

Clinical, Endoscopic and Radiological Correlates of Disease Severity and Sinonasal Quality of Life in Adults with Chronic Rhinosinusitis: A Hospital-Based Observational Study

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Abstract: Background- Chronic rhinosinusitis (CRS) is clinically heterogeneous, and symptom burden, endoscopic inflammation, radiological disease extent and patient-reported quality of life do not necessarily vary in parallel. An integrated assessment may therefore provide a more informative representation of disease burden. **Objective-** To evaluate the relationships among clinical, endoscopic and radiological disease severity and sinonasal quality of life in adults with CRS. **Methods-** This hospital-based observational study included 200 adults with CRS. Clinical history and symptom severity were recorded using a study assessment form. Participants underwent nasal endoscopic assessment, completed the 22-item Sinonasal Outcome Test (SNOT-22), and underwent CT of the paranasal sinuses. Clinical, endoscopic and radiological disease severity were classified as mild, moderate or severe. Associations were tested using Spearman's rank correlation. Comparison of SNOT-22 scores between severity groups used the KruskalWallis test and Holm-adjusted pairwise Mann-Whitney U tests. **Results-** Clinical severity was mild in 79 (39.5%), moderate in 67 (33.5%) and severe in 54 (27.0%) participants. Endoscopic severity was mild in 61 (30.5%), moderate in 104 (52.0%) and severe in 35 (17.5%), whereas radiological severity was mild in 17 (8.5%), moderate in 61 (30.5%) and severe in 122 (61.0%). Mean SNOT-22 scores increased across clinical, endoscopic and radiological severity categories. The greatest degree of association with SNOT-22 was with endoscopic severity ($\rho=0.730$, $p<0.001$), followed by the CT/LundMackay-type score ($\rho=0.616$, $p<0.001$) and radiological severity ($\rho=0.578$, $p<0.001$). The relation between clinical severity and SNOT-22 was least [clinical severity: $\rho=0.249$, $p<0.001$]. Endoscopic and radiological severity were more strongly correlated with each other ($\rho=0.567$, $p<0.001$) than either was with clinical severity. **Conclusion-** Clinical symptoms, nasal endoscopy, CT and SNOT-22 represent complementary dimensions of CRS. The endoscopic severity of disease had the greatest correlation with the patients reported burden of sinonasal disease, and radiological findings also had sizable correlations. Multidimensional assessment may provide a more complete characterization of disease severity than reliance on a single measure.

Keywords: Chronic rhinosinusitis; nasal endoscopy; computed tomography; Lund–Mackay; SNOT-22; disease severity; quality of life.

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INTRODUCTION

Chronic rhinosinusitis (CRS) is a chronic inflammatory disorder of the nose and paranasal sinuses characterized by persistent sinonasal symptoms together with objective evidence of disease. The clinical presentation is heterogeneous and may include nasal obstruction, nasal discharge, facial pain or pressure, headache, postnasal drainage and impaired smell. This heterogeneity makes assessment of severity multidimensional rather than dependent on a single symptom or examination finding.

Patient reporting of symptoms reflects the perceived disease burden, while nasal endoscopy and CT give direct information about sinonasal inflammation and extent of anatomical pathology. These are related fields but not interchangeable. Studies have reported variable relationships among symptoms, endoscopic findings and CT severity, indicating that subjective disease burden and objective disease extent may diverge in individual patients [1–3].

Nasal endoscopy provides direct visualization of the nasal cavity and accessible sinonasal structures and can identify mucosal edema, discharge and nasal polyps. Research has been conducted on the relationship between endoscopic findings and symptom scores. The correlation was yet found to be variable based on the scoring system in use and whether the patients were in a clinical population or not [4–7].

CT is widely used to characterize the anatomical distribution and extent of sinonasal disease. The Lund–Mackay system has been extensively used to quantify sinus opacification and ostiomeatal complex involvement, and its relationship with symptoms and outcomes has been investigated in different clinical settings [8–10]. However, symptom severity and CT burden do not always show close correspondence [11,12].

Patient-reported outcome measures are particularly important because CRS affects daily functioning and health-related quality of life. The SNOT-22 is a widely used instrument that captures multiple dimensions of sinonasal health beyond individual physical symptoms [13–16]. Differences between patient-reported burden and objective disease findings may therefore have direct relevance to clinical assessment.

Aetiologies Comorbid inflammatory conditions in particular allergic rhinitis and asthma and phenotypic features like nasal polyps could bring differences in presentation and symptom severity of CRS [17,19]. Olfactory dysfunction is also clinically relevant because smell impairment can influence quality of life and may be related to sinonasal inflammatory findings [20,21].

