSNOT-16 scores were significantly lower among Asian participants compared to Black or African American ($p = 0.026$), White participants ($p < 0.001$) and Other participants ($p < 0.001$) (Table 2). When examining participants in Phase 1 only, Asian participants have a significantly lower baseline mSNOT-16 score than

White participants (p = 0.007) and Other participants (p = 0.002) (Table 3). Additionally, within Phase 1 participants, Hispanic participants have a lower baseline mSNOT-16 score than non-Hispanic participants (p = 0.015). Analyses restricted to participants directly randomized to Phase 2 produced no significant differences across socioeconomic and demographic groups (Table 4).

Delayed Healthcare-Seeking Behavior

Mean symptom duration did not differ significantly across most socioeconomic or demographic groups, and lower socioeconomic status was not consistently associated with longer presentation delays (Table 5). However, Black or African American participants reported significantly lower symptom days prior to the first clinical visit (p = 0.014), coming earlier to the clinic on average by 1.5 days. Additionally, those with more than one race come later to the clinic, on average, by 2.3 days (p = 0.001). Among Phase 1 participants, stay-at-home parents reported a longer mean symptom duration before presentation (7.08 ± 1.98 days) than participants employed full-time by an employer (4.73 ± 2.07 days; p = 0.008), employed full-time while self-employed (4.52 ± 2.10 days; p = 0.033), employed part-time by an employer (4.80 ± 2.04 days; p = 0.021), unemployed participants (4.59 ± 2.20 days; p = 0.011), or reporting more than one employment category (4.96 ± 2.07 days; p = 0.047) (Table 6). Analyses for participants directly randomized to Phase 2 produced no significant differences across socioeconomic and demographic groups (Table 7).

Table 1. Characteristics of the study participants.

Characteristic	Georgetown University	Virginia Commonwealth University	Pennsylvania State University	University of California Los Angeles University	University of Washington	University of Wisconsin	Overall
Grand Total	309	262	267	259	227	197	1521

Characteristic	Georgetown University	Virginia Commonwealth University	Pennsylvania State University	University of California Los Angeles University	University of Washington	University of Wisconsin	Overall
Age-Group							
18-29	159 (51%)	88 (34%)	111 (42%)	59 (23%)	122 (54%)	98 (50%)	637 (42%)
30-44	75 (24%)	66 (25%)	40 (15%)	87 (34%)	47 (21%)	62 (31%)	377 (25%)
45-59	53(17%)	66 (25%)	40 (15%)	61 (24%)	34 (15%)	25 (13%)	279 (18%)
60+	19 (6%)	42 (16%)	52 (19%)	43 (17%)	22 (10%)	12 (6%)	190 (12%)
Missing	3 (1%)	0 (0%)	24 9%)	9 (3%)	2 (1%)	0 (0%)	38 (2%)
Gender							
Man	89 (29%)	92 (35%)	69 (26%)	93 (36%)	81 (36%)	59 (30%)	483 (32%)
Woman	213 (59%)	164 (63%)	171 (64%)	156 (60%)	134 (59%)	126 (64%)	964 (63%)
Non-binary	3 (1%)	5 (2%)	1 (0%)	1 (0%)	5 (2%)	11 (6%)	26 (2%)
Prefer not to answer	0 (0%)	0 (0%)	1 (0%)	0 (0%)	3 (1%)	0 (0%)	4 (0%)
Prefer to self describe	1 (0%)	1 (0%)	0 (0%)	0 (0%)	2 (1%)	1 (1%)	5 (0%)
Missing	3 (1%)	0 (0%)	25 (9%)	9 (3%)	2 (1%)	0 (0%)	39 (3%)
Race							
White	152 (49%)	137 (52%)	188 (70%)	116 (45%)	124 (55%)	145 (74%)	862 (57%)
Black or African American	92 (30%)	47 (18%)	14 (5%)	16 (6%)	7 (3%)	8 (4%)	184 (12%)

