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Socioeconomic factors impact quality of life outcomes and olfactory measures in chronic rhinosinusitis

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Abstract

BACKGROUND: Healthcare disparities related to socioeconomic factors may adversely impact disease states and treatment outcomes. Among patients with chronic rhinosinusitis (CRS), the impact of socioeconomic factors on outcomes following endoscopic sinus surgery (ESS) remains uncertain.

METHODS: Adult patients with refractory CRS were prospectively enrolled into an observational, multi-institutional cohort study between March, 2011 and June, 2015. Socioeconomic factors analyzed included household income, insurance status, years of education completed, race, age, and ethnicity. Income was stratified according to the Thompson and Hickey model. The 22-item SinoNasal Outcomes Test (SNOT-22) and Brief Smell Identification Test (BSIT) were completed pre- and postoperatively.

RESULTS: 392 patients met inclusion criteria. Higher age and male gender were associated with better mean preoperative SNOT-22 scores (both $p < 0.02$), while Medicare insurance status and male gender were associated with worse preoperative mean BSIT scores (both $p < 0.02$). Postoperatively, higher household income (\$100,001+/year) and lower age were associated with a

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greater likelihood of improving at least one minimal clinically important difference (MCID) on SNOT-22 scores (OR=2.40 and 1.03, respectively, both $p<0.05$), while no factors were associated with increased odds of achieving a MCID on BSIT scores.

CONCLUSIONS: Preoperative olfactory function and postoperative quality of life (QOL) improvement were associated with metrics of socioeconomic status in patients with CRS electing ESS. The odds of experiencing a clinically meaningful QOL improvement were more than twice as likely for patients with the highest household income level compared to other income tiers. Further investigation is warranted to identify barriers to postoperative improvement.

Keywords

Sinusitis; chronic disease; outcome assessment (health care); quality of life

INTRODUCTION

Socioeconomic status (SES) has been previously described as differential access, whether potential or real, to desired resources including financial resources, educational opportunities, material goods, healthcare social networks, and power.^{1,2} Disparities in health care related to SES are widespread and impact outcomes of many diseases centered on the airway including chronic obstructive pulmonary disease, asthma, and cystic fibrosis, as well as disorders of the cardiac and musculoskeletal systems.^{3–8} While there is no uniformly agreed upon definition of SES, current measurements of SES commonly include information such as household income, level of education, and/or occupation.^{1,2}

Prior research among patients with chronic rhinosinusitis (CRS) regarding associations between SES, measures of disease severity, and treatment outcomes has produced mixed results. Studies have demonstrated that utilization of rhinology health care services, as well as the prevalence and severity of CRS, are affected by various socioeconomic factors.^{9–13} On the other hand, alternative investigations have shown that baseline CRS disease severity is similar across different measures of SES, such that there are no differences in SES between patients with CRS and controls without sinus disease, and that outcomes following endoscopic sinus surgery (ESS) were not influenced by certain socioeconomic factors.^{14–16} No studies have thoroughly assessed the impact of SES on olfactory status among patients with CRS. The objective of this study was to evaluate the impact of SES on both preoperative and postoperative quality of life (QOL) and olfactory function following ESS in patients with refractory CRS. These findings may provide groundwork for future study to investigate mechanisms to improve SES-related disparities in treatment outcomes for patients with CRS.

MATERIALS and METHODS

Sample Study Population

An Institutional Review Board (IRB) at each enrollment site granted ethical oversight for this minimal risk study protocol, as well as voluntary enrollment and consent procedures. Study participants were prospectively enrolled and observed between March, 2011 and June, 2015 from a heterogeneous, adult patient population diagnosed with uncomplicated CRS by

fellowship trained rhinologists per current guidelines provided by the American Academy of Otolaryngology.^{17,18} Participants were enrolled from three academic, tertiary referral practices within the United States including Departments of Otolaryngology-Head and Neck Surgery within: Oregon Health and Science University (Portland, Oregon; IRB #7198), the Medical University of South Carolina (Charleston, South Carolina; IRB #12409), and Stanford University (Palo Alto, California; IRB #4947).