The present study therefore evaluated clinical, endoscopic and radiological severity together with SNOT-22 in adults with CRS, with particular emphasis on the relationships among these complementary measures.

Aim and Objectives

Aim- To evaluate the clinical, endoscopic and radiological correlates of disease severity and sinonasal quality of life in adults with CRS.

Objectives- (1) To describe the demographic and clinical characteristics of the study population; (2) to characterize clinical, endoscopic and radiological disease severity; (3) to compare SNOT-22 scores across severity categories; (4) to examine relationships among clinical, endoscopic and radiological measures; and (5) to assess associations between objective disease measures and patient-reported sinonasal burden.

MATERIALS AND METHODS

Study design and participants

A hospital-based observational study was conducted among 200 adults with CRS. Data were recorded using a structured study assessment form containing

demographic characteristics, clinical history, symptom severity, nasal endoscopy findings, SNOT-22 scores and CT findings. The principal variables included in the analysis were complete for all 200 participants.

Clinical assessment

The clinical assessment included age, sex, duration of CRS symptoms, previous history of CRS, allergic rhinitis or significant allergy-related symptoms, bronchial asthma, previous sinus surgery, previous treatment for CRS and a history of nasal polyps. Major clinical symptoms included nasal obstruction, nasal discharge, facial pain or pressure, headache and postnasal drip. Overall clinical symptom severity was classified as mild, moderate or severe according to the study assessment form.

Nasal endoscopy

Nasal endoscopy was used to assess the extent of nasal mucosal edema, nasal discharge and the presence of nasal polyps. An overall endoscopic disease-severity category of mild, moderate or severe was recorded. Endoscopic severity was analysed as a separate objective domain from overall clinical symptom severity.

Patient-reported sinonasal quality of life

Sinonasal quality of life was assessed using the 22-item Sinonasal Outcome Test (SNOT-22). The total SNOT-22 score was analysed as a continuous measure of patient-reported sinonasal symptom burden. Higher scores represented greater patient-reported burden.

CT assessment

CT of the paranasal sinuses was used to assess bilateral maxillary, ethmoid, frontal and sphenoid sinus involvement together with the right and left ostiomeatal complexes. A study CT/Lund–Mackay-type score was derived from the recorded sinus and ostiomeatal complex components. The resulting score was analysed as a continuous measure of radiological disease burden, while overall radiological disease severity was categorized as mild, moderate or severe.

Clinical–radiological correspondence and diagnosis

The relationship between clinical findings and CT findings was recorded as good, moderate or poor correspondence. Final clinical diagnosis was also recorded, including CRS without nasal polyposis, CRS with nasal polyposis and allergic fungal rhinosinusitis in the aggregate analytical classification.

Statistical analysis

Categorical variables were summarized using frequencies and percentages. Continuous variables were summarized using means with standard deviations, medians with interquartile ranges and ranges. Spearman's rank correlation was used to evaluate associations among ordinal severity measures, SNOT-22 and the study CT/Lund–Mackay-type score. SNOT-22 scores across mild, moderate and severe categories were



compared using the Kruskal–Wallis test. Significant overall comparisons were followed by pairwise Mann–Whitney U tests with Holm adjustment for multiple comparisons. Statistical tests were two-sided, with $p < 0.05$ considered statistically significant. Epsilon-squared (epsilon 2) was reported as the effect-size estimate for KruskalWallis comparisons.

RESULTS

Participant characteristics

The study population comprised 200 adults with CRS. There was a modest male predominance, with 110

(55.0%) men and 90 (45.0%) women. Recurrent or persistent CRS was reported in 122 (61.0%) participants and first episode in 78 (39.0%). Seventy one point five percent of participants had a history of previous CRS treatment, eleven point zero percent of previous sinus surgery. Forty eight point zero percent of participants reported a history of nasal polyps. Allergic rhinitis or significant allergy-related symptoms were present in 68 (34.0%), absent in 110 (55.0%) and unknown in 22 (11.0%); bronchial asthma was present in 27 (13.5%).

Table 1. Demographic and clinical characteristics of the study population.

