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Title: Functional burden and limitations in children with chronic sinusitis

Short Title: Functional impairment in chronic sinusitis

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Abbreviations used: ICD-9-CM=International Classification of Disease 9th edition Clinical Modification; MEPS=Medical Expenditure Panel Survey; FPL=federal poverty level; aOR= adjusted odds ratio; CI=confidence interval;

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BT Cheng had full access to all the data in the study and takes responsibility for the integrity of the data and accuracy of the data analysis.

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To the editor:

Chronic rhinosinusitis (CRS) is characterized by persistent inflammation of the sinus cavities, and in pediatric patients is responsible for 5.6 million outpatient visits annually¹. Although previous studies have established substantial activity, work, and social limitations among adults with CRS², studies in children have been single-center analyses of tertiary hospitals and focused on establishing the efficacy of surgical intervention in improving quality of life (QOL)^{3,4}. Data are limited on QOL in pediatric CRS in the broader, non-surgical population.

Most QOL measures in CRS and other chronic conditions do not address pediatric issues such as behavioral concerns and peer relationships. This study employs the Columbia Impairment Scale, a 13-question tool validated to evaluate functional health status in children, specifically in the domains of four major areas: interpersonal relations, broad psychopathological domains, functioning in job or schoolwork, and use of leisure time^{5,6}.

The objective of this study is to use a validated pediatric QOL tool to quantify the impact of pediatric CRS in a representative epidemiological sample. To contextualize the QOL impact of CRS, we compared it to that of a well-studied chronic disease, asthma. We hypothesized a decrease in QOL associated with CRS diagnosis, similar to the QOL burden of asthma.

We analyzed data from children (age 5-17 years) in the 2002-2015 Medical Expenditure Panel Survey (MEPS), a representative survey of the US population (weighted frequency: 837,769,147) published annually by the Agency for Healthcare Research and Quality. This study protocol was approved by the Northwestern University Institutional Review Board.

We used *International Classification of Diseases, Ninth Revision (ICD-9)* codes to determine diagnosis of CRS (473.x). Because there is no ICD-9 coding for CRS, we used the closest term, chronic sinusitis. Throughout the paper, we refer to chronic sinusitis as CRS for clarity. Parent-reported diagnoses were recorded and converted by professional coders into ICD-9 codes. Previous studies have established the Columbia Impairment Scale (CIS) scores associated with asthma⁷. As such, the control group comprised children with asthma (ICD-9 493.x).

Dependent variables were domains of functional impairment, assessed by the Columbia Impairment Scale. The CIS rates severity of impairment from 0 (“No problem”) to 4 (“A very big problem”) in 13 domains. Previous studies found that summed (range 0-52) CIS score ≥ 16 indicates severe impairment⁵.

We generated weighted frequency and prevalence of children who experienced problems (CIS ≥ 1) with each CIS domain. Logistic regression models were constructed to test the null hypothesis that there were no differences in CIS domains and severe impairment (dependent variables) associated with CRS diagnosis. All multivariable models were adjusted for age (continuous), sex, race, and income covariates.

We conducted multivariable linear regression analysis to determine if CRS diagnosis affects total CIS score. Multivariable models invoking stepwise variable selection ($\alpha=0.10$) were constructed to determine predictors of total CIS score in children with CRS.

All statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC). Complete case analysis was performed. A two-sided P-value <0.05 was considered statistically significant.

Among an estimated 837,769,147 (unweighted frequency: 98,873) children, there were 45,258,629 (unweighted: 4,102) with CRS and 85,654,234 (unweighted: 10,931) with asthma. In Rao-Scott χ^2 analysis, CRS was associated with differences in sex, income, race, region, insurance payer, and comorbid allergic rhinitis, migraines, or asthma ($P \leq 0.005$) (Figure 1) (Supplemental Table 1; all supplemental materials are available at: <https://data.mendeley.com/datasets/9mhskr788r/1>).

In multivariable survey logistic regression models adjusted for age (continuous), sex, race, and income, diagnosis of CRS was associated with problems with unhappiness, having fun, nervousness, sports and hobbies, schoolwork, home behavior, staying out of trouble, and getting along with mother, father, other adults, siblings, and other children (Supplemental Table 2).

In adjusted models, children with CRS vs asthma had increased rates of unhappiness (adjusted odds ratio (aOR) [95% confidence interval (CI)]: 1.18 [1.05, 1.32], $P=0.006$), nervousness (1.16 [1.05, 1.29], $P=0.005$), problems with home behavior (1.16 [1.04, 1.29], $P=0.009$), and trouble getting along with mother (1.25 [1.11, 1.40], $P=0.0002$), father (1.27 [1.13, 1.43], $P<0.0001$), siblings (1.15 [1.02, 1.30], $P=0.03$), and other children (1.15 [1.01, 1.31], $P=0.03$).