Characteristic	Georgetown University	Virginia Commonwealth University	Pennsylvania State University	University of California Los Angeles University	University of Washington	University of Wisconsin	Overall
Asian	35 (11%)	31 (12%)	13 (5%)	43 (17%)	49 (22%)	25 (13%)	196 (13%)
American Indian or Alaska Native	0 (0%)	1 (0%)	1 (0%)	4 (2%)	6 (3%)	1 (1%)	13 (1%)
Native Hawaiian or Other Pacific Islander	0 (0%)	2 (1%)	1 (0%)	3 (1%)	1 (0%)	0 (0%)	7 (0%)
More than one race	20 (6%)	9 (3%)	12 (4%)	21 (8%)	24 (11%)	11 (6%)	97 (6%)
Other	3 (1%)	31 (12%)	2 (1%)	33 (13%)	3 (1%)	1 (1%)	73 (5%)
Prefer not to answer	4 (1%)	4 (2%)	10 (4%)	14 (5%)	11 (5%)	5 (3%)	48 (3%)
Missing	3 (1%)	0 (0%)	26 (10%)	9 (3%)	2 (1%)	1 (1%)	41 (3%)
Ethnicity							
Hispanic or Latino	37 (12%)	37 (14%)	15 (6%)	88 (34%)	30 (13%)	27 (14%)	234 (15%)
Not Hispanic or Latino	262 (85%)	225 (86%)	221 (83%)	157 (61%)	186 (82%)	168 (85%)	1219 (80%)

Table 2. Baseline mSNOT Score for All Enrolled Participants (N = 1632).

Demographic variable	**Category**	**Baseline MSNOT-16 Mean (SD), N**	**ANOVA p-value***
Race	American Indian or Alaska Native	1.54 (0.62), N=13	0.0002
	Asian	1.27 (0.56), N=208	
	Black or African American	1.46 (0.60), N=193	
	More than one race	1.48 (0.52), N=101	

Demographic variable	Category	Baseline MSNOT-16 Mean (SD), N	ANOVA p-value*
	Native Hawaiian or Other Pacific Islander	1.55 (0.17), N=7	
	Other	1.61 (0.59), N=73	
	Prefer not to answer	1.40 (0.70), N=49	
	White	1.47 (0.57), N=901	
Annual household income	Less than $15,000	1.59 (0.57), N=76	0.2275
	$15,000 - $30,000	1.48 (0.52), N=78	
	$30,001 - $50,000	1.48 (0.62), N=120	
	$50,001 - $75,000	1.53 (0.50), N=154	
	$75,001 - $100,000	1.45 (0.59), N=155	
	$100,001 - $150,000	1.42 (0.55), N=202	
	$150,001 - $200,000	1.45 (0.56), N=151	
	More than $200,000	1.42 (0.56), N=264	
	Dont Know	1.42 (0.64), N=184	
	Prefer not to answer	1.39 (0.61), N=161	
Education level	Associate's degree/trade school	1.52 (0.54), N=120	0.0022
	Bachelor's degree	1.46 (0.57), N=446	
	High school degree or equivalent	1.45 (0.59), N=195	
	Master's degree	1.45 (0.56), N=246	
	Other	1.53 (0.71), N=12	
	Prefer not to answer	0.86 (0.57), N=10	
	Professional or Doctorate	1.28 (0.52), N=107	
	Some college or trade school	1.48 (0.59), N=383	
	Some high school	1.34 (0.61), N=25	
Has health insurance	No	1.33 (0.63), N=27	0.6258
	Prefer not to answer	1.45 (0.84), N=13	
	Yes	1.44 (0.57), N=1,039	
Health insurance type	Medicaid	1.54 (0.59), N=138	0.2084
	Medicare	1.39 (0.59), N=97	
	More than one	1.48 (0.52), N=78	
	Other	1.53 (0.64), N=87	
	Prefer not to answer	1.46 (0.58), N=67	
	Private	1.44 (0.56), N=990	
	Self-insured	1.23 (0.53), N=21	

