

Article

Quality of Life and Its Correlates in Iraqi Medical Students with Chronic Rhinosinusitis

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Abstract

Background: Chronic rhinosinusitis (CRS) impairs the quality of life (QoL), but its impact and risk factors remain unknown among Iraqis, including medical students. We aim to assess the QoL using the Sino-Nasal Outcome Test-22 (SNOT-22) in CRS-affected Iraqi medical students, categorize impairment severity, and identify associated correlates via multivariable analysis. **Methods:** We surveyed 435 Iraqi undergraduates with CRS to identify QoL correlates, SNOT-22 severity strata, associated symptoms, seasonality, and treatment history. Data analysis, including multivariable models, was conducted in IBM SPSS version 27. **Results:** Among 435 surveyed individuals, 76.6% had impaired QoL. Binary logistic regression identified key correlates: immune disturbances (OR = 2.68; $p = 0.028$), family history (OR = 2.12; $p = 0.003$), chronic comorbidities (OR = 2.07; $p = 0.037$), and pre-clinical (basic) educational level (OR = 1.95; $p = 0.007$). In sex-stratified models, chronic comorbidities predominated in females (OR = 4.64; $p < 0.001$) and immune disturbances in males (OR = 3.89; $p = 0.014$). Ordinal regression confirmed immune disturbances ($\beta = 0.65$; $p = 0.017$), chronic comorbidities ($\beta = 0.58$; $p = 0.023$), and family history ($\beta = 0.57$; $p = 0.003$). Logistic and ordinal regression exhibited good model fitting ($p > 0.05$) and showed comparable statistical accuracy (76.8% vs. 76.1%). **Conclusions:** Impaired QoL was common among CRS-affected medical students, with immune disturbances and family history as the strongest correlates. Sex-specific differences existed. Findings highlight the need for personalized management of high-risk groups.

Keywords: Arabs; immunologic factors; ostiomeatal complex; psychological well-being; Sino-Nasal Outcome Test-22



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1. Introduction

The European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS 2020) defines chronic rhinosinusitis (CRS) as inflammation of the nasal and sinus mucosa lasting ≥ 12 weeks, with ≥ 2 symptoms (e.g., nasal blockage, obstruction, congestion, or nasal discharge, and additional symptoms may include facial pain, and reduced or lost sense of smell) and endoscopic or computed tomography (CT) evidence of disease. These criteria help differentiate CRS from acute or allergic conditions for accurate diagnosis. CRS variably involves the ethmoid, maxillary, frontal, and sphenoid sinuses; it frequently affects the maxillary, anterior ethmoid sinus, and the ostiomeatal complex, while the frontal and sphenoid involvement is less common [1]. Its prevalence among Iraqi undergraduates, including medical students, remains unknown.

In Saudi Arabia, recent studies have outlined CRS epidemiology and clinical profile [2–4]. In 2024, AlRajhi and coworkers reviewed 14 studies ($n = 12,667$), reporting regional prevalence from 10–14% (eastern province) to 50% (southern region) [2]. In 2023, Alnemare and coauthors identified risk factors for CRS with nasal polyps (CRSwNP) in 386 adults, including personal ($p = 0.016$) and familial polyp history ($p = 0.049$), with gender differences in polyp rates and predisposition [3]. In 2023, Alfallaj and colleagues reported nasal polyps in 67.7% and comorbid asthma in 32% of 660 Riyadh CRS patients [4].

Health-related quality of life (HRQoL) and broader quality of life (QoL) tools are essential to assessing CRS burden [5]. Disease-specific instruments like the 22-item Sino-nasal Outcome Test (SNOT-22) are frequently used, alongside generic measures such as EuroQoL-5 Dimensions (EQ-5D) and Short Form-6 Dimensions (SF-6D). Surgical candidates typically score 25–73 on SNOT-22, with EQ-5D indices of 0.81–0.86, which is similar to or worse than those seen in COPD [6]. Otologic/facial pain and sleep issues contribute most to HRQoL decline, highlighting a broad impact beyond nasal symptoms [5,6]. QoL data in CRS-affected Iraqis, particularly medical students, remain limited.

Two cross-sectional studies highlight CRS prevalence and QoL impact among undergraduates [7,8]. In 2023, Zaidi and coworkers found CRS in 54% of health-science and 46% of social-science students in Karachi, with 7% and 9%, respectively, reporting poor QoL on SNOT-22 [7]. Similarly, another study reported 44.4% prevalence and significant QoL impairment among Indonesian medical students [8]. These findings emphasize both disciplinary variation and CRS's impact on future healthcare professionals.

Sino-nasal anatomical anomalies, such as nasal septum deviation (NSD), concha bullosa (CB), Haller cells (HCs), agger nasi cells (ANCs), and Onodi cells (OCs), among others, are common in CRS, though their causal role in sinusitis is still uncertain. Concha bullosa and multiple sinus surgeries worsen CRS symptoms and QoL (SNOT-20/22). Surgically treated midface fractures also increase CRS risk and long-term QoL impairment. These findings highlight the importance of thorough preoperative CT and careful review of trauma or surgery history in CRS management [9–17].

A retrospective CT study in India found high rates of NSD (62.8%) and CB (52.8%), with specific variants linked to sinus involvement: NSD and CB with maxillary sinusitis; ANCs with frontal and ethmoid disease; HCs with maxillary; and OCs with sphenoid sinusitis [9,10]. Another study from India reported NSD and CB in 88.2% and 76.4% of CRS cases, respectively [11]. In contrast, a Korean CT volumetric analysis found no significant link between NSD and CB with maxillary sinusitis [12].