Variable	Category	n	%
Sex	Male	110	55.0%
	Female	90	45.0%
CRS duration	>1–3 years	58	29.0%
	12–24 weeks	57	28.5%
	>24 weeks–1 year	43	21.5%
	>3 years	42	21.0%
Previous CRS history	Recurrent/persistent disease	122	61.0%
	First episode	78	39.0%
Allergic rhinitis/significant allergy	Absent	110	55.0%
	Present	68	34.0%
	Not known	22	11.0%
Bronchial asthma	Absent	173	86.5%
	Present	27	13.5%
Previous sinus surgery	No	178	89.0%
	Yes	22	11.0%
Previous CRS treatment	Yes	143	71.5%
	No	57	28.5%
History of nasal polyps	No	128	64.0%
	Yes	72	36.0%
Clinical severity	Mild	79	39.5%
	Moderate	67	33.5%
	Severe	54	27.0%
Endoscopic severity	Mild	61	30.5%
	Moderate	104	52.0%
	Severe	35	17.5%
Radiological severity	Mild	17	8.5%
	Moderate	61	30.5%
	Severe	122	61.0%

Continuous study measures

The mean age was 36.77 ± 10.36 years, with a median of 38 years (IQR 30–43; range 18–69 years). The mean

total SNOT-22 score was 35.95 ± 16.31 , with a median of 35 (IQR 23–50; range 8–85). The mean study CT/Lund–



Mackay-type score was 13.135 ± 5.088 , with a median of 14 (IQR 10–18; range 0–20).

Table 2. Continuous study measures

Measure	Mean $\pm$ SD	Median (IQR)	Range
Age (years)	36.77 ± 10.36	38 (30–43)	18–69
SNOT-22 total	35.95 ± 16.31	35 (23–50)	8–85
Study CT/Lund–Mackay-type score	13.135 ± 5.088	14 (10–18)	0–20

Symptom profile

Nasal obstruction and nasal discharge were mainly assessed in the mild-to-moderate severity category. Facial pain or pressure, headache and postnasal drip also

showed substantial representation in the moderate category. Olfactory symptoms were recorded separately from the principal aggregate symptom comparison.

Table 3. Distribution of major sinonasal symptoms

Symptom	Mild n (%)	Moderate n (%)	Severe n (%)
Nasal obstruction	75 (37.5)	83 (41.5)	42 (21.0)
Nasal discharge	66 (33.0)	84 (42.0)	50 (25.0)
Facial pain/pressure	70 (35.0)	93 (46.5)	37 (18.5)
Headache	76 (38.0)	74 (37.0)	50 (25.0)
Postnasal drip	73 (36.5)	78 (39.0)	49 (24.5)

Relationships among disease-severity domains

The three disease-severity domains were positively correlated. The strongest association was between endoscopic and radiological severity ($\rho=0.567$,

$p<0.001$), whereas clinical severity showed weaker associations with endoscopic severity ($\rho=0.310$, $p<0.001$) and radiological severity ($\rho=0.251$, $p<0.001$).

Table 4. Correlations among disease-severity domains

Association	Spearman ρ	p
Clinical severity–endoscopic severity	0.310	<0.001
Clinical severity–radiological severity	0.251	<0.001
Endoscopic severity–radiological severity	0.567	<0.001

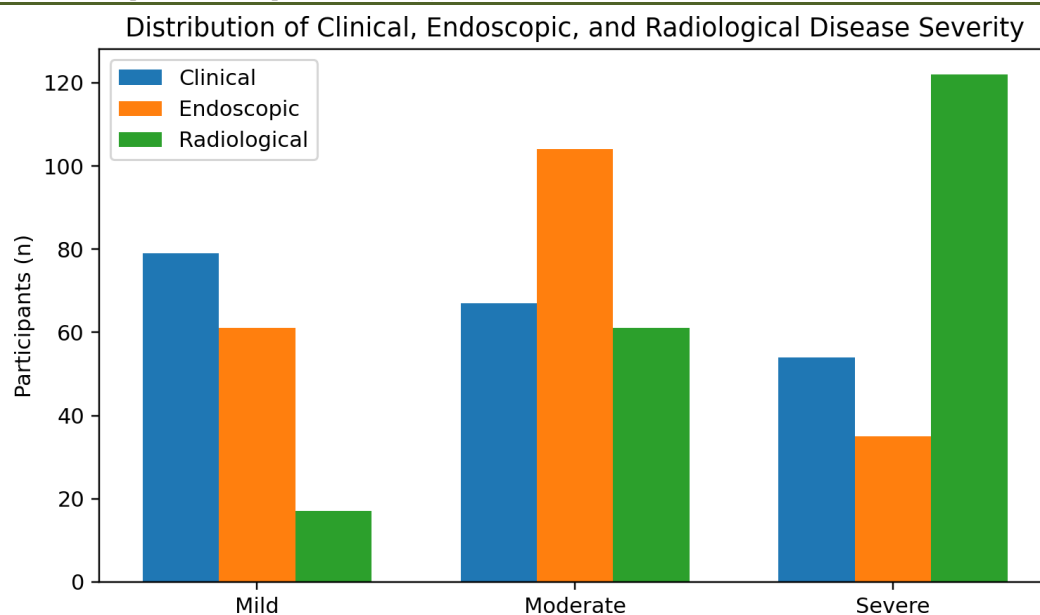


Figure 1. Distribution of clinical, endoscopic and radiological disease severity.