Demographic variable	Category	Baseline MSNOT-16 Mean (SD), N	ANOVA p-value*
	Uninsured	1.19 (0.00), N=1	
Employment status	Employed full-time (employee)	1.47 (0.56), N=691	0.0001
	Employed full-time (self)	1.50 (0.64), N=36	
	Employed part-time (employee)	1.52 (0.53), N=165	
	Employed part-time (self)	1.26 (0.57), N=23	
	Full-time student	1.32 (0.57), N=186	
	More than one	1.51 (0.59), N=198	
	Other	1.79 (0.52), N=21	
	Prefer not to answer	1.11 (0.85), N=12	
	Retired	1.31 (0.56), N=110	
	Stay at home parent	1.50 (0.69), N=17	
	Unemployed	1.44 (0.61), N=88	
Ethnicity	Hispanic or Latino	1.52 (0.56), N=240	0.0766
	Not Hispanic or Latino	1.44 (0.58), N=1,276	
	Prefer not to answer	1.36 (0.66), N=30	

**A significant ANOVA p-value indicates that at least one pair of categories differs. Specific group differences were identified using Bonferroni-adjusted pairwise comparisons.*

Table 3. Baseline mSNOT Score for Phase 1 Participants Only (N = 1194).

Demographic variable	Category	Baseline MSNOT-16 Mean (SD), N	ANOVA p-value*
Race	American Indian or Alaska Native	1.56 (0.65), N=11	0.0040
	Asian	1.33 (0.56), N=144	
	Black or African American	1.52 (0.58), N=162	
	More than one race	1.56 (0.43), N=64	
	Native Hawaiian or Other Pacific Islander	1.55 (0.17), N=7	
	Other	1.68 (0.57), N=59	
	Prefer not to answer	1.46 (0.73), N=41	
	White	1.52 (0.58), N=651	
Annual household income	Less than $15,000	1.64 (0.59), N=53	0.2996
	$15,000 - $30,000	1.55 (0.50), N=54	
	$30,001 - $50,000	1.57 (0.63), N=86	

Demographic variable	Category	Baseline MSNOT-16 Mean (SD), N	ANOVA p-value*
	$50,001 - $75,000	1.60 (0.51), N=108	
	$75,001 - $100,000	1.49 (0.59), N=112	
	$100,001 - $150,000	1.45 (0.55), N=153	
	$150,001 - $200,000	1.51 (0.56), N=109	
	More than $200,000	1.49 (0.57), N=192	
	Dont Know	1.46 (0.63), N=142	
	Prefer not to answer	1.46 (0.59), N=129	
Education level	Associate's degree/trade school	1.53 (0.54), N=100	0.0198
	Bachelor's degree	1.51 (0.59), N=331	
	High school degree or equivalent	1.50 (0.57), N=148	
	Master's degree	1.53 (0.55), N=169	
	Other	1.34 (0.75), N=8	
	Prefer not to answer	0.83 (0.67), N=7	
	Professional or Doctorate	1.33 (0.55), N=72	
	Some college or trade school	1.53 (0.59), N=286	
	Some high school	1.55 (0.56), N=16	
Has health insurance	No	1.47 (0.65), N=20	0.7936
	Prefer not to answer	1.62 (0.87), N=9	
	Yes	1.49 (0.56), N=753	
Health insurance type	Medicaid	1.62 (0.57), N=102	0.0536
	Medicare	1.46 (0.59), N=69	
	More than one	1.48 (0.51), N=54	
	Other	1.65 (0.59), N=69	
	Prefer not to answer	1.47 (0.61), N=56	
	Private	1.49 (0.56), N=723	
	Self-insured	1.27 (0.53), N=16	
Employment status	Employed full-time (employee)	1.52 (0.56), N=524	0.0010
	Employed full-time (self)	1.49 (0.61), N=25	
	Employed part-time (employee)	1.57 (0.55), N=120	
	Employed part-time (self)	1.21 (0.62), N=17	
	Full-time student	1.41 (0.58), N=130	
	More than one	1.60 (0.57), N=152	
	Other	1.89 (0.37), N=11	

Demographic variable	Category	Baseline MSNOT-16 Mean (SD), N	ANOVA p-value*
	Prefer not to answer	1.12 (0.90), N=11	
	Retired	1.35 (0.57), N=77	
	Stay at home parent	1.55 (0.79), N=11	
	Unemployed	1.48 (0.59), N=62	
Ethnicity	Hispanic or Latino	1.61 (0.54), N=185	0.0179
	Not Hispanic or Latino	1.48 (0.58), N=932	
	Prefer not to answer	1.47 (0.73), N=22	

**A significant ANOVA p-value indicates that at least one pair of categories differs. Specific group differences were identified using Bonferroni-adjusted pairwise comparisons.*

Table 4. Baseline mSNOT Score for Participants Directly Randomized to Phase 2 (N = 438).