Studies show sino-nasal anatomical variations worsen CRS symptoms and reduce QoL. A Nigerian study found a significant link ($p < 0.001$) between anatomical variants and pathologies, including nasal polyps, and higher symptom severity on SNOT-20 [13]. In 2020, Qualliotine and coauthors reported worse baseline SNOT-22 scores in American CRS patients with CB, whose QoL remained more impaired post-surgery than those without [14]. Similarly, the “mySinusitisCoach” project in Europe found that patients with >3 prior major sinus surgeries had significantly less QoL improvement after surgery [15].

An American survey comparing surgically repaired midface and mandibular fractures found midface fractures significantly increase CRS risk and cause lasting QoL impairment, underscoring the need for long-term follow-up and management [16]. Similarly, another intensive care unit (ICU) study from the United States reported that craniofacial trauma and nasal instrumentation may trigger occult maxillary sinusitis, highlighting the role of early detection in preventing acute and chronic complications [17].

The present study aims to assess the QoL in Iraqi medical students with CRS using the SNOT-22; categorize impairment (mild, moderate, or severe); determine each category's prevalence; identify QoL impairment's correlates via uni- and multivariable analyses; and

evaluate the multivariable model's accuracy. Findings can have clinical, societal, and economic implications for Iraq's future healthcare professionals.

2. Materials and Methods

2.1. Study Design and Data Collection

This cross-sectional study was conducted from 20 June to 1 July 2025, including 436 Iraqi medical students. After excluding one student for insufficient English language skills, the final sample was 435 students from Medicine, Dentistry, and Pharmacy. Data were collected using a paper-based questionnaire, and only students who met EPOS criteria for CRS received the SNOT-22 questionnaire.

The questionnaire (Appendix A) included four sections: socio-demographics (age, sex, nationality, residence, education, occupation, marital or relationship status, housing, economic status); potential correlates (smoking, environmental exposures, having pets, chronic comorbidities, family history of respiratory or allergic disease); the validated English SNOT-22 scale assessing 22 sino-nasal, otologic, sleep, and emotional symptoms; and symptom periodicity as well as treatment history, covering seasonal patterns, prior interventions, adherence to treatment, and perceived benefit.

2.2. Inclusion and Exclusion Criteria

Participants were undergraduate students aged 16–27 from Medicine, Dentistry, and Pharmacy with confirmed CRS. They provided informed consent after being briefed on the study. Inclusion required questionnaire completion. CRS was defined per EPOS 2020 as ≥ 12 weeks of symptoms with ≥ 2 symptoms (e.g., nasal obstruction or discharge) plus endoscopic or CT evidence [1]. Exclusions applied to students from other faculties, incomplete questionnaires, first-year students lacking a relevant medical background, or insufficient English language proficiency.

2.3. Diagnosis of Chronic Rhinosinusitis

Chronic rhinosinusitis was identified according to EPOS 2020 criteria, based on relevant sino-nasal symptoms lasting for at least 12 weeks together with objective evidence of inflammation. During administration of the paper-based questionnaire, participants were asked about their relevant medical and surgical history, and they were requested to provide any available documentation confirming a previous CRS diagnosis, including prior clinical examination, nasal endoscopy, or computed tomography. When objective evidence was not already available, further assessment was performed by a specialist otolaryngologist, who conducted nasal endoscopy and/or referred participants for CT imaging for a definitive diagnosis.

2.4. The Sino-Nasal Outcome Test-22

The SNOT-22 is a 22-item patient-reported measure assessing HRQoL in adults with CRS. Items are rated 0 ("no problem") to 5 ("worst"), yielding total scores from 0 to 110 that reflect symptom burden and daily impact. Scores were stratified per Toma and Hopkins (2016) as mild (8–20), moderate (>20–50), and severe (>50) impairment [18]. They reported excellent diagnostic accuracy for identifying CRS patients with impaired QoL, with an AUC of 0.942 ($p < 0.05$) and, at a >20 threshold, 98.1% sensitivity, 81.8% specificity, 96.2% positive predictive value, and 91.7% negative predictive value. The SNOT-22 was later validated in an extensive study of around 3000 patients across 87 National Health Service (NHS) hospitals in England and Wales [19]. In 2009, Hopkins and colleagues confirmed its reliability, validity, and responsiveness for assessing sino-nasal surgery outcomes [20].

The SNOT-22 primarily assesses symptom severity and HRQoL in CRSwNP patients, serving as a clinical and research tool to evaluate baseline burden, guide treatment, and monitor responses. Its sensitivity to change makes it helpful in tracking outcomes, with a minimally important difference (MID) of about 8.9 points indicating meaningful improvement [20]. However, Yim and coauthors found that while SNOT-22 reliably measures QoL, it poorly distinguishes CRS from non-CRS patients, limiting its diagnostic utility [21]. The SNOT-22 items are grouped into five domains reflecting CRS's multifaceted impact: (1) nasal symptoms (e.g., congestion, discharge), (2) ear/facial symptoms (e.g., facial pain, ear fullness), (3) sleep dysfunction (e.g., difficulty falling or staying asleep), (4) functional limitations (e.g., reduced concentration, productivity), and (5) emotional distress (e.g., frustration, sadness) [19,21]. This structure enables a comprehensive assessment of CRS's physical and psychosocial burden.

2.5. The Systematic Review of the Literature

Relevant articles (case reports, series, reviews, research papers, systematic reviews, and meta-analyses) on CRS and HRQoL were retrieved using MeSH terms via MEDLINE and EBSCOhost. Additional Iraqi literature was searched through the Iraqi Academic Scientific Journals website and the University of Baghdad Digital Repository.

2.6. Data Analysis and Statistical Methods

The minimum required sample size was calculated as $n = 377$ using a standard formula. Raw data were entered in Microsoft Excel 2016. Statistical analyses were performed using IBM SPSS Statistics version 27. The level of significance was set at $\alpha = 0.05$ (95% CI) with 80% power ($1 - \beta = 0.80$). Effect sizes were reported as odds ratios with 95% CIs for χ^2 tests and logistic regressions.