Study participants were sampled from patient populations with medically refractory symptoms of CRS, with or without nasal polyposis, after completing appropriate therapies including, but not limited to: high volume saline irrigation (~240ml. QD), topical corticosteroid sprays (21 days), systemic corticosteroids (5 days), and either broad spectrum or culture directed antibiotic therapy (14 days). All participants reported persistent symptoms of CRS including nasal congestion, mucopurulent drainage, facial pain/pressure, or olfactory impairment and voluntarily elected to pursue endoscopic sinus surgery (ESS) as a subsequent treatment modality.¹⁷

Surgical procedure selection was dictated by preoperative endoscopic and radiographic image findings as well as the intraoperative discretion of each enrolling physician. Primary or revision ESS was conducted under general anesthesia and consisted of unilateral or bilateral maxillary antrostomy, partial or total ethmoidectomy, sphenoidotomy, frontal sinusotomy, as well as septoplasty and/or inferior turbinate reduction as required to optimize sinonasal patency. Postoperative symptom management included regimens of daily, high volume saline irrigation and topical corticosteroid rinses/sprays, as necessary, to facilitate optimal recovery per the standard of care (SOC). Study participants were observed through the SOC and evaluated up to 18 months postoperatively using 6-month intervals.

Exclusion Criteria

Patients with a history or comorbid head trauma resulting in olfactory loss, Alzheimer's/dementia, or Parkinson's disease were not considered for participation due to potential contributions to olfactory dysfunction. Study participants were not considered for final analyses if they presented with any variant of comorbid primary ciliary dyskinesia due to differential treatment considerations with that patient population. Additional exclusions included participant who were unwilling or unable to provide complete demographic / socioeconomic data during baseline enrollment meetings or any participant lost to follow-up during the study duration.

Socioeconomic Data Collection

Considered the primary predictive factors of interest, socioeconomic factor data was collected at enrollment. Screened factors included age (scale), gender (dichotomous), race (categorical), ethnicity (categorical), household income (categorical), health insurance coverage (categorical), and completed education years (scaled and categorical).

Outcome Measures

Participants were asked to complete preoperative and postoperative patient-reported outcome measures (PROMs) at pre-determined intervals. The 22-item SinoNasal Outcome Test

(SNOT-22) is a 22-item validated survey developed to quantify the severity of sinonasal symptoms (©2006, Washington University, St. Louis, MO).¹⁹ Individual symptom scores are measured using Likert score options (range: 0–5) where higher scores reflect worse symptom severity from: 0= ‘No problem’ to 5= ‘Problem as bad as it can be’. Higher summarized total scores reflect worse overall symptom severity and disease impairment (scale range: 0–110). Minimal clinically important differences (MCIDs) for SNOT-22 total scores, defined for postoperative within-subject changes for a patient population electing ESS, has been approximated to be 9.0 points.¹⁹

Complimentary measures of olfactory function were also collected by employing the Brief Smell Identification Test (BSIT, Sensonics, Inc., Haddon Heights, NJ) during patient evaluations. The BSIT is a validated, 12-item, cross-cultural, diagnostic tool of olfactory identification.²⁰ Respondents identify odorants from 4 options in a ‘forced choice’ response format using ‘scratch-and-sniff’ microencapsulated strips activated with pencil strikes. Higher total summarized BSIT scores reflect superior olfactory function (scale range: 0–12) while BSIT scores ≥ 9 are clinically interpreted as ‘normal’ olfaction for healthy males and females of all ages. A MCID value for total BSIT scores has been previously described defined as a within-subject change of at least 1.0 point for a patient population electing ESS.²¹