Demographic variable	Category	Baseline MSNOT-16 Mean (SD), N	ANOVA p-value*
Race	American Indian or Alaska Native	1.44 (0.53), N=2	0.1210
	Asian	1.15 (0.54), N=64	
	Black or African American	1.16 (0.64), N=31	
	More than one race	1.33 (0.64), N=37	
	Other	1.32 (0.61), N=14	
	Prefer not to answer	1.08 (0.44), N=8	
	White	1.35 (0.52), N=250	
Annual household income	Less than $15,000	1.47 (0.50), N=23	0.5121
	$15,000 - $30,000	1.34 (0.54), N=24	
	$30,001 - $50,000	1.25 (0.54), N=34	
	$50,001 - $75,000	1.37 (0.45), N=46	
	$75,001 - $100,000	1.34 (0.59), N=43	
	$100,001 - $150,000	1.33 (0.56), N=49	
	$150,001 - $200,000	1.31 (0.53), N=42	
	More than $200,000	1.23 (0.49), N=72	
	Dont Know	1.28 (0.67), N=42	
	Prefer not to answer	1.12 (0.61), N=32	
Education level	Associate's degree/trade school	1.46 (0.59), N=20	0.0900
	Bachelor's degree	1.31 (0.51), N=115	

Demographic variable	Category	Baseline MSNOT-16 Mean (SD), N	ANOVA p-value*
	High school degree or equivalent	1.29 (0.61), N=47	
	Master's degree	1.27 (0.53), N=77	
	Other	1.92 (0.52), N=4	
	Prefer not to answer	0.92 (0.32), N=3	
	Professional or Doctorate	1.18 (0.46), N=35	
	Some college or trade school	1.32 (0.57), N=97	
	Some high school	0.98 (0.57), N=9	
Has health insurance	No	0.95 (0.33), N=7	0.1656
	Prefer not to answer	1.06 (0.74), N=4	
	Yes	1.30 (0.55), N=286	
Health insurance type	Medicaid	1.30 (0.60), N=36	0.3211
	Medicare	1.20 (0.57), N=28	
	More than one	1.48 (0.55), N=24	
	Other	1.06 (0.62), N=18	
	Prefer not to answer	1.38 (0.43), N=11	
	Private	1.32 (0.54), N=267	
	Self-insured	1.09 (0.55), N=5	
	Uninsured	1.19 (0.00), N=1	
Employment status	Employed full-time (employee)	1.32 (0.54), N=167	0.0616
	Employed full-time (self)	1.53 (0.74), N=11	
	Employed part-time (employee)	1.40 (0.46), N=45	
	Employed part-time (self)	1.41 (0.42), N=6	
	Full-time student	1.11 (0.49), N=56	
	More than one	1.22 (0.56), N=46	
	Other	1.67 (0.66), N=10	
	Prefer not to answer	1.00 (0.00), N=1	
	Retired	1.20 (0.54), N=33	
	Stay at home parent	1.40 (0.48), N=6	
	Unemployed	1.34 (0.64), N=26	
Ethnicity	Hispanic or Latino	1.21 (0.55), N=55	0.2173
	Not Hispanic or Latino	1.31 (0.55), N=344	

Demographic variable	Category	Baseline MSNOT-16 Mean (SD), N	ANOVA p-value*
	Prefer not to answer	1.06 (0.29), N=8	

**A significant ANOVA p-value indicates that at least one pair of categories differs. Specific group differences were identified using Bonferroni-adjusted pairwise comparisons.*

Table 5. Number of Symptom Days at First Visit for ALL Participants.