SNOT-22 according to disease severity

SNOT-22 scores differed significantly across clinical, endoscopic and radiological severity categories. For clinical severity, mean SNOT-22 increased from 30.85 ± 16.18 in the mild group to 38.82 ± 13.91 in the moderate group and 39.85 ± 17.56 in the severe group ($H=15.61$, $p<0.001$, $\epsilon^2=0.069$). The corresponding

means for endoscopic severity were 20.05 ± 8.90 , 38.89 ± 11.17 and 54.91 ± 13.77 ($H=106.70$, $p<0.001$, $\epsilon^2=0.531$). For radiological severity, mean SNOT-22 scores were 17.35 ± 9.99 , 27.02 ± 13.03 and 43.01 ± 14.19 , respectively ($H=66.54$, $p<0.001$, $\epsilon^2=0.328$).

Table 5. SNOT-22 scores across clinical, endoscopic and radiological severity categories.

Severity domain	Mild	Moderate	Severe	Kruskal-Wallis H	p	epsilon ²
Clinical	30.85 ± 16.18	38.82 ± 13.91	39.85 ± 17.56	15.61	<0.001	0.069
Endoscopic	20.05 ± 8.90	38.89 ± 11.17	54.91 ± 13.77	106.70	<0.001	0.531
Radiological	17.35 ± 9.99	27.02 ± 13.03	43.01 ± 14.19	66.54	<0.001	0.328

Table 6. Holm-adjusted pairwise comparisons of SNOT-22 across severity categories.

Severity domain	Pairwise comparison	Holm-adjusted p
Clinical	Mild vs Moderate	<0.001
Clinical	Mild vs Severe	0.004
Clinical	Moderate vs Severe	0.965
Endoscopic	Mild vs Moderate	<0.001
Endoscopic	Mild vs Severe	<0.001
Endoscopic	Moderate vs Severe	<0.001
Radiological	Mild vs Moderate	0.004
Radiological	Mild vs Severe	<0.001
Radiological	Moderate vs Severe	<0.001

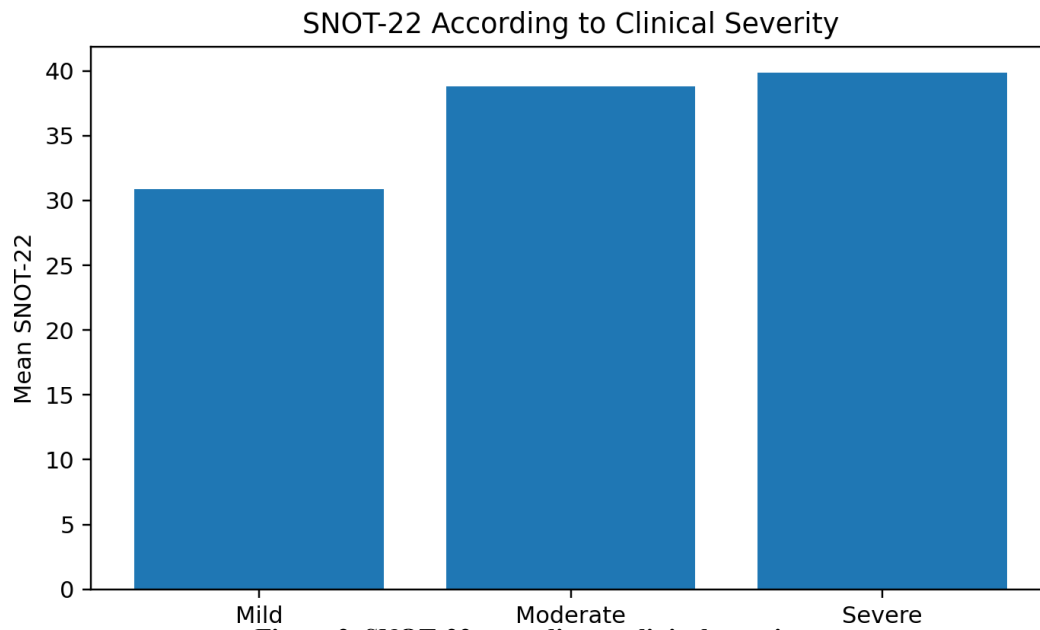


Figure 2. SNOT-22 according to clinical severity.