Data Management and Statistical Analyses

This investigation represents a secondary analysis of prospectively collected data. Data was manually compiled using a relational database (Access, Microsoft Corp., Redmond, WA) compliant with the Health Insurance Portability and Accountability Act of 1996. Statistical analyses were performed using SPSS v.24.0 statistical software (IBM Corp., Armonk, NY). Descriptive analysis was completed and used to confirm assumptions of linearity and/or distribution normality for scaled data. Annual household income was stratified using an approximated income class model described by Thompson and Hickey using $< \$25,000$ (‘lower’), $\$25,001-\$100,000$ (‘middle’), and $> \$100,000$ (‘upper’) subgroupings.²² Categorical education level was considered using 0–11 years to represent having not completed high school, 12–15 years to represent having completed high school but not college, and 16+ years to represent having completed college. Two-sided, Pearson’s correlation coefficients (R) were used to evaluate associations between scaled outcome measures. Unadjusted and adjusted linear regression modeling was utilized to identify significant associations between independent SES factors and preoperative outcome measures. Multivariate modeling was completed by screening candidate variables at the 0.200 α -level for preliminary model inclusion. Final models were constructed using manual, forward selection ($p < 0.100$) and backwards elimination ($p < 0.050$). Covariate risk factors listed in Table 1 were included into bivariate models to evaluate potential effect estimate confounding ($> 10\%$ difference in effect estimate) for SES factors. Goodness-of-model-fit was evaluated using coefficients of multiple determination (R^2) to determine the total explained model variation (%) while multi-collinearity was assessed using variance inflation factors (VIFs). Unadjusted and adjusted regression effect estimates (β) associated with SES factors, standard errors (SE), 95% confidence intervals, t-test statistics, and type-1 error probability (p-values) are reported with appropriate referent groups.

Average postoperative differences (postoperative - preoperative) and associated prevalence of MCID were reported using the last available postoperative outcome measure (6 months) due to historical statistical similarity between mean 6 month and 18 month postoperative outcomes in this patient cohort.^{23,24} Within-subject improvement of mean outcome measures was evaluated using matched pairs t-testing. Unadjusted and adjusted logistic regression modeling was utilized to identify significant associations between SES factors and the prevalence of MCID values using identical stepwise procedures for variable inclusion. Goodness of model fit was assessed using Hosmer-Lemeshow (H-L) test statistics. Odds ratios (OR) with 95% confidence intervals (CI) were reported with associated p-values with appropriate referent groups.

RESULTS

Final Cohort and Preoperative Associations

A total of 392 study participants met inclusion criteria for analysis after exclusions of other patients for comorbid ciliary dyskinesia (n=23), incomplete demographic / socioeconomic data (n=36), and loss to postoperative follow-up (n=103). There were several differences between patients with and without follow-up as described in Table 1. The mean age of patients without follow-up was significantly lower compared to those with follow-up (45.2 [SD±12.6] vs 51.3 [SD±15.2] years; p<0.001). Patients without follow-up also reported a significantly higher prevalence of lower household income compared to those with follow-up (24% vs 12%; p=0.005). Significantly fewer patients without follow-up had Medicare insurance provision than those with follow-up (2% vs. 21%; p=0.029), however a greater prevalence of those without follow-up had employer provided/private health insurance (84%) and Medicaid/state assisted coverage (11%).

The final study cohort was observed for a mean of 15.6 [SD±4.9] months after ESS. Preoperative patient data for the final study cohort is described overall in Table 1. Average preoperative SNOT-22 and BSIT scores, stratified by independent socioeconomic factors, are described in Table 2. Additional bivariate correlation coefficients were evaluated between scaled preoperative measures with only weak significant association between age and preoperative SNOT-22 total score (R= -0.164; p=0.001) and between education years and SNOT-22 total score (R= -0.114; p=0.024).

Unadjusted effect estimates of preoperative SNOT-22 and BSIT scores across independent socioeconomic factors are further described in Table 3. Preliminary linear regression variable screening identified age, education level, gender, income classes and health insurance provider type as significantly associated (p<0.050) with preoperative sinus symptom severity, while race or ethnicity was not associated with either outcome measure. Both gender and insurance provider type were also identified as independent significant predictors of unadjusted preoperative BSIT score.

Multivariate linear regression was completed in order to adjust for any additional covariate significantly associated differences in preoperative differences in SNOT-22 and BSIT scores. Further analysis involved the design of “dummy” variables for significant categorical covariates from Table 3 and to manually adjust for potential enrollment location differences

due to the lack of ordered categories. After adjustment for enrollment location, revision ESS, asthma, ASA sensitivity, allergy, depression, and tobacco use/smoking (all $p < 0.050$), only the socioeconomic variables of higher age (adjusted $\beta = -0.2$ (SE ± 0.1); 95% CI: $-0.28, -0.04$; $t = -2.54$; $p = 0.012$) and male gender (adjusted $\beta = -6.1$; 95% CI: $-9.9, -2.3$; $t = -3.16$; $p = 0.002$) were significantly associated with lower mean preoperative SNOT-22 scores. Education, income class, and health insurance type were no longer statistically significant in final regression modeling (all $p > 0.100$). The coefficient of multiple determination (R^2) was only able to explain a total of ~18% of total model variance for the final model of SNOT-22 preoperative score differences with minimal collinearity (all VIFs < 2.0) and approximately normal probability plotting of standardized residuals.