Binary variables were coded 0/1, and multi-response items (e.g., chronic comorbidities) were converted to dummy variables for Chi-squared tests, binary logistic, and ordinal regression analyses. Continuous variables like age, showing non-normal distribution by the Shapiro–Wilk test ($p < 0.05$), were summarized as medians and interquartile ranges (IQR). SNOT-22 scores, being ordinal, were also reported similarly.

Three multivariable binary logistic regression models (total sample, male, female) were built via the stepwise method and assessed with the Hosmer–Lemeshow test and Nagelkerke R^2 . Multivariable ordinal regression models for the same groups were evaluated using Pearson goodness-of-fit and Nagelkerke R^2 . Model performance was measured by sensitivity, specificity, and statistical accuracy.

2.7. Assessment and Grouping of Allergic and Immune-Related Conditions

Allergic and immune-related conditions, including seasonal allergy, non-seasonal allergy, eczema, and other immune disturbances, were collected through the survey questionnaire. These variables were combined into a single composite category ("immune disturbances") for multivariable analysis to preserve statistical power, given the limited number of participants in each subgroup.

3. Results

3.1. Descriptive Statistics

Among 435 students, 76.6% had impaired QoL; of these, 28.5% experienced mild, 35.4% moderate, and 12.6% severe impairment. Most students were in their twenties, with a median of 20 years (IQR 20–21). The raw SNOT-22 scores showed a median of 19 (IQR 8–36), reflecting predominantly mild to moderate QoL impairment among CRS-affected medical students.

Concerning socio-demographic parameters, 288 (66.2%) were medical students, 85 (19.5%) were in Dentistry, and 62 (14.3%) were in pharmacy. Pre-clinical students (basic sciences education) numbered 225 (51.7%), and 210 (48.3%) were in their clinical education stage (clinical sciences education). There were 292 (67.1%) females and 143 (32.9%) males. By region of residence, 224 (51.5%) were from the south of Iraq, 185 (42.5%) from the capital, 14 (3.2%) from the west, and 12 (2.8%) from the north. City-wise, 185 (42.5%) were from Baghdad, 107 (24.6%) from Karbala, and 54 (12.4%) from Babylon, among other cities.

Most CRS-affected students were from urban areas (387; 89.0%), and lived in houses (413; 94.9%), with 18 (4.1%) in apartments and 4 (0.9%) in hostels. Only 39 (9%) were employed (Figure 1). Most were single (415; 95.4%), and 20 (4.6%) were in relationships. Family income was middle in 197 (45.3%), high in 120 (27.6%), and low in 118 (27.1%).

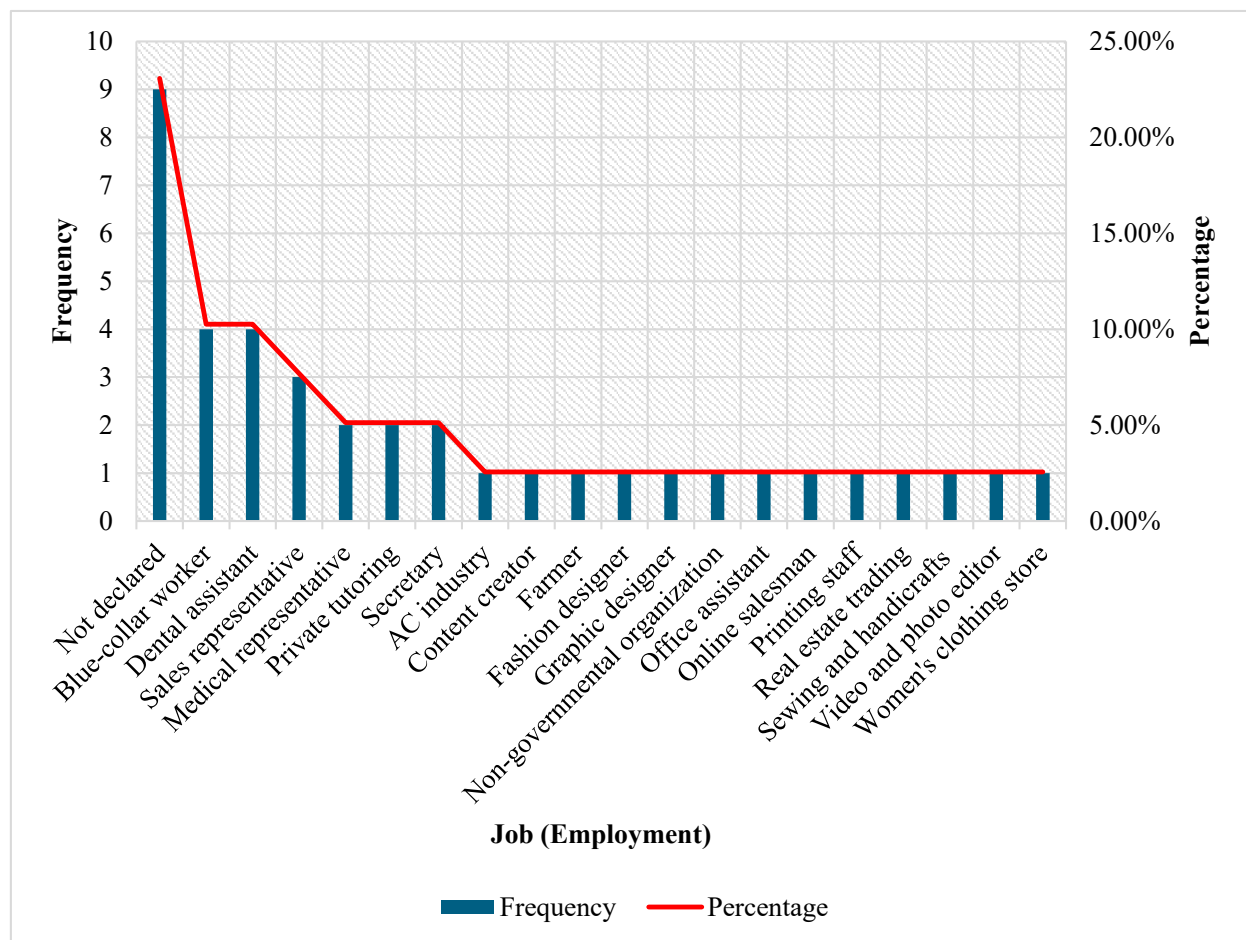


Figure 1. Sectoral distribution of employment among CRS-affected Iraqi medical students.