Demographic variable	Category	Symptom days Mean (SD), N	ANOVA p-value*
Race	American Indian or Alaska Native	6.69 (4.07), N=13	0.0000
	Asian	7.67 (4.47), N=214	
	Black or African American	6.13 (3.69), N=198	
	More than one race	8.43 (5.19), N=105	
	Native Hawaiian or Other Pacific Islander	3.71 (0.95), N=7	
	Other	6.50 (4.17), N=76	
	Prefer not to answer	6.10 (3.78), N=52	
	White	7.34 (4.61), N=925	
Annual household income	Less than $15,000	7.51 (4.97), N=77	0.3720
	$15,000 - $30,000	7.76 (5.20), N=80	
	$30,001 - $50,000	7.64 (4.65), N=122	
	$50,001 - $75,000	7.30 (4.20), N=159	
	$75,001 - $100,000	7.50 (4.45), N=161	
	$100,001 - $150,000	7.04 (4.30), N=204	
	$150,001 - $200,000	7.37 (4.66), N=157	
	More than $200,000	7.32 (4.61), N=272	
	Dont Know	6.58 (4.04), N=189	
	Prefer not to answer	6.72 (4.60), N=169	
Education level	Associate's degree/trade school	6.42 (4.19), N=125	0.1666
	Bachelor's degree	7.13 (4.51), N=458	
	High school degree or equivalent	6.99 (4.49), N=204	
	Master's degree	7.65 (4.69), N=249	
	Other	8.77 (3.65), N=13	
	Prefer not to answer	8.80 (4.37), N=10	
	Professional or Doctorate	7.63 (4.37), N=110	

Demographic variable	Category	Symptom days Mean (SD), N	ANOVA p-value*
	Some college or trade school	7.12 (4.49), N=395	
	Some high school	8.04 (5.35), N=25	
Has health insurance	No	6.85 (4.61), N=27	0.7969
	Prefer not to answer	7.77 (4.02), N=13	
	Yes	7.38 (4.55), N=1,074	
Health insurance type	Medicaid	7.48 (4.72), N=145	0.1076
	Medicare	7.55 (4.00), N=99	
	More than one	7.76 (4.88), N=79	
	Other	6.43 (4.42), N=92	
	Prefer not to answer	6.62 (4.62), N=68	
	Private	7.23 (4.49), N=1,017	
	Self-insured	5.91 (4.21), N=22	
	Uninsured	16.00 (0.00), N=1	
Employment status	Employed full-time (employee)	6.89 (4.47), N=707	0.0922
	Employed full-time (self)	7.53 (5.14), N=36	
	Employed part-time (employee)	7.12 (4.53), N=169	
	Employed part-time (self)	8.46 (5.26), N=24	
	Full-time student	7.73 (4.71), N=194	
	More than one	7.07 (4.42), N=206	
	Other	9.24 (4.58), N=21	
	Prefer not to answer	7.62 (5.17), N=13	
	Retired	7.80 (4.37), N=111	
	Stay at home parent	8.47 (2.52), N=19	
	Unemployed	7.02 (4.28), N=92	
Ethnicity	Hispanic or Latino	6.64 (4.31), N=250	0.0870
	Not Hispanic or Latino	7.32 (4.54), N=1,311	
	Prefer not to answer	6.93 (4.64), N=30	

**A significant ANOVA p-value indicates that at least one pair of categories differs. Specific group differences were identified using Bonferroni-adjusted pairwise comparisons.*

Table 6. Number of Symptom Days at First Visit for Phase 1 participants.