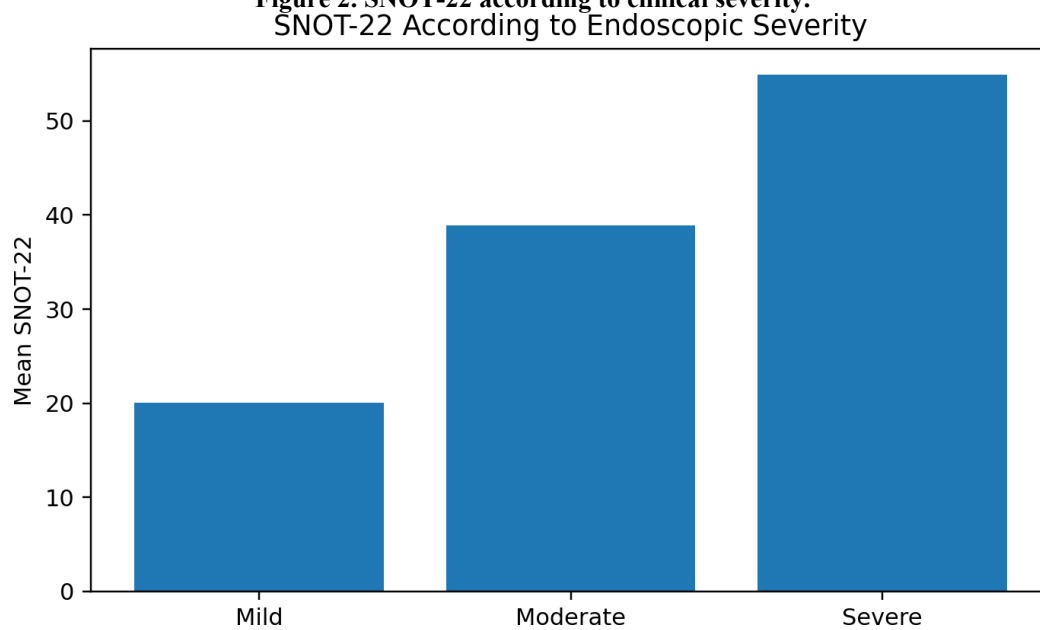


Figure 3. SNOT-22 according to endoscopic severity.

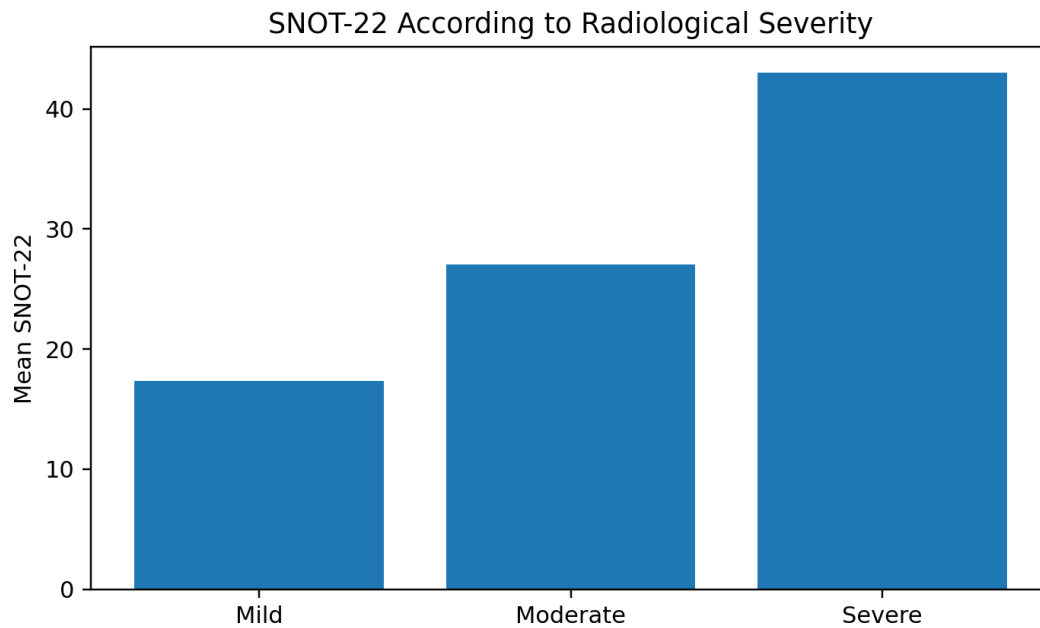


Figure 4. SNOT-22 according to radiological severity.