Regarding potential correlates of QoL impairment, most students were non-smokers (399; 91.7%) and non-vapers (400; 92.0%). Chemical exposure was reported by 130 (29.9%), environmental exposure to dirt, dust, or plants by 144 (33.1%), and pet exposure by 99 (22.8%). Chronic comorbidities were present in 218 (50.1%), including chronic depression (35; 8%), gastrointestinal disorders (59; 13.6%), among others. Seasonal allergies affected 103 (23.7%) and non-seasonal allergies 35 (8%). Eczema was reported by 24 (5.5%), other immune-related disorders by 16 (3.7%), and overall immune disturbances by 146 (33.6%).

Concerning sino-nasal anomalies and pathologies, NSD was reported by 55 (12.6%), prior sino-nasal trauma in 8 (1.8%), and nasal polyps in 11 (2.5%). Overall, 74 students (17.1%) had sino-nasal anomalies or trauma. On another note, a positive family history of sino-nasal disorders and allergies was reported by 247 (56.8%).

Among 333 (76.6%) students with impaired QoL, seasonality (periodic pattern) of CRS symptoms was reported by 142 (42.6%) individuals, most commonly in winter (59; 41.6%), spring (37; 26.1%), summer (34; 23.9%), and autumn (12; 8.5%) (Figure 2). Further, among those with impaired QoL, only 167 (50.2%) received treatment. Among those who specified a treatment type, 42.3% used self-management, 20.1% had family-known prescriptions, and only 37.6% received physician care. Medical treatment accounted for 97.6%, while surgical treatment accounted for 4.8%.

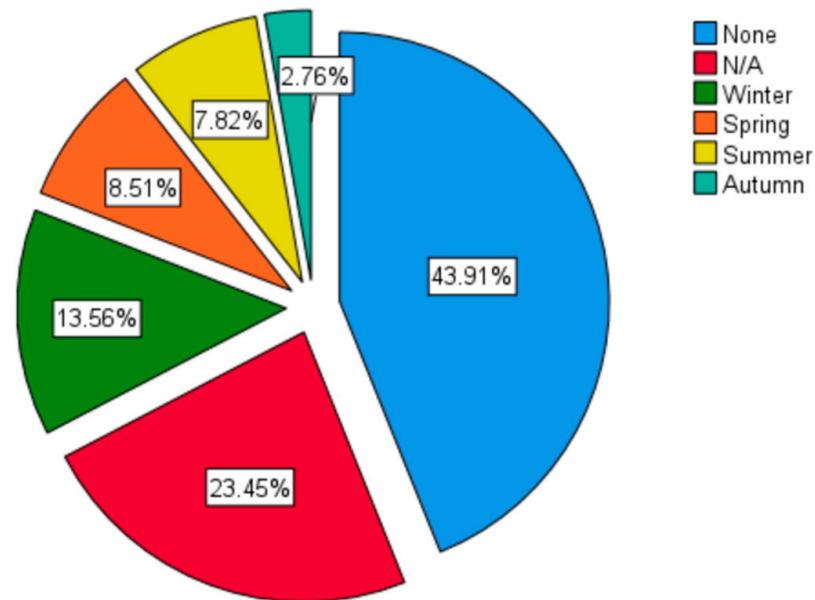


Figure 2. Seasonality of CRS symptoms in Iraqi medical students with(out) QoL impairment. N/A: no quality of life (QoL) impairment; None: QoL impairment without a seasonal pattern.

3.2. Univariable Chi-Squared Testing

In univariable analyses (Table 1), depression was the strongest correlate of impaired QoL (OR = 11.49, 95% CI 1.55–84.98; $p = 0.003$), followed by immune disturbances (OR = 5.64, 95% CI 2.91–10.94; $p < 0.001$), seasonal allergy (OR = 5.50, 95% CI 2.46–12.28; $p < 0.001$) and non-seasonal allergy (OR = 5.50, 95% CI 1.30–23.33; $p = 0.010$). Chronic comorbidities (OR = 4.54, 95% CI 2.73–7.53; $p < 0.001$) and gastrointestinal disorders (OR = 3.76, 95% CI 1.46–9.66; $p = 0.004$) were also significant correlates, as was a positive family history of sino-nasal disease and allergies (OR = 3.35, 95% CI 2.11–5.34; $p < 0.001$).