Children with CRS had higher CIS scores compared to those without CRS (least squares (LS) mean: 7.5 vs 6.5; adjusted beta [95% CI]: 0.97 [0.60, 1.34], $P<0.0001$) and asthma (7.4 vs 7.0; 0.41 [0.06, 0.77], $P=0.02$).

Importantly, children with CRS were more likely to have severe functional impairment ($CIS \geq 16$) compared to children without CRS (Supplemental Table 2). Children with CRS had higher odds of comorbid anxiety (prevalence: 3.6% vs 2.2%; crude OR [95% CI]: 1.65 [1.31, 2.07], $P<0.0001$) and similar odds of comorbid depression diagnoses (2.6% vs 2.2%; 1.19 [0.93, 1.53], $P=0.16$).

In multivariable models invoking stepwise selection, higher CIS scores were observed in CRS children who were older (12-17 years, adjusted beta [95% CI]: 0.48 [0.03, 0.93]), had lower family income (poor/near poor/low: 2.00 [1.47, 2.54], middle income: 0.56 [0.02, 1.10]), had comorbid depression (9.04 [7.27, 10.81], anxiety (7.26 [6.23, 8.29]), or asthma (0.70 [0.15, 1.24]), and lived in the Western United States (1.24 [0.48, 1.99]); lower scores (less impairment) were seen in those who identified as black (-0.64 [-1.14, -0.13]) (Supplemental Table 3).

Diagnosis of CRS in children is associated with detriment to QOL, with a burden that is greater than that of asthma. Compared to children with asthma, children with CRS had increased problems with unhappiness, nervousness, home behavior, and relationships with mother, father, siblings, and other children. Mean CIS scores were higher in children with CRS compared to children without CRS (7.5 vs 6.5) and previously reported population estimates (7.5 vs 6.5)⁸. These findings highlight the significant impact CRS has on social functioning particularly in older children from lower income households and with comorbid depression, anxiety, or asthma. Decreased social QOL associated with sinus symptoms has been previously reported in one adult study² and in one small pediatric study (n=21)⁹.

Children with CRS in the present study were also more likely than children without CRS to have severe impairment (CIS ≥ 16), which correlates with mental health diagnoses⁵. Specifically, we found children with CRS in this cohort demonstrated higher rates of problems with unhappiness and nervousness, despite having similar prevalence of depression diagnosis. Children with CRS might benefit from screening for depressive symptoms during routine management. Simple questionnaires such as the Patient Health Questionnaire or the Beck Depression Inventory have been validated for adolescents in general, and could be included as part of intake questionnaires^{10,11}. Further work is needed to test these in the pediatric CRS population.

Higher CIS scores in CRS children from lower income households may reflect broader socio-economic disparities in healthcare utilization. This is in agreement with previous studies that found differences in race and socio-economic status of children who received care for CRS at an outpatient otolaryngology clinic¹². Lower healthcare access may lead to poor symptom management and greater degree of functional limitation. As such, there may be additional opportunities to improve healthcare access in specific socio-economic groups of CRS children.

Strengths of the present study include the large sample size and sample design that allowed for nationwide estimates of health status and impairment. However, there are limitations. Cross-sectional analysis prevented any conclusions about causality of predictors that drive increased functional impairment. CRS is very common worldwide, but may be underdiagnosed. Symptoms in children are limited and can be very similar to the common cold or allergic symptoms. As such, our incidence of CRS likely underestimates the scope of the problem. Additionally, there were limited data on severity, symptoms, and clinical phenotype. In particular, previous studies have suggested sinus symptoms lead to impaired sleep¹³. We were unable to evaluate sleep symptoms; future studies are needed on the moderating effect of sleep on functional impairment. Our findings are limited to US children; additional studies are needed to understand the global functional impairment of pediatric CRS.