After covariate adjustment for enrollment location, nasal polyposis, ASA sensitivity, and alcohol use (all $p < 0.050$), only the variables of male gender (adjusted $\beta = -0.8$; 95% CI: $-1.4, -0.1$; $t = -2.43$; $p = 0.016$) and Medicare insurance (adjusted $\beta = -1.1$; 95% CI: $-1.8, -0.3$; $t = -2.87$; $p = 0.004$) were significantly associated with lower mean preoperative BSIT scores. The coefficient of multiple determination (R^2) was only able to explain a total of ~23% of total model variance for the final model of BSIT preoperative score differences with minimal collinearity (all VIFs < 2.0) and approximately normal probability plotting of standardized residuals.

Postoperative Outcome Improvement

Within-subject postoperative mean SNOT-22 total scores were significantly improved ($t = 21.7$; $p < 0.001$) for the entire cohort with an average postoperative score of 29.0 [SD ± 21.5] from a preoperative average score of 53.1 [SD ± 20.0] (Table 1). Postoperative changes did not significantly change for mean BSIT scores of the total cohort ($t = -1.4$; $p = 0.156$) with an average postoperative score of 9.1 [SD ± 2.6] from a preoperative average score of 8.8 [SD ± 3.1]. As the primary outcomes of interest to this investigation, a total of 312 / 392 (80%) of study participants reported improvement of at least one MCID value on postoperative SNOT-22 total scores, while 126/319 (40%) of study participants reported improvement of at least one MCID value during postoperative olfactory scoring using the BSIT.

Logistic Regression Modeling of Socioeconomic Factors

Unadjusted odds ratios of reporting an MCID on both SNOT-22 and BSIT scores across independent socioeconomic factors are further described in Table 4. Preliminary variable screen identified age, education (years completed) and income classes as significantly associated with differential odds of experiencing an MCID on SNOT-22 scores. Without covariate adjustment, for each year increase in age, study participants were ~3% less likely to report an MCID. Interestingly, for each additional year of education, patients were ~10% more likely to report an MCID on SNOT-22 total scores. Additionally, income classes were identified as a potential unadjusted significant predictor of increased odds of reporting an MCID on SNOT-22 total scores ($p = 0.078$). A total of 33/46 (72%) of study participants reporting a household income of \$0–25,000 experienced at least one MCID, compared to 166/214 (78%) of patients with a household income between \$26,000–\$100,000 and 113/132 (86%) of patients with a household income greater than \$100,000. Without adjustment,

study participants in the upper income class reported a higher odds of reporting an MCID on SNOT-22 total scores compared to counterparts in the lower income class (OR=2.34; 95% CI: 1.05, 5.24; p=0.035). No significant differences in MCID prevalence between lower and middle income classes (p=0.398) or middle and upper income classes (p=0.066). No significant unadjusted associations were identified between any socioeconomic variables and the odds of reporting an MCID on BSIT olfactory testing.

After covariate adjustment in logistic regression modeling for enrollment location (p=0.050) and revision ESS (p=0.001), the variables of lower age (adjusted OR=1.03; 95% CI: 1.01, 1.04; p=0.003) and upper income (\$100,001+) class (adjusted OR=2.40; 95% CI: 1.01, 5.71; p=0.048) were significantly associated with a greater likelihood of improving at least one MCID on SNOT-22 total scores. Final logistic regression model fit was adequate (H-L $\chi^2=6.40$; p=0.602).

DISCUSSION

This study explored the impact of SES on preoperative and postoperative measures of QOL and olfaction in patients with medically refractory CRS who underwent ESS. Findings from this study demonstrate that various SES factors, including household income, insurance provision and age, associate with both baseline disease characteristics and postoperative outcomes in this population.