Associations with patient-reported sinonasal burden

Endoscopic severity demonstrated the strongest association with SNOT-22 ($\rho=0.730$, $p<0.001$). Radiological severity also showed a strong positive association with SNOT-22 ($\rho=0.578$, $p<0.001$), while

the continuous study CT/Lund–Mackay-type score was similarly associated with SNOT-22 ($\rho=0.616$, $p<0.001$). Clinical severity had a statistically significant but comparatively weak association with SNOT-22 ($\rho=0.249$, $p<0.001$).

Table 7. Associations between disease measures and patient-reported sinonasal burden.

Association with SNOT-22	Spearman rho	p
Clinical severity–SNOT-22	0.249	<0.001
Endoscopic severity–SNOT-22	0.730	<0.001
Radiological severity–SNOT-22	0.578	<0.001
CT/Lund–Mackay-type score–SNOT-22	0.616	<0.001

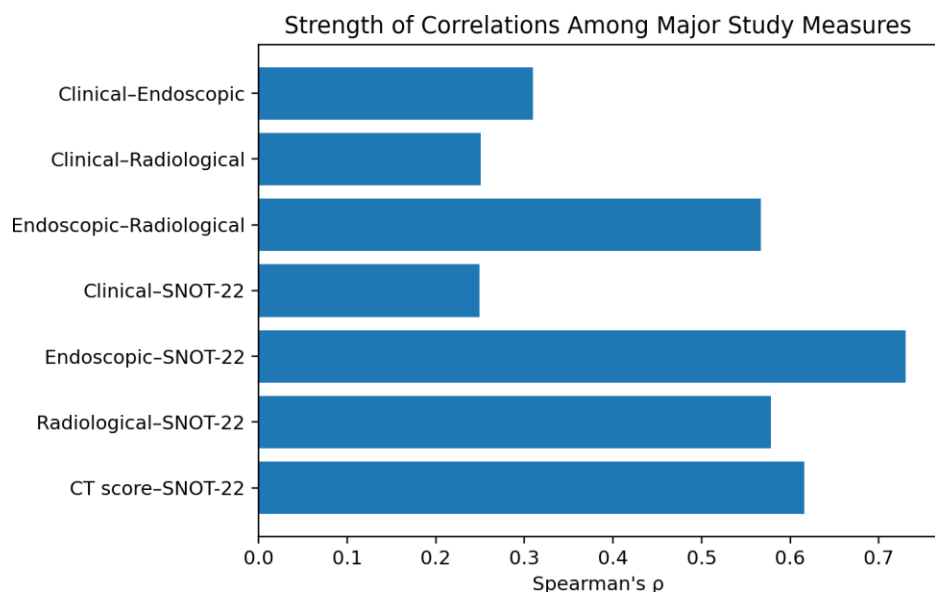


Figure 5. Strength of correlations among major study measures.