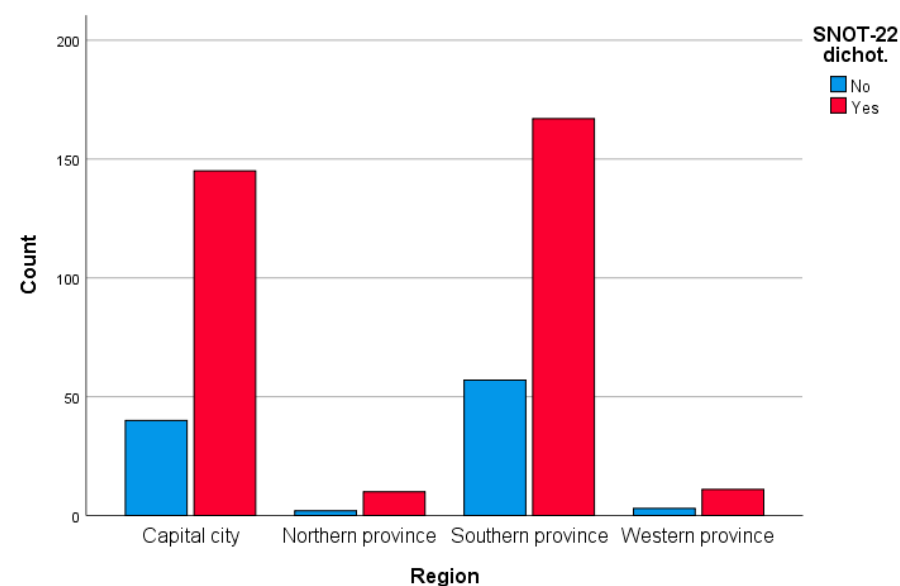
Sino-nasal anatomic anomalies more than doubled the odds (OR = 2.53, 95% CI 1.17–5.49; $p = 0.016$), while exposure to cleaning chemicals (OR = 2.37, 95% CI 1.35–4.13; $p = 0.002$), NSD (OR = 2.29, 95% CI 1.00–5.22; $p = 0.045$) and exposure to pets (OR = 2.15, 95% CI 1.16–3.99; $p = 0.013$) also conferred significantly high odds. Finally, lower educational level (pre-clinical vs. clinical) was associated with greater impairment (OR = 1.84, 95% CI 1.17–2.88; $p = 0.008$), as was female gender (OR = 1.70, 95% CI 1.07–2.68; $p = 0.023$).

In contrast, factors such as medical science discipline, geographic region of residence (Figure 3), type or location of residence (urban vs. rural), employment, relationship status, socioeconomic status, tobacco smoking, use of electronic cigarettes and vaping, exposure to dirt or plants, eczema, existence of nasal polyps, and history of sino-nasal trauma showed no significant association.

Table 1. Chi-square test of independence between categorical variables and SNOT-22 scores.

Variable	Pearson's χ^2	df	p-Value	OR	95% CI
Depression	8.99	1	0.003	11.49	1.55–84.98
Immune disturbances	31.01	1	<0.001	5.64	2.91–10.94
Seasonal allergy	20.85	1	<0.001	5.50	2.46–12.28
Non-seasonal allergy	6.70	1	0.010	5.50	1.30–23.33
Chronic comorbidities	37.67	1	<0.001	4.54	2.73–7.53
Gastrointestinal disorders	8.53	1	0.004	3.76	1.46–9.66
Eczema	3.23	1	0.072	3.54	0.82–15.31
Family history	27.41	1	<0.001	3.35	2.11–5.34
Nasal Polyps	1.30	1	0.470	3.12	0.40–24.72
Anatomic anomalies	5.84	1	0.016	2.53	1.17–5.49
Exposure to cleaning chemicals	9.52	1	0.002	2.37	1.35–4.13
Nasal septum deviation	4.03	1	0.045	2.29	1.00–5.22
Exposure to pets	6.19	1	0.013	2.15	1.16–3.99
Educational level	7.09	1	0.008	1.84	1.17–2.88
Gender	5.20	1	0.023	1.70	1.07–2.68
Sino-nasal trauma	2.50	1	0.207	1.31	1.25–1.39
Medical science discipline	4.25	2	0.119	*	*
Region	1.18	3	0.757	*	*
Residence	0.01	1	0.927	*	*
Type of residence	0.02	2	0.991	*	*
Employment status	0.01	1	0.954	*	*
Relationship status	0.50	1	0.432	*	*
Family income	1.03	2	0.596	*	*
Smoking	0.35	1	0.554	*	*
Vaping	2.49	1	0.115	*	*
Exposure to dirt, plants, or dust	1.31	1	0.252	*	*

*. An odds ratio can only be calculated for a 2×2 contingency table.

**Figure 3.** Distribution of SNOT-22 scores across Iraqi provinces.

3.3. Multivariable Binary Logistic Regression Model

In multivariable analysis of the entire sample (Table 2), immune disturbances emerged as the strongest correlate of impaired QoL (OR = 2.68, 95% CI 1.11–6.47; $p = 0.028$), followed by a positive family history (OR = 2.12, 95% CI 1.29–3.51; $p = 0.003$), presence of chronic comorbidities (OR = 2.07, 95% CI 1.04–4.09; $p = 0.037$) and pre-clinical educational level (OR = 1.95, 95% CI 1.20–3.16; $p = 0.007$).

Table 2. Multivariable binary logistic regression analysis.

Cohort	Variable	p-Value	OR	95% CI
Total sample	Immune disturbances	0.028	2.68	1.11–6.47
	Family history	0.003	2.12	1.29–3.51
	Chronic comorbidities	0.037	2.07	1.04–4.09
	Educational level	0.007	1.95	1.20–3.16
Females	Chronic comorbidities	<0.001	4.64	2.32–9.29
	Educational level	0.027	2.01	1.09–3.74
	Family history	0.031	2.00	1.07–3.74
Males	Immune disturbances	0.014	3.89	1.32–11.48
	Family history	0.019	2.73	1.18–6.33

95% confidence interval (95% CI); odds ratio (OR).

When models were stratified by sex, among females, chronic comorbidities showed the highest risk (OR = 4.64, 95% CI 2.32–9.29; $p < 0.001$), with pre-clinical medical education (OR = 2.01, 95% CI 1.09–3.74; $p = 0.027$) and family history (OR = 2.00, 95% CI 1.07–3.74; $p = 0.031$) also independently associated with impaired QoL.