Following multivariate adjustment, higher household income was identified as a significant independent predictor of reporting a clinically meaningful improvement in SNOT-22 total score following ESS. This is a finding that has not been previously identified. In 2010, a prior investigation of a similar patient cohort electing ESS evaluated the predictive ability of annual household income, stratified above and below \$50,000, on disease-specific QOL outcomes using the Rhinosinusitis Disability Index and Chronic Sinusitis Survey, but found no significant association between dichotomized income levels and postoperative score improvements.¹⁵ A European study of patients with CRS who underwent ESS determined that SES did not impact postoperative generalized QOL, as measured using the Medical Outcomes Study Short-Form 36 (SF-36) survey, although this paper was limited by not providing definitions for SES or describing how study participants were stratified into “low”, “medium”, or “high” SES tiers.²⁶ Our current study employed a three-tiered income model intended to parallel U.S. class structure based on sociologic principles,²² and it is possible that the additional stratification provided by this model compared to the binary division by Smith et al.¹⁶ explains those significant differences between studies of similar patient cohorts.

Baseline symptom severity as measured by SNOT-22 was not impacted by traditional measures of SES in this study, including income, education status, race/ethnicity or insurance status. Our results showed that male gender and higher mean age were associated with lower (better) preoperative SNOT-22 total scores. Even though the current study population and the population evaluated by Bergmark et al. are lacking some generalizability due to baseline QOL status and differences in treatment modality, our preoperative findings (Table 3) are similar to those of Bergmark et al., who found no significant associations

between race/ethnicity, zip code-based income, education level, or insurance status and mean baseline SNOT-22 score or the EuroQol 5-dimensional visual analog scale, among patients with CRS presenting to a tertiary care center.¹⁴ Additionally, the finding in the current study that male subjects reported lower (better) preoperative SNOT-22 scores compared to female patients is consistent with prior work.^{27,28}

Additional findings from our cohort suggest that some measures of SES may significantly associate with worse preoperative olfactory function but do not associate with any magnitude of postoperative improvement in olfaction. After multifactorial adjustment, Medicare insurance status was significantly associated with worse preoperative mean BSIT scores when compared to all other types of medical care insurance provisions ($p=0.004$). Increased age was not a significant independent predictor in multi-factorial modeling ($\beta=0.01$ [SE ± 0.01]; 95% CI: $-0.02, 0.03$; $t=0.51$; $p=0.612$) of worse preoperative BSIT scores at the 0.050 α -level used for final multivariate model entry, nor was age found to significantly confound the reported effect estimates for either gender or Medicare insurance status in that model. Additionally, no evidence of direct collinearity was found between age and Medicare based insurance status (VIF=1.44) in regards to their association with preoperative BSIT scores with both variables included in simple preliminary models.

Olfactory dysfunction is frequently present in patients with CRS and is also associated with other disorders, including neurodegenerative diseases.^{29,30} Olfactory dysfunction may be the first presenting signs of disorders such as Alzheimer's disease and Parkinson's disease, which most commonly affect the Medicare-aged population.³⁰ While patients with diagnoses of these neurodegenerative diseases were excluded from this study, there is the potential for non-diagnosed, early versions of these diseases to have contributed in part to the baseline olfactory loss identified in the Medicare population in this study.

The results of this investigation on pre-treatment olfaction contrast slightly to previous research. A prior study by Katotomichelakis et al. determined that worse baseline olfaction, as measured using Sniffin' Sticks, was associated with higher age (> 55 years), female gender, and lower SES.²⁶ This previous study employed different measures of age stratification and SES than this current investigation, which may explain differences of significance for age as a covariate. This same study also found that a greater likelihood of improvement on the Questionnaire of Olfactory Disorders was associated with "medium" or "high" SES.²⁶

One strength of the current analysis was the ability to use prospective, self-reported household income data and not rely on average income based on location (e.g. zip code or county). Our data did not allow for any further exploration as to the underlying reasons for why lower average age, higher education (years completed) and upper household income (\$100,000+) were associated with greater likelihood of reporting a clinically meaningful improvement in symptom severity following ESS as measured by the SNOT-22 questionnaire. Potential explanations for this might include improved access to health care from a tertiary care facility, greater ability to afford postoperative medications/prescriptions including off-label use (e.g. budesonide rinses), or increased capability to return for follow up appointments. Additionally, many patients of lower SES may have worse self-reported

global health,³¹ and this trend may apply to disease specific QOL for patients with CRS as well.