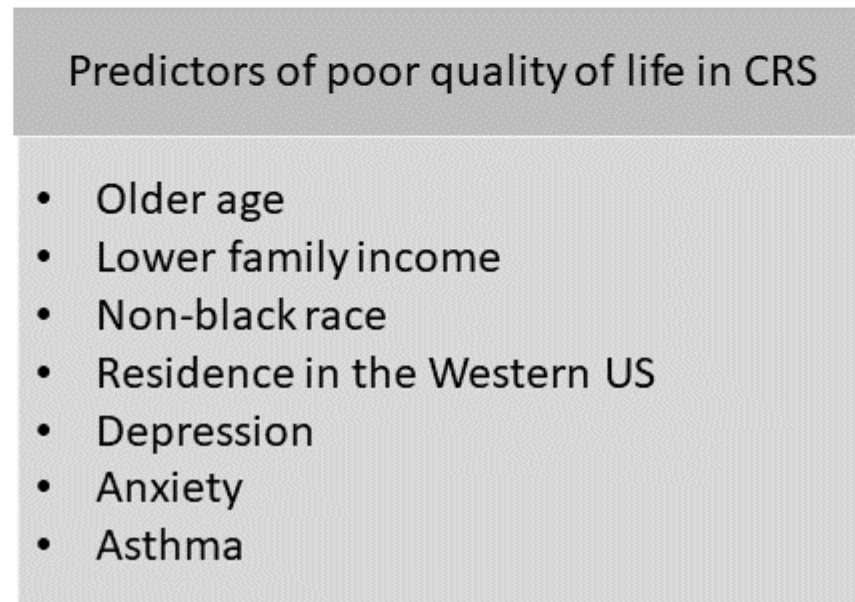
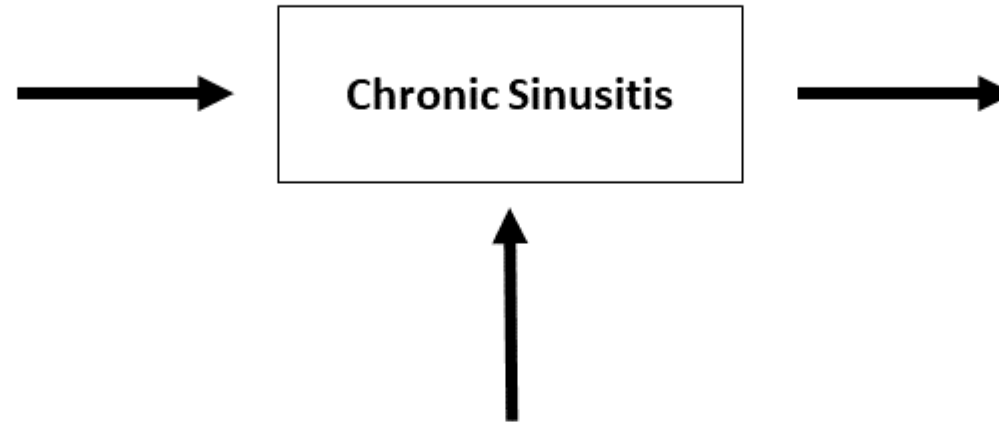
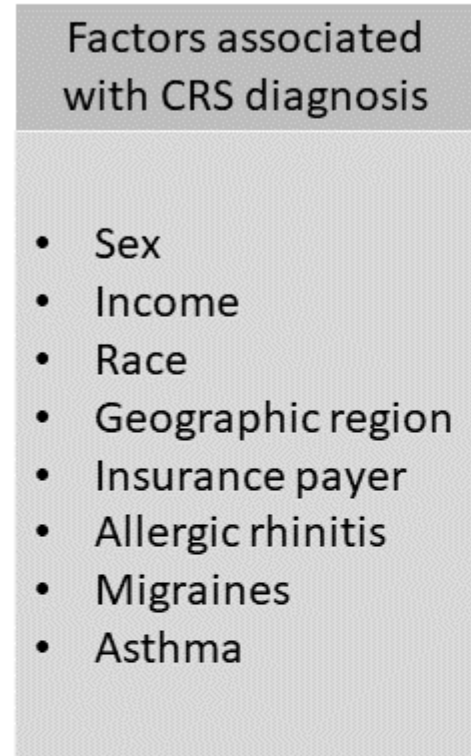
In conclusion, pediatric CRS is associated with substantial QOL burden across multiple psychosocial and cognitive domains. Moreover, CRS children with lower family income and comorbid asthma, anxiety, and depression had higher CIS scores associated with even greater functional impairment. These findings suggest pediatric CRS might be a population that requires greater attention and screening for mental health symptoms.