Demographic variable	Category	Symptom days Mean (SD), N	ANOVA p-value*
Race	American Indian or Alaska Native	5.27 (2.33), N=11	0.6784
	Asian	5.10 (2.06), N=145	
	Black or African American	4.88 (2.16), N=167	
	More than one race	5.06 (2.17), N=67	
	Native Hawaiian or Other Pacific Islander	3.71 (0.95), N=7	
	Other	4.73 (1.91), N=60	
	Prefer not to answer	4.74 (2.23), N=43	
	White	4.88 (2.16), N=657	
Annual household income	Less than $15,000	4.68 (2.08), N=53	0.7530
	$15,000 - $30,000	4.75 (2.34), N=55	
	$30,001 - $50,000	5.10 (1.95), N=87	
	$50,001 - $75,000	5.07 (2.18), N=112	
	$75,001 - $100,000	5.13 (2.24), N=114	
	$100,001 - $150,000	4.99 (2.16), N=153	
	$150,001 - $200,000	4.88 (2.30), N=111	
	More than $200,000	4.87 (2.03), N=194	
	Dont Know	4.81 (2.15), N=145	
	Prefer not to answer	4.67 (2.08), N=132	
Education level	Associate's degree/trade school	4.78 (2.20), N=102	0.3223
	Bachelor's degree	4.84 (2.09), N=336	
	High school degree or equivalent	4.84 (2.08), N=154	
	Master's degree	4.95 (2.18), N=170	
	Other	6.50 (1.93), N=8	
	Prefer not to answer	6.43 (2.57), N=7	
	Professional or Doctorate	5.03 (1.96), N=72	
	Some college or trade school	4.91 (2.22), N=290	
	Some high school	4.75 (1.88), N=16	
Has health insurance	No	4.60 (2.33), N=20	0.5404
	Prefer not to answer	5.56 (2.13), N=9	
	Yes	4.98 (2.18), N=764	
Health insurance type	Medicaid	5.11 (2.28), N=106	0.0889
	Medicare	5.49 (2.18), N=70	

Demographic variable	Category	Symptom days Mean (SD), N	ANOVA p-value*
	More than one	4.89 (2.23), N=54	
	Other	4.49 (2.09), N=72	
	Prefer not to answer	4.91 (2.28), N=57	
	Private	4.88 (2.10), N=731	
	Self-insured	4.18 (1.85), N=17	
Employment status	Employed full-time (employee)	4.73 (2.07), N=531	0.0007
	Employed full-time (self)	4.52 (2.10), N=25	
	Employed part-time (employee)	4.80 (2.04), N=122	
	Employed part-time (self)	5.47 (2.12), N=17	
	Full-time student	5.13 (2.32), N=132	
	More than one	4.96 (2.07), N=155	
	Other	5.55 (2.02), N=11	
	Prefer not to answer	5.73 (2.20), N=11	
	Retired	5.51 (2.29), N=78	
	Stay at home parent	7.08 (1.98), N=12	
	Unemployed	4.59 (2.20), N=64	
Ethnicity	Hispanic or Latino	4.64 (2.11), N=190	0.1455
	Not Hispanic or Latino	4.97 (2.14), N=945	
	Prefer not to answer	4.68 (2.15), N=22	

**A significant ANOVA p-value indicates that at least one pair of categories differs. Specific group differences were identified using Bonferroni-adjusted pairwise comparisons.*

Table 7. Number of Symptom Days at First Visit for Directly Randomized Participants.

Demographic variable	Category	Symptom days Mean (SD), N	ANOVA p-value*
Race	American Indian or Alaska Native	14.50 (0.71), N=2	0.4473
	Asian	13.07 (3.17), N=69	
	Black or African American	12.87 (2.83), N=31	
	More than one race	14.37 (3.25), N=38	
	Other	13.13 (3.63), N=16	
	Prefer not to answer	12.56 (2.92), N=9	
	White	13.36 (3.29), N=268	

Demographic variable	Category	Symptom days Mean (SD), N	ANOVA p-value*
Annual household income	Less than $15,000	13.75 (3.58), N=24	0.2055
	$15,000 - $30,000	14.40 (3.14), N=25	
	$30,001 - $50,000	13.94 (3.18), N=35	
	$50,001 - $75,000	12.62 (2.86), N=47	
	$75,001 - $100,000	13.23 (2.99), N=47	
	$100,001 - $150,000	13.20 (3.08), N=51	
	$150,001 - $200,000	13.37 (3.24), N=46	
	More than $200,000	13.42 (3.42), N=78	
	Dont Know	12.41 (3.24), N=44	
	Prefer not to answer	14.03 (3.56), N=37	
Education level	Associate's degree/trade school	13.65 (3.10), N=23	0.8443
	Bachelor's degree	13.43 (3.16), N=122	
	High school degree or equivalent	13.62 (3.27), N=50	
	Master's degree	13.47 (3.11), N=79	
	Other	12.40 (2.61), N=5	
	Prefer not to answer	14.33 (0.58), N=3	
	Professional or Doctorate	12.55 (3.29), N=38	
	Some college or trade school	13.22 (3.42), N=105	
	Some high school	13.89 (4.37), N=9	
Has health insurance	No	13.29 (3.15), N=7	0.9498
	Prefer not to answer	12.75 (2.22), N=4	
	Yes	13.28 (3.32), N=310	
Health insurance type	Medicaid	13.92 (3.44), N=39	0.1446
	Medicare	12.52 (2.85), N=29	
	More than one	13.96 (2.81), N=25	
	Other	13.45 (3.33), N=20	
	Prefer not to answer	15.45 (3.36), N=11	
	Private	13.23 (3.24), N=286	
	Self-insured	11.80 (4.82), N=5	
	Uninsured	16.00 (0.00), N=1	
Employment status	Employed full-time (employee)	13.43 (3.23), N=176	0.1247
	Employed full-time (self)	14.36 (2.80), N=11	
	Employed part-time (employee)	13.17 (3.50), N=47	