In males, immune disturbances (OR = 3.89, 95% CI 1.32–11.48; $p = 0.014$) and family history (OR = 2.73, 95% CI 1.18–6.33; $p = 0.019$) were the only significant factors in multivariable analysis. Smoking showed a borderline association, achieving significance only at the 90% confidence level (OR = 2.30, 95% CI -0.87–6.08; $p = 0.093$).

3.4. Multivariable Ordinal Regression Model

In the total sample, immune disturbances emerged as the strongest correlate of increasingly severe QoL impairment (estimate = 0.65 ± 0.27 , 95% CI 0.11–1.17; $p = 0.017$), followed by chronic comorbidities (0.58 ± 0.26 , 95% CI 0.08–1.08; $p = 0.023$), positive family history (0.57 ± 0.19 , 95% CI 0.19–0.95; $p = 0.003$), pre-clinical level of educational (0.44 ± 0.18 , 95% CI 0.09–0.79; $p = 0.014$) and female gender (0.39 ± 0.19 , 95% CI 0.01–0.77; $p = 0.043$). Exposure to cleaning chemicals showed a borderline effect (0.39 ± 0.20 , 95% CI -0.01–0.79; $p = 0.052$).

Among females, chronic comorbidities again predominated (1.18 ± 0.23 , 95% CI 0.73–1.64; $p < 0.001$), with family history (0.57 ± 0.23 , 95% CI 0.12–1.02; $p = 0.014$) and pre-clinical educational level (0.43 ± 0.22 , 95% CI 0.01–0.86; $p = 0.048$) also significant. Urban residence showed a borderline association with impaired QoL (0.57 ± 0.33 , 95% CI -0.08–1.24; $p = 0.088$). In males, immune disturbances led the risks (1.31 ± 0.37 , 95% CI 0.57–2.04; $p < 0.001$), followed by family history (0.68 ± 0.34 , 95% CI 0.01–1.34; $p = 0.048$). Smoking approached significance (0.67 ± 0.36 , 95% CI -0.38–1.38; $p = 0.064$).

3.5. Statistical Accuracy of Multivariable Models

All multivariable models demonstrated adequate fit (Hosmer–Lemeshow; Pearson test; p -values > 0.05) and comparable statistical accuracy and variance explanatory metric across cohorts (Table 3). In the total sample, logistic regression achieved a Nagelkerke's pseudo- R^2 of 0.20 with 76.8% overall accuracy, while ordinal regression reached an R^2 of 0.19 with 76.1% accuracy.

Among females, both regression models had comparable performance (logistic Nagelkerke's $R^2 = 0.19$, ordinal Nagelkerke's $R^2 = 0.17$; 79.8% accuracy for both). In males, logistic regression had a slightly higher Nagelkerke's R^2 (0.21 vs. 0.20) but similar overall accuracy (69.9%).

Table 3. Overview of regression models' goodness-of-fit and statistical accuracy.

Model	Cohort	<i>p</i> -Value	R ²	Accuracy
Logistic	Total sample	0.844	0.199	76.80
	Females	0.182	0.194	79.80
	Males	0.562	0.211	69.90
Ordinal	Total sample	0.741	0.190	76.09
	Females	0.428	0.170	79.79
	Males	0.225	0.196	69.93

p-value: probability value for goodness-of-fit test; R² denotes: Nagelkerke's pseudo-R².

4. Discussion

4.1. Study Findings and Interpretations

In univariable analyses, depression, immune disturbances, and allergic conditions were the strongest factors associated with an impaired QoL, followed by chronic comorbidities, gastrointestinal disorders, and a positive family history. Moderate associations were observed with sino-nasal anatomical variants, exposure to cleaning chemicals or pets, basic (pre-clinical) educational level, and female gender, while most demographic and lifestyle factors showed no significant association.

In multivariable analysis based on binary logistic regression, immune disturbances and family history remained the strongest correlates, with chronic comorbidities and pre-clinical education showing moderate effects. Sex-stratified analyses revealed that chronic comorbidities were the dominant correlate in females, while immune disturbances represented the most important factor in males.

Multivariable ordinal regression models showed consistent findings, with immune disturbances, family history, and chronic comorbidities being associated with greater severity of QoL impairment. Weaker or borderline associations were found for female gender, pre-clinical educational level, and chemical exposure. In sex-stratified models, comorbidities were most influential in females, while immune disturbances led among males.

All multivariable models demonstrated good fit and comparable statistical accuracy across cohorts, with high sensitivity but modest specificity. Binary Logistic and ordinal regression models performed similarly, with minor differences in variance explanatory magnitude between subgroups.

4.2. Discussion of the Literature

In 2023, Brunet and coworkers performed an analysis of 62 CRSwNP patients, correlating SNOT-22 scores with clinical and molecular markers. High tissue eosinophilia ($p = 0.01$) and elevated IL-8 expression ($p = 0.01$) were associated with worse SNOT-22 scores; intolerance to non-steroidal anti-inflammatory drugs (NSAIDs) also predicted poorer QoL ($p = 0.04$) [22]. Our findings that immune disturbances (OR = 2.68, $p = 0.028$) and chronic comorbidities (OR = 2.07, $p = 0.037$) as top correlates align with the former study's emphasis on underlying inflammatory markers. Both identify host-immune factors as strong drivers of symptom burden.

In 2016, Farhood and colleagues conducted a cross-sectional study and meta-analysis of "normal" SNOT-22 scores in non-CRS adults. They found that the mean SNOT-22 in 1517 healthy controls was 11 ± 9.4 ; multivariable regression analysis revealed that asthma ($p = 0.003$) and depression ($p = 0.002$) were risk factors of mildly elevated SNOT-22 even in non-CRS individuals [23]. Our study identified a positive family history (logistic regression: OR = 2.12, $p = 0.003$) and pre-clinical education level (ordinal regression: OR = 0.44, $p = 0.014$) as socio-demographic correlates. However, chronic comorbidities, particularly depression in univariable analysis (χ^2 test; OR = 8.99, $p = 0.003$) and immune disturbances

in multivariable analysis (logistic regression; OR = 2.68, $p = 0.028$), emerged as strong risk factors, mirroring findings from Farhood and coworkers' study.