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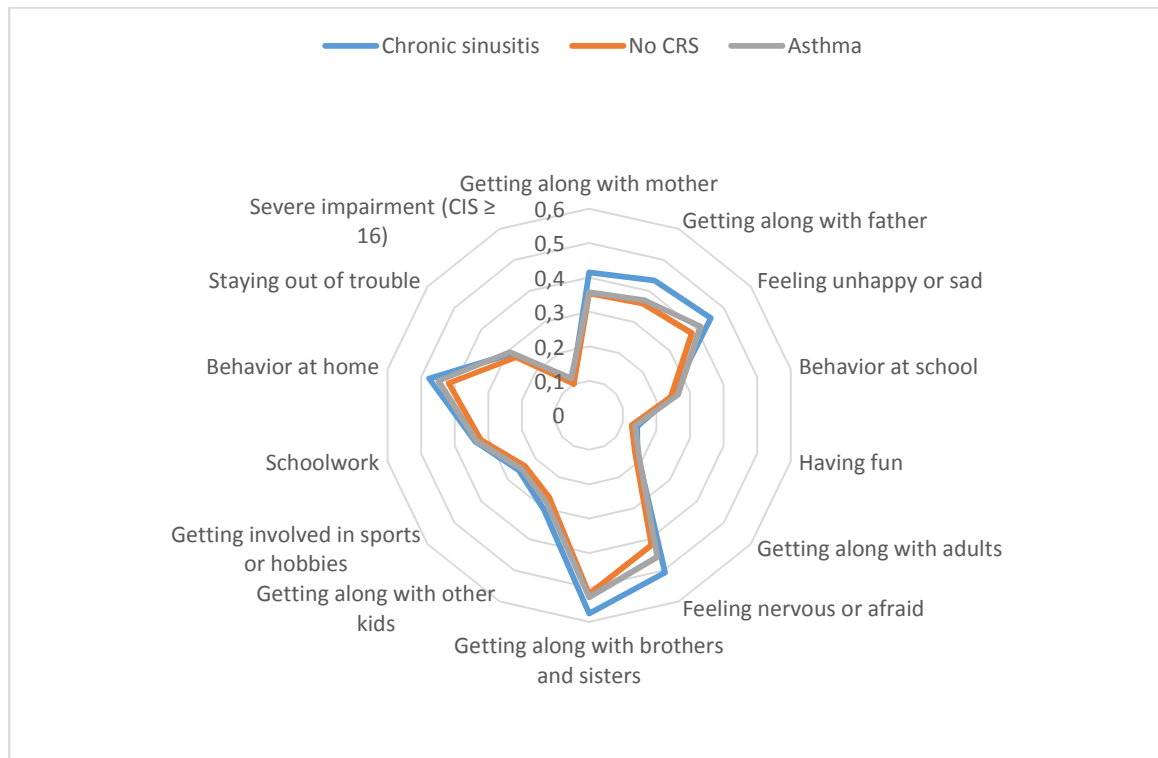
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Figure 1: Conceptual map of factors associated with chronic sinusitis and functional impairment.



Supplemental Figure 1: Proportion of children with CRS vs without CRS vs with asthma who experienced some/lots of difficulty with each CIS domain of functional impairment.



Supplemental Table 1. Sociodemographic associations of clinical diagnosis of chronic rhinosinusitis and asthma among US children (n=98,873).