Demographic variable	Category	Symptom days Mean (SD), N	ANOVA p-value*
	Employed part-time (self)	15.71 (2.69), N=7	
	Full-time student	13.26 (3.58), N=62	
	More than one	13.49 (3.35), N=51	
	Other	13.30 (2.67), N=10	
	Prefer not to answer	18.00 (4.24), N=2	
	Retired	13.21 (3.16), N=33	
	Stay at home parent	10.86 (1.21), N=7	
	Unemployed	12.57 (2.13), N=28	
Ethnicity	Hispanic or Latino	12.98 (3.20), N=60	0.6247
	Not Hispanic or Latino	13.41 (3.23), N=366	
	Prefer not to answer	13.13 (3.94), N=8	

**A significant ANOVA p-value indicates that at least one pair of categories differs. Specific group differences were identified using Bonferroni-adjusted pairwise comparisons.*

Discussion

The present study examined whether socioeconomic and demographic factors were associated with symptom severity at presentation and delayed healthcare-seeking behavior among adults with ARS. Contrary to our hypothesis, traditional socioeconomic indicators including household income, insurance status, insurance type, educational attainment, and employment status were not consistently associated with either baseline symptom severity or the duration of symptoms before presentation. Although race and ethnicity were not consistently associated with ARS presentation overall, several subgroup differences were observed, particularly among Asian, Hispanic, Black, and multiracial participants. This suggests that factors beyond socioeconomic status alone may contribute to differences in how patients experience symptoms and seek care for ARS.

Although socioeconomic factors were not consistently associated with delayed presentation in this study, prior research has identified differences in healthcare access and utilization associated with income, insurance status, and educational attainment among patients with sinonasal disease[8,9]. Studies have shown that lower socioeconomic status, lower income, public insurance, and reduced educational attainment are associated with barriers to healthcare access, decreased utilization of rhinology services,

and poorer sinonasal outcomes[4,9]. However, studies of ARS have suggested that these disparities may be reflected more strongly in how and where patients access care than in symptom severity once care is obtained. For example, patients with Medicaid or no insurance are more likely to seek treatment for ARS in emergency departments rather than outpatient clinics, yet symptom severity among these patients is largely comparable to that of privately insured patients[7]. Similarly, prior research has identified racial and ethnic differences in the symptoms reported by patients with ARS, suggesting that differences in symptom experience or reporting may contribute to variation in healthcare-seeking behavior[7].

The limited socioeconomic differences observed in this study may also reflect characteristics of the NOSES study population. Participants were recruited from outpatient primary care and urgent care clinics after successfully accessing medical care, thereby excluding many individuals who may face the greatest barriers to obtaining care. Previous studies have demonstrated that uninsured patients and those with lower socioeconomic status are more likely to delay care, rely on emergency departments, or experience difficulty accessing outpatient service[3,7]. Since enrollment required participants to already be receiving outpatient evaluation, socioeconomic disparities in healthcare access may have been reduced before study entry. This cohort represents patients who may have already overcome many of the structural barriers associated with obtaining medical evaluation, possibly reducing differences by income or insurance status. Approximately 96% of participants in the NOSES cohort were insured, resulting in limited representation of uninsured individuals and potentially reducing the ability to detect differences by insurance status.