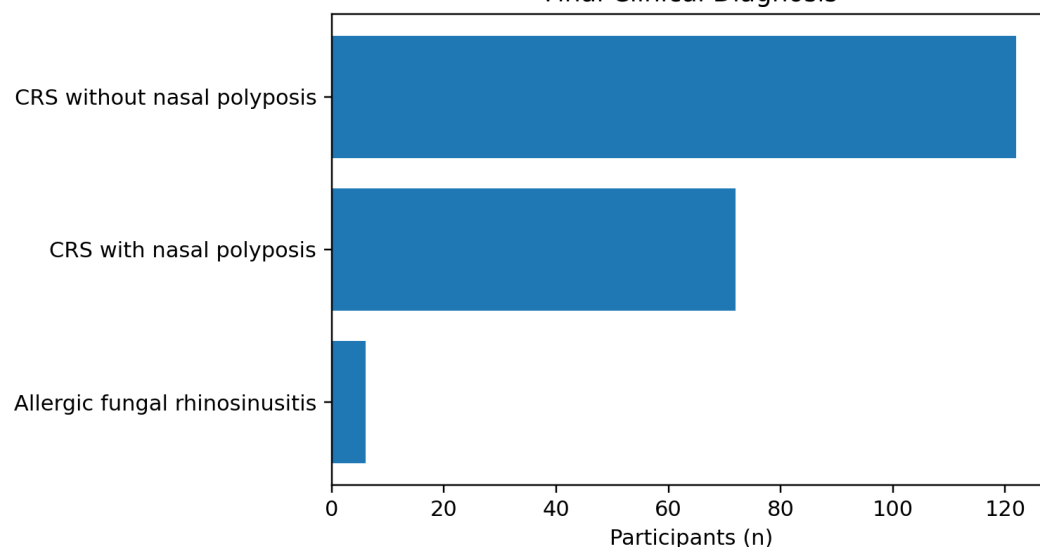
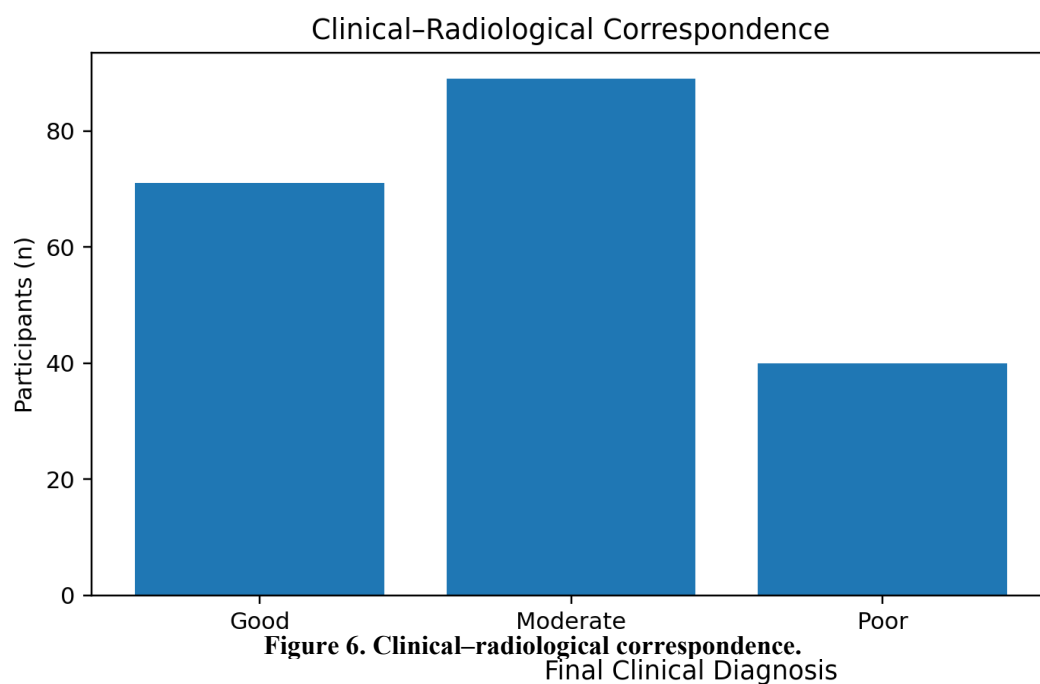
Clinical–radiological correspondence and diagnostic pattern

Clinical–radiological correspondence was classified as moderate in 89 (44.5%) participants, good in 71 (35.5%)

and poor in 40 (20.0%). The aggregate final clinical classification comprised CRS without nasal polyposis in 122 (61.0%) participants, CRS with nasal polyposis in 72 (36.0%) and allergic fungal rhinosinusitis in 6 (3.0%).

Table 8. Clinical–radiological correspondence and final clinical classification

Variable	Category	n	%
Clinical–CT correspondence	Partially — Moderate correspondence	89	44.5%
	Yes — Good correspondence	71	35.5%
	No — Poor correspondence	40	20.0%
Final clinical diagnosis	CRS without nasal polyposis	122	61.0%
	CRS with nasal polyposis	72	36.0%
	Allergic fungal rhinosinusitis	6	3.0%



DISCUSSION

This hospital-based observational study demonstrates that clinical, endoscopic and radiological severity measures are related but represent distinct dimensions of CRS. The distribution of severity categories differed substantially across modalities: clinical severity was distributed across mild, moderate and severe categories, endoscopic severity was concentrated in the moderate category, and radiological severity was predominantly severe. This shows that the perceived severity of CRS varies as, which area is evaluated.

The most consistent association found between the three severity domains was between endoscopic and radiological severity ($\rho=0.567$). From a clinical perspective this can be understood as they both assess the objective features of sinonasal disease but in different parts of the anatomy. CT provides information about the extent and distribution of sinus disease, whereas endoscopy directly visualizes accessible nasal and sinonasal structures. Studies of this work have also reported relationships between endoscopic and CT findings but shown that objectively observed measures do not always follow severity of symptoms. [1,7,22,23].