Characteristic	Chronic Rhinosinusitis Diagnosis					Asthma Diagnosis				
	No		Yes		Rao-Scott P-Value	No		Yes		Rao-Scott P-Value
	Weighted Frequency	% Prevalence [95 % CI]	Weighted Frequency	% Prevalence [95% CI]		Weighted Frequency	% Prevalence [95% CI]	Weighted Frequency	% Prevalence [95% CI]	
Sex					0.005					<.0001
Male	406,486,414	94.9 [94.6-95.2]	21,891,084	5.1 [4.8-5.4]		377,284,219	88.1 [87.6-88.6]	51,090,278	11.9 [11.4-12.4]	
Female	386,027,104	94.3 [93.9-94.7]	23,367,545	5.7 [5.3-6.1]		374,830,693	91.6 [91.2-91.6]	34,563,956	8.4 [8.0-8.8]	
Age (years)					0.31					0.0006
5-11	429,999,794	94.7 [94.4-95.0]	24,065,829	5.3 [5.0-5.6]		405,681,012	89.3 [88.9-89.8]	48,384,611	10.7 [10.2-11.1]	
12-17	362,510,724	94.5 [94.1-94.8]	21,192,799	5.5 [5.2-5.9]		346,433,900	90.3 [89.8-90.7]	37,269,623	9.7 [9.3-10.2]	
Income					<.0001					<.0001
Poor, near poor, low	296,892,055	96.5 [96.2-96.8]	10,730,541	3.5 [3.2-3.8]		270,605,289	88.0 [87.5-88.5]	37,017,307	12.0 [11.5-12.5]	
Middle income	262,508,072	94.1 [93.7-94.6]	16,324,871	5.9 [5.4-6.3]		252,965,104	90.7 [90.3-91.2]	25,867,838	9.3 [8.8-9.7]	
High income	233,110,391	92.8 [92.2-93.3]	18,203,217	7.2 [6.7-7.8]		228,544,520	90.9 [90.3-91.5]	22,769,088	9.1 [8.5-9.7]	
Race					<.0001					<.0001
White	433,718,416	94.2 [93.8-94.6]	26,746,217	5.8 [5.4-6.2]		415,121,810	90.2 [89.7-90.6]	45,342,823	9.8 [9.4-10.3]	
Black	73,227,154	96.9 [96.4-97.4]	2,334,284	3.1 [2.6-3.6]		61,962,277	82.0 [80.9-83.1]	13,599,160	18.0 [16.9-19.1]	
Multiracial/other	285,474,366	94.6 [94.3-95.0]	16,176,645	5.4 [5.0-5.7]		274,951,842	91.1 [90.7-91.6]	26,699,168	8.9 [8.4-9.3]	
Region					<.0001					<.0001
Northeast	140,778,750	95.4 [95.0-95.9]	6,714,608	4.6 [4.1-5.0]		130,044,305	88.2 [87.3-89.0]	17,449,053	11.8 [11.0-12.7]	
Midwest	183,286,785	93.9 [93.4-94.4]	11,908,729	6.1 [5.6-6.6]		177,325,715	90.8 [90.2-91.5]	17,869,798	9.2 [8.5-9.8]	
South	277,344,033	93.3 [92.8-93.8]	19,871,776	6.7 [6.2-7.2]		264,867,123	89.1 [88.5-89.7]	32,348,685	10.9 [10.3-11.5]	
West	191,100,950	96.6 [96.1-97.1]	6,763,516	3.4 [2.9-3.9]		179,877,770	90.9 [90.3-91.5]	17,986,697	9.1 [8.5-9.7]	
Insurance coverage					<.0001					<.0001
Private	526,809,432	93.5 [93.2-93.9]	36,456,964	6.5 [6.1-6.8]		511,344,443	90.8 [90.4-91.2]	51,921,953	9.2 [8.8-9.6]	
Public	214,677,839	96.7 [96.4-97.0]	7,381,775	3.3 [3.0-3.6]		192,198,460	86.6 [85.9-87.2]	29,861,153	13.4 [12.8-14.1]	
None	51,023,247	97.3 [96.7-97.9]	1,419,890	2.7 [2.1-3.3]		48,572,009	92.6 [91.7-93.6]	3,871,128	7.4 [6.4-8.3]	
Allergic rhinitis					<.0001					<.0001
No	707,911,116	95.3 [95.0-95.5]	35,116,905	4.7 [4.5-5.0]		679,348,232	91.4 [91.1-91.8]	63,679,789	8.6 [8.2-8.9]	
Yes	84,599,401	89.3 [88.4-90.2]	10,141,724	10.7 [9.8-11.6]		72,766,681	76.8 [75.6-78.0]	21,974,444	23.2 [22.0-24.4]	
Nasal polyps					0.75					0.002
No	792,428,386	94.6 [94.3-94.9]	45,251,828	5.4 [5.1-5.7]		752,079,293	89.8 [89.4-90.1]	85,600,920	10.2 [9.9-10.6]	
Yes	82,132	92.4 [76.0-100.0]	6,801	7.6 [0.0-24.0]		35,619	40.1 [0.0-90.9]	53,313	59.9 [9.1-100.0]	
Migraine					<.0001					<.0001
No	782,821,669	94.7 [94.4-94.9]	44,176,558	5.3 [5.1-5.6]		743,099,197	89.9 [89.5-90.2]	83,899,031	10.1 [9.8-10.5]	
Yes	9,688,848	90.0 [87.5-92.4]	1,082,071	10.0 [7.6-12.5]		9,015,716	83.7 [80.4-87.0]	1,755,203	16.3 [13.0-19.6]	
Asthma					<.0001					

No	713,091,467	94.8 [94.5-95.1]	39,023,446	5.2 [4.9-5.5]	-	-	-	-
Yes	79,419,051	92.7 [91.9-93.5]	6,235,183	7.3 [6.5-8.1]	-	-	-	-

Bold face indicate statistically significant P-values.