In this investigation, there were differences between patients who completed follow-up and those who did not complete follow-up (Table 1). Patients who did not complete follow-up were more frequently of lower SES (lowest income tier) than those who completed follow-up. As patients with lower income had a lower likelihood of achieving a MCID on SNOT-22 score, the finding that this group was also less likely to complete follow-up suggests that this disparity may even be underestimated.

This study has several potential limitations. This investigation was performed in a patient population who had access to a tertiary care center and underwent ESS at one of these institutions, and the results may not be generalizable to other patient populations in alternative settings. Additionally, only patients who underwent ESS were included and the results may not apply to those who underwent medical management of CRS. Data capture of SES variables occurred during preoperative enrollment meetings and assumes SES remains constant throughout the study duration. However unlikely, there is a potential for misclassification bias due to changes in SES following patient enrollment following changes in either employment/income status or health insurance provision. Next, inflation may have altered the current values in the Thompson and Hickey classification. Additionally, loss to postoperative study follow-up may introduce some measure of relative selection bias, although the percentage of follow-up loss (~21%) in this investigation is similar to that of other patient cohorts electing ESS in a tertiary referral environment.^{32,33}

Additionally, SES can be evaluated by either composite scales or singular measures.² In this investigation, some common measures of SES were used to define independent risk factors associated with preoperative QOL and postoperative outcomes. It is possible that using different metrics or composite measures of SES would produce different results. For example, all college students (aged 18–22 years; n=13) with minimal income may have been categorized in the lowest income tier, however this may not be an accurate representation of their overall SES.

CONCLUSIONS

Preoperative olfactory function and postoperative QOL improvement were associated with baseline metrics of SES in patients with CRS electing ESS. The odds of experiencing a clinically meaningful improvement in QOL after ESS were more than twice as likely for patients with the highest household income level compared to other income tiers. Further investigation of socioeconomic factors is warranted to identify additional barriers to postoperative improvement.

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Table 1:

Comparison of preoperative socioeconomic factors, and patient-reported outcome measures between patients with and without postoperative follow-up (n=498)

	With Follow-up (n=395)		Without Follow-up (n=103)		
Independent socioeconomic factors:	Mean [SD]	N (%)	Mean [SD]	N (%)	p-value
Gender:					
Female		210 (54%)		47 (46%)	
Male		182 (46%)		56 (54%)	0.151
Age at enrollment	51.3 [15.2]		45.2 [12.6]		<0.001
Education (years completed)	15.5 [2.9]		15.0 [3.0]		0.159
Education (categorical):	----	----	----	----	----
0–11 years		7 (2%)		4 (4%)	
12–15 years		169 (43%)		48 (47%)	0.329
16+ years		215 (55%)		51 (49%)	
Race:	----	----	----	----	----
White/Caucasian		333 (85%)		82 (79%)	
African American		21 (5%)		8 (8%)	0.693
Asian		17 (4%)		6 (6%)	
Other		21 (5%)		7 (7%)	
Ethnicity:	----	----	----	----	----
Non-Hispanic/Latino		372 (95%)		97 (94%)	0.770
Hispanic/Latino		20 (5%)		6 (6%)	
Household Income:	----	----	----	----	----
\$0-\$25,000 (lower)		46 (12%)		25 (24%)	
\$26,000-\$100,000 (middle)		214 (54%)		49 (48%)	0.005
\$100,001+ (upper)		132 (34%)		29 (28%)	
Health insurance type:	----	----	----	----	----
Employer provided/private		292 (75%)		86 (84%)	
Medicare		84 (21%)		2 (2%)	0.029
Medicaid/state assisted		16 (4%)		11 (11%)	
Comorbid conditions/diagnoses:	----	----	---	---	----
Revision ESS		212 (54%)		48 (47%)	0.176
Nasal polyposis		139 (36%)		31 (30%)	0.308
Septal deviation		156 (40%)		43 (42%)	0.719
Asthma		143 (37%)		36 (35%)	0.774
ASA sensitivity		28 (7%)		4 (4%)	0.231
Allergy (positive mRAST/skin prick)		180 (46%)		40 (39%)	0.198
Depression *		60 (15%)		17 (17%)	0.765
Tobacco use/smoking		20 (5%)		9 (9%)	0.166