In 2018, Geramas and collaborators conducted a systematic review of 30 studies on the social correlates of CRS. They highlighted "living and working location" as a key factor influencing both disease incidence and severity, primarily through varying environmental exposures (pollutants, occupational irritants) and disparities in healthcare access across locales [24]. More recently, Zhang and coauthors conducted a meta-analysis of 12 Chinese population studies and found that CRS prevalence was significantly higher in rural areas (27%, 95% CI 0.14–0.68) than in urban settings (18%, 95% CI 0.07–0.43), attributing much of this difference to poorer living conditions and limited specialist Healthcare care in rural settings [25]. Together, these results lend support to the borderline association we observed based on residence—specifically among CRS-affected female medical students—and more severe SNOT-22 impairment (estimate 0.57, 95% CI –0.87–1.24), highlighting how geographic context influences both environmental exposures and the social and geographic correlates of QoL outcomes in CRS patients.

Lam, Hirsch, and Tan (2014) systematically reviewed cigarette-smoke exposure in CRS, reporting that active smokers had increased odds of CRS (OR = 1.9, 95% CI 1.8–2.1) and former smokers possessed a more minor but significant risk (OR = 1.3, 95% CI 1.2–1.4), highlighting a dose–response relationship despite few studies directly measuring SNOT-22 [26]. In our male subgroup, smoking exhibited a borderline association with impaired QoL (OR = 2.30, 95% CI –0.87–6.08), consistent with Lam and colleagues' findings on symptom exacerbation in smokers. Nonetheless, the present study results concerning smoking should be considered exploratory and require confirmation in future studies.

In a systematic analysis by Orlandi and coauthors, pooling five studies on $\text{NSD} \geq 10^\circ$ revealed a modest yet significant association with rhinosinusitis (OR = 1.47, $p < 0.001$) [27]. In 2022, Malpani and colleagues categorized septal deformities (spur, thickening, dislocation) and linked severe deviations to CRS via ostiomeatal complex obstruction, impaired mucociliary clearance, and mucosal inflammation [28]. In their systematic review, Chen collaborators found that CRSwNP is associated with more severe sino-nasal symptoms, higher asthma comorbidity, and worse SNOT-22 scores than isolated CRS (without nasal polyps) [29]. These results partially mirror our univariable χ^2 analysis, which demonstrated a significant association between sino-nasal anatomical anomalies, especially NSD, and CRS. However, we did not observe a link between nasal polyps and CRS, potentially reflecting the low polyp prevalence in the present student cohort.

In summary, our findings align with medium-to-high evidence studies identifying immune-related factors (e.g., immune disturbances and chronic comorbidities) and environmental exposures (e.g., tobacco smoke and cleaning chemicals) as important correlates of impaired QoL in individuals with CRS. Consistent with prior research, our results support associations between inflammatory markers and pollution with worse SNOT-22 outcomes. Notably, our study highlights socio-demographic factors—specifically, pre-clinical (basic) educational level and positive family history—as important correlates, areas rarely addressed in similar research, which suggests that, beyond biological and environmental factors, psychosocial and academic factors may significantly influence symptom burden, especially among younger, medically educated populations. These associations stress the need for future longitudinal studies and meta-analyses that integrate both clinical and socio-demographic variables to better understand QoL impairment in CRS, particularly within understudied groups such as Middle Eastern medical students.

4.3. Study Limitations and Recommendations

An important limitation of this study is that the English version of the SNOT-22 has not been formally validated in Iraqi medical students or the broader Iraqi population. Although Iraqi medical students are required to demonstrate English proficiency for admission to medical school and complete their medical education exclusively in English, and the questionnaires were administered under supervision with an English-fluent (IELTS-certified) researcher available to clarify any ambiguities. Nonetheless, some degree of measurement bias cannot be excluded. Future studies should undertake formal psychometric validation of these instruments in representative Iraqi populations, including medical students.

Another limitation is that allergic and immune-related conditions (seasonal allergy, non-seasonal allergy, eczema, and other immune conditions) were bundled as a single composite variable ("immune disturbances") rather than individually, primarily to preserve statistical power given the limited number of participants in each subgroup. Furthermore, these conditions were self-reported and were not confirmed through clinical examination or laboratory investigations due to resource limitations. Therefore, potential misclassification and differences between specific conditions could not be fully assessed. Future studies with larger samples and objective diagnostic assessments are needed to clarify the individual contributions of specific allergic and immune conditions.

Depression was strictly associated with poorer QoL in the univariable analysis; however, it did not remain as an independent correlate in the multivariable models. This finding should be interpreted cautiously, as depression may act as a confounding factor rather than an independent correlate of QoL. Moreover, the relatively small number of CRS-affected students with depression (35; 8%) may have limited the statistical power to detect an independent association after adjustment for other variables. Also, given the cross-sectional design of this study, causal relationships cannot be established; depression may represent either a contributing factor to impaired QoL or a consequence of it. Nevertheless, these interpretations remain hypothesis-generating and require confirmation through future longitudinal studies with larger and more representative samples.

The present study also possesses other limitations inherent to its cross-sectional study design, which restricts causal inference, and the low specificity of the multivariable models, limiting accurate identification of students without QoL impairment (true negatives) based on the SNOT-22 instrument. Further, research gaps remain for CRS-affected Iraqi undergraduate medical students because several parameters and potential confounders that could influence QoL are unknown. These include coexisting rare medical conditions; life-expectancy determinants (genetic, familial, and environmental); co-occurring substance misuse (alcohol and other drugs); intercultural and inter-ethnic variation within the Iraqi population; unknown sino-nasal and mid-facial morphometric parameters; seasonal symptom variability, and meteorological parameters, as well as baseline educational knowledge and interventions regarding CRS.