Supplemental Table 2. Associations chronic rhinosinusitis diagnosis and functional domains using the Columbia Impairment Scale.												
Variable	Chronic Rhinosinusitis						Asthma					
	No			Yes			No			Yes		
	Wtd Freq (% Prev [95% CI])	Wtd Freq (% Prev [95% CI])	Crude OR [95% CI]	P	Adjusted OR* [95% CI]	P	Wtd Freq (% Prev [95% CI])	Wtd Freq (% Prev [95% CI])	Crude OR [95% CI]	P	Adjusted OR* [95% CI]	P
Columbia Impairment Scale												
Getting along with mother												
No problem	494,821,836 (64.6 [64.0-65.2])	25,591,233 (58.5 [56.3-60.6])	1.00 [ref]	-	1.00 [ref]	-	466,984,896 (64.3 [96.7-64.9])	53,428,174 (64.3 [62.8-65.7])	1.00 [ref]	-	1.00 [ref]	-
Some/big problem	270,733,964 (35.4 [34.8-36.0])	18,170,200 (41.5 [39.4-43.7])	1.30 [1.19-1.42]	<.0001	1.29 [1.18-1.40]	<.0001	259,220,187 (35.7 [35.1-36.3])	29,683,977 (35.7 [34.3-37.2])	1.00 [0.94-1.07]	0.98	1.03 [0.96-1.10]	0.42
Getting along with father												
No problem	467,831,630 (64.0 [63.3-64.6])	23,792,791 (56.6 [54.5-58.7])	1.00 [ref]	-	1.00 [ref]	-	442,245,592 (63.6 [63.0-64.3])	49,378,828 (62.9 [61.4-64.5])	1.00 [ref]	-	1.00 [ref]	-
Some/big problem	263,485,528 (36.0 [35.4-36.7])	18,262,378 (43.4 [41.3-45.5])	1.36 [1.25-1.48]	<.0001	1.35 [1.23-1.47]	<.0001	252,649,768 (36.4 [35.7-37.0])	29,098,138 (37.1 [35.5-38.6])	1.03 [0.97-1.10]	0.36	1.06 [0.99-1.14]	0.09
Feeling unhappy or sad												
No problem	476,815,105 (61.8 [61.2-62.4])	24,052,225 (54.8 [52.7-56.9])	1.00 [ref]	-	1.00 [ref]	-	451,608,375 (61.7 [61.1-62.3])	49,258,955 (58.7 [57.2-60.3])	1.00 [ref]	-	1.00 [ref]	-
Some/big problem	295,021,557 (38.2 [37.6-38.8])	19,856,084 (45.2 [43.1-47.3])	1.33 [1.23-1.45]	<.0001	1.35 [1.24-1.47]	<.0001	280,281,249 (38.3 [37.7-38.9])	34,596,392 (41.3 [39.7-42.8])	1.13 [1.06-1.21]	0.0002	1.16 [1.09-1.24]	<.0001
Behavior at school												
No problem	579,429,382 (75.6 [75.2-76.1])	32,843,728 (75.5 [73.8-77.2])	1.00 [ref]	-	1.00 [ref]	-	551,006,535 (75.9 [75.4-76.4])	61,266,575 (73.6 [72.4-74.8])	1.00 [ref]	-	1.00 [ref]	-
Some/big problem	186,632,225 (24.4 [23.9-24.8])	10,648,800 (24.5 [22.8-26.2])	1.01 [0.92-1.11]	0.89	1.09 [0.99-1.21]	0.08	175,276,624 (24.1 [23.6-24.6])	22,004,401 (26.4 [25.2-27.6])	1.13 [1.06-1.21]	0.0004	1.04 [0.97-1.11]	0.27
Having fun												
No problem	674,609,752 (87.3 [87.0-87.7])	37,643,809 (85.7 [84.3-87.2])	1.00 [ref]	-	1.00 [ref]	-	639,789,585 (87.4 [87.0-87.7])	72,463,975 (86.4 [85.4-87.4])	1.00 [ref]	-	1.00 [ref]	-
Some/big problem	97,744,922 (12.7 [12.3-13.0])	6,275,485 (14.3 [12.8-15.7])	1.15 [1.02-1.30]	0.02	1.15 [1.02-1.30]	0.02	92,584,223 (12.6 [12.3-13.0])	11,436,184 (13.6 [12.6-14.6])	1.09 [1.00-1.19]	0.06	1.10 [1.01-1.21]	0.03
Getting along with adults												
No problem	640,742,350 (83.0 [82.5-83.4])	36,044,118 (82.1 [80.5-83.6])	1.00 [ref]	-	1.00 [ref]	-	608,283,943 (83.1 [82.6-83.5])	68,502,525 (81.6 [80.6-82.7])	1.00 [ref]	-	1.00 [ref]	-
Some/big problem	131,632,499 (17.0 [16.6-17.5])	7,871,436 (17.9 [16.4-19.5])	1.06 [0.96-1.18]	0.26	1.13 [1.02-1.26]	0.02	124,103,937 (16.9 [16.5-17.4])	15,399,998 (18.4 [17.3-19.4])	1.10 [1.03-1.18]	0.007	1.06 [0.98-1.13]	0.13
Feeling nervous or afraid												
No problem	449,232,041 (58.2 [57.6-58.8])	21,654,434 (49.3 [47.3-51.4])	1.00 [ref]	-	1.00 [ref]	-	425,241,443 (58.1 [57.5-58.7])	45,645,033 (54.4 [53.0-55.9])	1.00 [ref]	-	1.00 [ref]	-
Some/big problem	322,473,588 (41.8 [41.2-42.4])	22,235,408 (50.7 [48.6-52.7])	1.43 [1.32-1.55]	<.0001	1.38 [1.27-1.50]	<.0001	306,497,865 (41.9 [41.3-42.5])	38,211,132 (45.6 [44.1-47.0])	1.16 [1.10-1.23]	<.0001	1.20 [1.13-1.27]	<.0001