Although no consistent associations with race or ethnicity were observed overall, several significant subgroup differences emerged. Some of these findings are consistent with previously reported racial and ethnic differences in symptom presentation and healthcare-seeking among patients with sinusitis, while others have not been well described in the existing literature[7,8]. Asian participants reported lower baseline mSNOT-16 scores than Black or African American, White, and Other participants, particularly among Phase 1 participants (Table 3). Existing literature provides limited evidence to explain the lower symptom severity observed among Asian participants. A national study of adults with sinusitis

found that Asian individuals had greater odds of obtaining medications from a foreign country, suggesting that healthcare utilization may differ across racial and ethnic groups. However, that study did not evaluate whether these behaviors were associated with symptom severity or timing of presentation[8]. Cultural differences in symptom perception, self-management practices, healthcare expectations, or thresholds for seeking medical attention may therefore contribute to the lower symptom burden observed at presentation. As these factors were not measured in the present study, this interpretation remains speculative and requires further investigation.

Similarly, Hispanic participants in Phase 1 demonstrated lower baseline symptom severity than non-Hispanic participants, possibly reflecting variation in how ARS symptoms are experienced or reported rather than differences in overall disease burden. Prior research examining adults with uncomplicated ARS found that Hispanic patients were more likely than White patients to report facial pain and headache, but less likely to report several more typical ARS complaints, including sinonasal symptoms, cough or sputum production, and cold- or flu-like symptoms[7]. This suggests that ARS may present differently across racial and ethnic groups, which could influence patient-reported measures of symptom burden. The mSNOT-16 captures patients' perceived sinonasal symptoms and their effects on quality of life, therefore differences in the types of symptoms experienced or emphasized could contribute to variation in mSNOT-16 scores across groups[11].

Black or African American participants presented earlier than White participants, whereas participants reporting more than one race presented later. This finding among Black participants is consistent with a national study of adults with sinusitis, which found that Black and Hispanic individuals had lower odds of delaying medical care because of cost than White individuals[8]. Although the reasons for these differences remain unclear, together these findings suggest that racial and ethnic differences in healthcare-seeking behavior may not be fully explained by traditional socioeconomic measures such as income or insurance status. Additionally, previous research has shown that Black and Hispanic patients with ARS report different symptom profiles than White patients, with Black patients less likely to report classic sinonasal symptoms and Hispanic patients more likely to report facial pain and headache[7]. These

differences in symptom presentation may also contribute to variation in when patients decide to seek medical evaluation.

Limitations

Several features of the study design should be considered when interpreting these findings. Participants were enrolled after presenting to outpatient primary care or urgent care settings, so the study may underrepresent individuals who face substantial barriers to obtaining outpatient care, seek treatment primarily through emergency departments, or do not seek medical care. The available socioeconomic measures also provide only a partial representation of social disadvantage; factors such as transportation, healthcare availability, health literacy, caregiving responsibilities, and other barriers to accessing care were not directly measured. This is due to the fact that this study is a secondary analysis of the NOSES randomized clinical trial. The current analysis was restricted to the variables collected for the parent study's primary purposes and was not designed to evaluate social determinants of health. Consequently, some dimensions of SES relevant to healthcare access, such as housing stability, transportation, or health literacy, were only partially captured or not assessed at all. Furthermore, socioeconomic and demographic characteristics were self-reported and grouped into predefined categories, which may change meaningful differences within groups. Lastly, this secondary analysis was not specifically powered to detect differences across socioeconomic and demographic groups, as the sample size was determined by the objectives of the parent NOSES randomized clinical trial. Several subgroups also included relatively few participants, which may have limited the ability to detect meaningful differences.

Conclusion

Among adults with acute rhinosinusitis presenting to outpatient clinics, traditional socioeconomic indicators were not consistently associated with symptom severity or delayed presentation, whereas racial and ethnic differences were observed across several clinical outcomes. These findings suggest that socioeconomic status alone may not fully explain variation in ARS presentation and highlight the need to

better understand the factors that influence when and how patients seek care. Future research incorporating more direct measures of healthcare access, health literacy, and cultural context is needed to clarify the mechanisms underlying these racial and ethnic differences.

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