	With Follow-up (n=395)		Without Follow-up (n=103)		
Independent socioeconomic factors:	Mean [SD]	N (%)	Mean [SD]	N (%)	p-value
Alcohol use		179 (46%)		46 (45%)	0.856
Oral corticosteroid dependency		30 (8%)		3 (3%)	0.118
Diabetes mellitus (Type I / II)		26 (7%)		3 (3%)	0.236
Patient-reported outcome measures:					
SNOT-22 total score	53.1 [20.0]		54.1 [22.9]		0.643
BSIT total score	8.8 [3.1]		9.0 [2.9]		0.639

* self-reported; SD, standard deviation; ESS, endoscopic sinus surgery; ASA, acetylsalicylic acid;

SNOT-22, 22-item SinoNasal Outcome Test survey; BSIT, Brief Smell Identification Test; mRAST, modified radioallergosorbent testing.

Table 2:

Mean preoperative SNOT-22 and BSIT scores stratified by independent socioeconomic factors

Independent socioeconomic factors:	SNOT-22 total score	BSIT total score
	Mean [SD]	Mean [SD]
Female	57.4 [19.4]	9.2 [2.8]
Male	48.0 [19.7]	8.3 [3.3]
Education (categorical):	----	----
0–11 years	70.7 [26.0]	9.9 [0.9]
12–15 years	54.5 [19.8]	8.7 [3.0]
16+ years	51.2 [19.7]	8.9 [3.1]
Race:	----	----
White/Caucasian	53.4 [20.1]	8.9 [3.0]
African American	53.1 [24.2]	9.6 [2.7]
Asian	50.2 [17.6]	7.2 [3.7]
Other	49.6 [16.5]	8.1 [3.3]
Ethnicity:	----	----
Non-Hispanic/Latino	52.9 [19.9]	8.8 [3.1]
Hispanic/Latino	55.5 [22.8]	8.5 [3.2]
Household Income:	----	----
\$0-\$25,000 (lower)	59.9 [23.8]	8.6 [2.9]
\$26,000-\$100,000 (middle)	53.1 [20.2]	8.8 [3.0]
\$100,001+ (upper)	50.7 [17.8]	8.8 [3.2]
Health insurance type:	----	----
Employer provided/private	53.7 [18.9]	9.1 [3.0]
Medicare	48.4 [22.7]	7.9 [3.1]
Medicaid/state assisted	64.9 [20.6]	8.7 [2.8]

SNOT-22, 22-item SinoNasal Outcome Test; SD, standard deviation; BSIT, Brief Smell Identification Test.

Table 3:

Unadjusted effect estimates of independent socioeconomic factors for preoperative SNOT-22 and BSIT scores (n=392)