Getting along with brothers and sisters												
No problem	346,746,976 (48.1 [47.3-48.8])	16,725,551 (42.5 [40.1-44.9])	1.00 [ref]	-	1.00 [ref]	-	326,971,987 (47.8 [47.0-48.6])	36,500,540 (47.2 [45.7-48.8])	1.00 [ref]	-	1.00 [ref]	-
Some/big problem	374,737,107 (51.9 [51.2-52.7])	22,614,799 (57.5 [55.1-59.9])	1.25 [1.13-1.38]	<.0001	1.23 [1.11-1.35]	<.0001	356,566,864 (52.2 [51.4-53.0])	40,785,042 (52.8 [51.2-54.3])	1.03 [0.96-1.09]	0.44	1.05 [0.98-1.11]	0.16
Getting along with other kids												
No problem	567,789,176 (73.5 [73.0-74.0])	30,621,940 (69.7 [67.7-71.8])	1.00 [ref]	-	1.00 [ref]	-	538,272,499 (73.5 [72.9-74.0])	60,138,617 (71.7 [70.4-73.0])	1.00 [ref]	-	1.00 [ref]	-
Some/big problem	204,592,086 (26.5 [26.0-27.0])	13,303,614 (30.3 [28.2-32.3])	1.21 [1.10-1.33]	0.0001	1.23 [1.12-1.35]	<.0001	194,149,010 (26.5 [26.0-27.1])	23,746,689 (28.3 [27.0-29.6])	1.10 [1.02-1.17]	0.008	1.08 [1.01-1.15]	0.03
Getting involved in sports or hobbies												
No problem	586,408,795 (76.3 [75.9-76.8])	32,323,403 (74.1 [72.4-75.9])	1.00 [ref]	-	1.00 [ref]	-	556,239,629 (76.3 [75.9-76.8])	62,492,568 (75.0 [73.7-76.2])	1.00 [ref]	-	1.00 [ref]	-
Some/big problem	181,948,850 (23.7 [23.2-24.1])	11,287,024 (25.9 [24.1-27.6])	1.13 [1.02-1.24]	0.01	1.14 [1.03-1.25]	0.008	172,350,282 (23.7 [23.2-24.1])	20,885,592 (25.0 [23.8-26.3])	1.08 [1.00-1.16]	0.04	1.08 [1.01-1.17]	0.04
Schoolwork												
No problem	518,257,488 (67.8 [67.2-68.3])	28,667,462 (66.0 [64.1-67.9])	1.00 [ref]	-	1.00 [ref]	-	491,683,282 (67.8 [67.3-68.3])	55,241,668 (66.5 [65.1-67.8])	1.00 [ref]	-	1.00 [ref]	-
Some/big problem	246,548,250 (32.2 [31.7-32.8])	14,765,490 (34.0 [32.1-35.9])	1.08 [0.99-1.18]	0.07	1.13 [1.03-1.23]	0.009	233,456,884 (32.2 [31.7-32.7])	27,856,855 (33.5 [32.2-34.9])	1.06 [1.00-1.13]	0.06	1.02 [0.95-1.09]	0.60
Behavior at home												
No problem	449,854,989 (58.2 [57.6-58.9])	23,008,774 (52.4 [50.2-54.6])	1.00 [ref]	-	1.00 [ref]	-	426,661,518 (58.3 [57.6-58.9])	46,202,245 (55.1 [53.5-56.6])	1.00 [ref]	-	1.00 [ref]	-
Some/big problem	322,529,334 (41.8 [41.1-42.4])	20,922,977 (47.6 [45.4-49.8])	1.27 [1.17-1.38]	<.0001	1.30 [1.19-1.41]	<.0001	305,746,679 (41.7 [41.1-42.4])	37,705,633 (44.9 [43.4-46.5])	1.14 [1.07-1.21]	<.0001	1.12 [1.05-1.19]	0.0006
Staying out of trouble												
No problem	563,110,401 (72.9 [72.4-73.4])	31,293,290 (71.3 [69.4-73.1])	1.00 [ref]	-	1.00 [ref]	-	535,167,494 (73.1 [72.5-73.6])	59,236,197 (70.6 [69.3-71.9])	1.00 [ref]	-	1.00 [ref]	-
Some/big problem	209,266,265 (27.1 [26.6-27.6])	12,617,059 (28.7 [26.9-30.6])	1.09 [0.99-1.19]	0.07	1.15 [1.05-1.26]	0.002	197,217,784 (26.9 [26.4-27.5])	24,665,539 (29.4 [28.1-30.7])	1.13 [1.06-1.21]	0.0005	1.06 [0.99-1.14]	0.09
Severe impairment: CIS ñ 16												
No	711,653,056 (89.8 [89.5-90.1])	40,197,447 (88.8 [87.5-90.1])	1.00 [ref]	-	1.00 [ref]	-	676,383,266 (89.9 [89.6-90.3])	75,467,237 (88.1 [87.3-89.0])	1.00 [ref]	-	1.00 [ref]	-
Yes	80,857,462 (10.2 [9.9-10.5])	5,061,181 (11.2 [9.9-12.5])	1.11 [0.97-1.26]	0.12	1.21 [1.06-1.38]	0.006	75,731,646 (10.1 [9.7-10.4])	10,186,997 (11.9 [11.0-12.7])	1.21 [1.11-1.31]	<.0001	1.16 [1.06-1.27]	0.0008