5. Conclusions

In this cross-sectional study of Iraqi medical students with CRS, over three-quarters had QoL impairment, mostly of mild to moderate severity. Immune disturbances and positive family history were the strongest correlates, followed by chronic comorbidities and a pre-clinical level of education. Sex-stratified multivariable analyses revealed that chronic comorbidities were the leading factor in females, while immune disturbances were the strongest correlate in males. It is crucial to emphasize that these findings should be interpreted within the context of the studied population and are primarily applicable to Iraqi medical students with CRS. Further studies involving more diverse and representative Iraqi samples are needed to confirm the broader applicability of these results.

Moderate associations were observed with sino-nasal anatomical anomalies, chemical or pet exposure, female gender, and pre-clinical education. All multivariable regression models showed good fit and high sensitivity, confirming the multifactorial nature of QoL impairment in CRS-affected Iraqi medical students. These findings support targeted, personalized (risk-based) interventions, particularly for undergraduate students with immune, allergic, or chronic comorbidities.

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Abbreviations

The following abbreviations are used in this manuscript:

95% CI	95% confidence interval
AUC	Area under the curve
COPD	Chronic obstructive pulmonary disease
CRS	Chronic rhinosinusitis
CRSwNP	Chronic rhinosinusitis with nasal polyps
CT	Computed tomography
df	Degrees of freedom
EPOS 2020	European Position Paper on Rhinosinusitis and Nasal Polyps 2020
EQ-5D	EuroQol-5 Dimensions
HRQoL	Health-related quality of life
ICU	Intensive care unit
IL-8	Interleukin-8
IQR	Interquartile range
MeSH	Medical Subject Headings
MID	Minimally important difference
NHS	National Health Service
NSAIDs	Non-steroidal anti-inflammatory drugs
OR	Odds ratio
<i>p</i> -value	Probability value
QoL	Quality of life
R ²	Coefficient of determination
SF-6D	Short Form-6 Dimensions

SNOT-20	20-item Sino-nasal Outcome Test
SNOT-22	22-item Sino-nasal Outcome Test
SPSS	Statistical Package for the Social Sciences
W	Shapiro–Wilk test statistic
α	Level of significance
β	Beta error
χ^2	Chi-square test statistic

Appendix A.

Four-part questionnaire evaluating quality of life impact and risk factors in Iraqi medical students with chronic rhinosinusitis.

Appendix A.1. Section 1: Socio-Demographic Data

1. Age:
2. Gender: ☐ Male ☐ Female
3. Nationality: ☐ Iraqi ☐ Non-Iraqi
4. City of residence:
5. Region of residence: ☐ Baghdad ☐ Southern region ☐ Northern region
☐ Western region
6. Nature of residence: ☐ Urban ☐ Rural
7. Education level: ☐ High school or less ☐ College ☐ Postgraduate
8. Occupation: ☐ Student ☐ Employed ☐ Unemployed ☐ Housewife
9. Marital Status: ☐ Single ☐ In relationship
10. Type of residence: ☐ Apartment ☐ Villa ☐ Other

Appendix A.2. Section 2: Risk Factors

1. Do you smoke? ☐ Yes ☐ No
2. Are you frequently exposed to cleaning chemicals/detergents? ☐ Yes ☐ No
3. Are you regularly exposed to dirt, plants, or dust? ☐ Yes ☐ No
4. Do you have pets at home? ☐ Yes ☐ No
5. Do you suffer from any of these chronic comorbidities? (Select all that apply)
☐ Asthma ☐ Seasonal allergy ☐ Non-seasonal allergy ☐ Nasal septal deviation
☐ Gastrointestinal disorders ☐ Depression ☐ Eczema ☐ Immune disorders ☐ None
6. Do you have a family history of any of the following? (Select all that apply)
☐ Asthma ☐ Allergies ☐ Sinusitis ☐ Eczema ☐ None

Appendix A.3. Section 3: SNOT-22 Questionnaire

Please rate the severity of the following problems over the past 2 weeks using the scale below:

- 0 = No problem
1 = Very mild problem
2 = Mild or slight problem
3 = Moderate problem
4 = Severe problem
5 = Problem as bad as it can be

1. Need to blow nose ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
2. Nasal blockage ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
3. Sneezing ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
4. Runny nose ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
5. Cough ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

6. Post-nasal discharge ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
7. Thick nasal discharge ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
8. Ear fullness ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
9. Dizziness ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10. Ear pain ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
11. Facial pain/pressure ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
12. Difficulty falling asleep ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
13. Waking up at night ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
14. Lack of good night's sleep ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
15. Waking up tired ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
16. Fatigue ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
17. Reduced productivity ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
18. Reduced concentration ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
19. Frustrated/Restless/Irritable ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
20. Sad ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
21. Embarrassed ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
22. Sense of smell/taste loss ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Appendix A.4. Section 4: Seasonality and Treatment

1. Do your chronic rhinosinusitis symptoms follow a seasonal pattern? ☐ Yes ☐ No
2. If yes, during which months do your symptoms typically occur (or worsen)?
☐ Winter ☐ Spring ☐ Summer ☐ Autumn
3. Do you receive any medical treatment for chronic rhinosinusitis? ☐ Yes ☐ No
4. If yes, which of the following best describes your treatment?
☐ Self-management ☐ Family management ☐ Physician prescription
5. Which of the following treatments do you use?
☐ Nasal saline rinses ☐ Antihistamines ☐ Antibiotics ☐ Corticosteroids ☐ Others
6. Do you follow your treatment as prescribed? ☐ Yes ☐ No
7. Has your condition improved with treatment? ☐ Yes ☐ No
8. Have you ever undergone sinus surgery? ☐ Yes ☐ No

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