Independent socioeconomic factors:	Preoperative SNOT-22 score			Preoperative BSIT score		
	Unadjusted β (SE)	95% CI	p-value	Unadjusted β (SE)	95% CI	p-value
Age at enrollment	-0.2 (0.1)	-0.3, -0.1	0.001	-0.02 (0.01)	-0.04, 0.01	0.058
Education (years completed)	-0.8 (0.3)	-1.5, -0.1	0.024	0.03 (0.06)	0.08, 0.15	0.555
Female	<i>Referent</i>	----	----	<i>Referent</i>	----	----
Male	-9.3 (2.0)	-13.2, -5.4	<0.001	-0.9 (0.3)	-1.6, -0.2	0.009
Education (categorical):						
0–11 years	<i>Referent</i>	----	----	<i>Referent</i>	----	----
12–15 years	-16.2 (7.7)	-31.5, -1.0	0.037	-1.2 (1.2)	-3.4, 1.1	0.316
16+ years	-19.5 (7.7)	-34.6, -4.4	0.012	-1.0 (1.2)	-3.4, 1.3	0.398
Race:						
White/Caucasian	<i>Referent</i>	----	----	<i>Referent</i>	----	----
African American	-0.3 (4.6)	-9.3, 8.7	0.944	0.7 (0.7)	-0.6, 2.1	0.287
Asian	-3.2 (5.0)	-12.9, 6.6	0.523	-1.7 (0.9)	-3.5, 0.2	0.075
Other	-3.8 (4.5)	-12.7, 5.0	0.392	-0.8 (0.7)	-2.2, 0.7	0.299
Ethnicity:						
Non-Hispanic/Latino	<i>Referent</i>	----	----	<i>Referent</i>	----	----
Hispanic/Latino	2.6 (4.6)	-6.5, 11.6	0.576	-0.4 (0.8)	-1.9, 1.2	0.665
Household Income:						
\$0–\$25,000 (lower)	<i>Referent</i>	----	----	<i>Referent</i>	----	----
\$26,000–\$100,000 (middle)	-6.8 (3.4)	-13.5, -0.1	0.046	0.2 (0.5)	-0.8, 1.2	0.708
\$100,001+ (upper)	-9.2 (3.3)	-15.7, -2.6	0.007	0.2 (0.6)	-1.0, 1.3	0.777
Health insurance type:						
Employer provided/private	<i>Referent</i>	----	----	<i>Referent</i>	----	----
Medicare	-5.3 (2.5)	-10.1, -0.5	0.031	-1.1 (0.4)	-2.0, -0.3	0.007
Medicaid/state assisted	-11.1 (4.9)	1.5, 20.7	0.023	-0.3 (0.8)	-2.0, 1.3	0.682

SNOT-22, 22-item SinoNasal Outcome Test; BSIT, Brief Smell Identification Test; β , effect estimate; SE, standard error; CI, confidence interval. Negative effect estimates for the SNOT-22 represent less/better overall symptom severity. Negative effect estimates for the BSIT represent worse olfactory function.

Table 4:

Unadjusted estimates of independent socioeconomic factors for reporting a minimal clinically important difference on postoperative SNOT-22 and BSIT scores (n=392)

Independent socioeconomic factors:	SNOT-22 score			BSIT score		
	Unadjusted OR	95% CI	p-value	Unadjusted OR	95% CI	p-value
Age at enrollment	0.97	0.96, 0.99	0.002	0.99	0.98, 1.01	0.239
Education (years completed)	1.10	1.00, 1.19	0.034	1.00	0.93, 1.07	0.926
Female	<i>Referent</i>	----	----	<i>Referent</i>	----	----
Male	0.74	0.45, 1.21	0.223	1.07	0.69, 1.68	0.756
Education (categorical):						
0–11 years	<i>Referent</i>	----	----	<i>Referent</i>	----	----
12–15 years	1.29	0.15, 11.12	0.817	1.04	0.23, 4.77	0.965
16+ years	0.67	0.41, 1.10	0.114	0.79	0.50, 1.25	0.309
Race:						
White/Caucasian	<i>Referent</i>	----	----	<i>Referent</i>	----	----
African American	1.26	0.45, 3.58	0.659	0.89	0.35, 2.30	0.816
Asian	0.63	0.16, 2.42	0.496	0.46	0.12, 1.79	0.261
Other	2.34	0.39, 13.96	0.353	2.41	0.52, 11.1	0.260
Ethnicity:						
Non-Hispanic/Latino	<i>Referent</i>	----	----	<i>Referent</i>	----	----
Hispanic/Latino	0.76	0.27, 2.15	0.602	2.39	0.83, 6.91	0.105
Household Income:						
\$0-\$25,000 (lower)	<i>Referent</i>	----	----	<i>Referent</i>	----	----
\$26,000-\$100,000 (middle)	1.36	0.67, 2.79	0.398	0.79	0.38, 1.67	0.540
\$100,001+ (upper)	2.34	1.05, 5.24	0.035	0.86	0.53, 1.42	0.564
Health insurance type:						
Employer provided/private	<i>Referent</i>	----	----	<i>Referent</i>	----	----
Medicare	1.69	0.52, 5.48	0.378	1.50	0.45, 5.00	0.510
Medicaid/state assisted	0.67	0.20, 2.26	0.514	1.46	0.41, 5.24	0.560

SNOT-22, 22-item SinoNasal Outcome Test; BSIT, Brief Smell Identification Test; OR, odds ratio; CI, confidence interval.