1

*Adjusted for age (continuous), sex (male/female), race (white/non-white), and income (poor/middle/high).

2

Bold face indicate statistically significant P-values.

3

Wtd. Freq. = weighted frequency; OR = odds ratio

Supplemental Table 3. Sociodemographic and clinical associations of increased Columbia Impairment Scale score among children with chronic rhinosinusitis.

Characteristic	Chronic Rhinosinusitis				
	CIS score	Bivariable Model		Multivariable Stepwise Model	
	Mean [95% CI]	Crude Beta [95% CI]	P	Adjusted Beta [95% CI]	P
Sex					
Male	7.6 [7.1-8.1]	0.55 [0.11, 0.99]	0.02	0.37 [-0.04, 0.78]	0.08
Female	7.1 [6.6-7.6]	1.00 [ref]	-	1.00 [ref]	-
Age (years)					
5-11	7.0 [6.4-7.5]	1.00 [ref]	-	1.00 [ref]	-
12-17	7.7 [7.3-8.2]	0.79 [0.33, 1.24]	0.0007	0.48 [0.03, 0.93]	0.04
Income					
Poor, near poor, low	8.8 [8.1-9.5]	2.10 [1.53, 2.66]	<.0001	2.00 [1.47, 2.54]	<.0001
Middle income	7.2 [6.6-7.7]	0.49 [-0.07, 1.05]	0.09	0.56 [0.02, 1.10]	0.04
High income	6.7 [6.2-7.2]	1.00 [ref]	-	1.00 [ref]	-
Race					
White	7.4 [6.9-7.9]	1.00 [ref]	-	1.00 [ref]	-
Black	6.6 [5.6-7.5]	-0.79 [-1.30, -0.28]	0.003	-0.64 [-1.14, -0.13]	0.01
Other or multiple	7.4 [6.9-8.0]	0.08 [-0.50, 0.67]	0.78	0.38 [-0.19, 0.95]	0.19
Region					
Northeast	6.8 [6.1-7.5]	1.00 [ref]	-	1.00 [ref]	-
Midwest	7.4 [6.7-8.2]	0.58 [-0.27, 1.44]	0.18	0.57 [-0.28, 1.42]	0.19
South	7.1 [6.6-7.7]	0.29 [-0.37, 0.95]	0.39	0.26 [-0.40, 0.92]	0.44
West	8.3 [7.4-9.3]	1.48 [0.66, 2.30]	0.0004	1.24 [0.48, 1.99]	0.001
Insurance coverage					
Private	7.1 [6.7-7.5]	1.00 [ref]	-		
Public	8.7 [7.9-9.5]	1.58 [1.06, 2.10]	<.0001		
None	7.2 [5.3-9.1]	0.11 [-1.26, 1.49]	0.87		
Depression					
No	7.1 [6.7-7.4]	1.00 [ref]	-	1.00 [ref]	-
Yes	17.6 [15.1-20.1]	10.55 [8.80, 12.31]	<.0001	9.04 [7.27, 10.81]	<.0001
Anxiety					
No	7.0 [6.7-7.4]	1.00 [ref]	-	1.00 [ref]	-
Yes	15.2 [13.2-17.2]	8.20 [7.06, 9.33]	<.0001	7.26 [6.23, 8.29]	<.0001
Allergic rhinitis					
No	7.3 [6.9-7.7]	1.00 [ref]	-		
Yes	7.6 [6.9-8.3]	0.29 [-0.25, 0.83]	0.29		
Asthma					
No	7.3 [6.8-7.7]	1.00 [ref]	-	1.00 [ref]	-
Yes	8.0 [7.2-8.7]	0.71 [0.15, 1.27]	0.01	0.70 [0.15, 1.24]	0.01
Migraine					
No	7.3 [6.9-7.7]	1.00 [ref]	-		
Yes	9.1 [7.1-11.0]	1.77 [0.12-3.42]	0.04		

Bold face indicate statistically significant P-values.