Clinical severity was less strongly associated with both endoscopic and radiological severity. The clinical–endoscopic correlation was $\rho=0.310$ and the clinical–radiological correlation was $\rho=0.251$. This pattern is consistent with the multidimensional nature of CRS, in which symptom perception may be influenced by inflammatory activity, anatomical disease, comorbid allergic disease, lower-airway disease and individual perception of health. Previous work has also shown that the relationship between sinonasal symptoms and CT abnormalities may be modest [10–12].

The relationship between disease severity and SNOT-22 was particularly informative. Endoscopic severity showed the strongest correlation with SNOT-22 ($\rho=0.730$), with a large gradient in mean scores from mild to severe disease. The Kruskal–Wallis effect size for endoscopic severity was $\epsilon^2=0.531$, substantially larger than the corresponding effect sizes for clinical severity (0.069) and radiological severity (0.328). These findings suggest that the severity of disease seen with endoscopy correlated more strongly with the patients' perception of sinonasal burden in this cohort.

Radiological severity was also strongly associated with SNOT-22 ($\rho=0.578$), and the continuous CT/Lund–Mackay-type score showed a positive association of similar magnitude ($\rho=0.616$). It is also in line with research demonstrating correlation between the extent of disease on CT and symptom severity as well as quality-of-life end points, but that CT severity alone should be regarded as an imperfect surrogate for patient experience [9,24,26].

The clinical severity–SNOT-22 association was statistically significant but comparatively weak ($\rho=0.249$). The pairwise analysis provides an important explanation: SNOT-22 scores differed significantly between mild and moderate clinical severity and between mild and severe clinical severity, but the moderate and severe groups did not differ significantly after Holm adjustment ($p=0.965$). Thus, a statistically significant overall test does not imply equally large differences between every severity category. The relatively small separation between moderate and severe clinical groups may account for the weaker correlation.

The clinical–radiological correspondence analysis further illustrates the multidimensional nature of CRS. Moderate correspondence was the most common finding and was seen in more than half of the cohort. Good correspondence was the next most common finding with poor correspondence in 1/5 th of the cohort. The results obtained support the recommendation that CT findings should only be interpreted plus clinical symptoms and endoscopy rather than radiological severity in isolation. The presence of allergic rhinitis or significant allergic symptoms, asthma and nasal polyps in the cohort provides additional clinical context. Previous studies have reported associations among upper- and lower-airway inflammatory conditions and CRS symptom burden [17–19]. The present study was not designed to establish causal relationships between these comorbidities and the principal outcome measures.

Olfactory dysfunction is an important component of CRS because impaired smell can influence daily functioning and quality of life. The study assessment included olfactory symptoms, although a validated quantitative olfactory test was not used. Consequently, the present analysis does not provide an independent quantitative estimate of olfactory function or its relationship with SNOT-22. Validated olfactory measures and standardized assessment of the olfactory cleft may provide additional information in future studies [20,21].

Strengths

A major strength of the study is the simultaneous evaluation of clinical symptoms, nasal endoscopy, CT findings and a patient-reported outcome in the same cohort. The use of correlation analysis together with category-based comparisons also allowed the strength of associations and differences between individual severity categories to be examined. Reporting epsilon-squared alongside the Kruskal–Wallis statistic provides additional information about the magnitude of group differences.

Limitations

The observational, hospital-based design limits external validity to other clinical settings and makes it impossible to assess causality. Endoscopic, radiological, and clinical



severity groupings were predefined as our assessment model, the analytical dataset available to us had limited detail on the assessment process to explore the influence of assessor characteristics or inter-observer variation. Olfactory function was not quantified using a validated objective olfactory test. The study also focused on associations among the measured domains and did not evaluate treatment response or longitudinal outcomes. These considerations should be taken into account when interpreting the observed relationships.

CONCLUSION

Preoperative assessments clinical, endoscopic, and radiological are different but overlapping measures of severity, with endoscopic severity demonstrating the greatest correlation with patient-reported sinonasal burden. The CT/LundMackay-type score and radiological severity had less correlation. Clinical severity was significantly related to SNOT-22 but showed weaker relationships with objective disease measures. The variation among assessment domains and the incomplete clinical-radiological correspondence seen in a large number of subjects, offers rationale for a multidimensional model, incorporating symptoms, nasal endoscopy, CT and patient-rated measures.

Ethical considerations

Participant information in the study records was designated as confidential and for academic and research purposes. The dataset contained a participant acknowledgement of confidentiality and academic use.

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