

ASSESSMENT OF OLFACTORY FUNCTION BEFORE ENDOSCOPIC SINUS SURGERY: A CROSS - SECTIONAL STUDY

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ABSTRACT

Background: Olfactory disorders are common in chronic rhinosinusitis (CRS) patients, yet most studies in Vietnam relied on subjective assessments, leaving a gap in understanding objective olfactory dysfunction. This study aimed to objectively evaluate olfactory function in CRS patients using the Sniffin' Sticks test and compare results with subjective self-reports.

Methods: This cross-sectional study included 40 chronic rhinosinusitis patients from the University of Medicine Center, Ho Chi Minh City, who were candidates for endoscopic sinus surgery. The Sniffin' Sticks test assessed threshold, discrimination, and identification abilities, with total scores analyzed using age-adjusted and ideal cut-points.

Results: Using age-adjusted cut-points, normosmia, hyposmia, and anosmia rates were 45.0%, 30.0%, and 25.0%, respectively, shifting to 27.5%, 47.5%, and 25.0% with ideal cut-points. The threshold component showed the most significant impairment. Significant correlations were observed among test components ($P < 0.05$). Only 55.0% of participants accurately self-reported their olfactory function, revealing a discrepancy between subjective and objective assessments.

Conclusion: This study highlighted the need for objective olfactory testing in CRS patients. Self-reported function may not accurately reflect actual olfactory ability, underscoring the importance of standardized assessment methods in clinical practice.

Keywords: Olfactory function, endoscopic sinus surgery.

I. INTRODUCTION

Chronic rhinosinusitis stands out as a prominent contributor to olfactory disorders, a condition that significantly impairs one's quality of life [1]. Olfactory disorders can give rise to a host of issues, ranging from anxiety and depression to eating disorders and weight management difficulties [2,3]. Consequently, it is imperative that olfactory disorders receive prompt evaluation and intervention, ideally by Ear, Nose, and Throat (ENT) specialists. Across the globe, individuals suffering from chronic rhinosinusitis undergo

comprehensive assessments of their sense of smell, employing both subjective elements like medical history and objective methods such as smell testing. Among these approaches, smell tests have earned validation and gained a reputation for their high reliability, offering a precise reflection of the patient's olfactory function [4].

In Vietnam, research on olfactory disorders in individuals with chronic rhinosinusitis has primarily centered on subjective assessments through medical history, neglecting the incorporation of objective odor evaluation techniques. Consequently, there is

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currently no information on the rate of objective olfactory disorders in patients with chronic rhinosinusitis in Vietnam, and there remains a pressing need to determine the suitability of such tests for this specific group.

The primary focus of this study is to conduct a comprehensive investigation into olfactory impairment among patients who meet the diagnostic criteria for chronic rhinosinusitis (CRS), particularly those scheduled for endoscopic sinus surgery. Our principal objective is to establish internally valid estimates of olfactory impairment, spanning various psychophysical olfactory domains, by employing cut-points derived from population norms. In addition to this primary objective, our secondary research goals encompass examining the relationships between subjective and objective olfactory assessment methods, as well as investigating the associations between objective olfactory assessment techniques and the severity scales used to evaluate chronic rhinosinusitis (specifically, the CT-scan Lund-Mackay score and the endoscopic Lund-Kennedy score) within this patient cohort. This multi-dimensional approach aims to provide a comprehensive understanding of olfactory dysfunction in CRS patients undergoing surgical intervention.

II. METHODS

2.1. Study design

A descriptive cross-sectional study was conducted at University of Medicine Center of Ho Chi Minh City from December 2022 to August 2023. The study employs convenience sampling for participant selection. All patients gave written informed consent, and the protocols were approved by the Institutional Review Board and Ethics Committee at University of Medicine and Pharmacy at Ho Chi Minh City. The study was performed following the Declaration of Helsinki.

2.2. Subject

The study included 40 individuals (≥ 18 years) who satisfied diagnostic criteria for CRS according to the European Position Paper on Rhinosinusitis (EPOS 2020). These patients had generally not responded well to conventional medical treatments, indicating the severity of their rhinosinusitis and making them suitable candidates for Functional Endoscopic

Sinus Surgery (FESS). Patients with nasal polyps as detected during preoperative nasal endoscopy are classified as CRSwNP, and otherwise as CRSsNP. Individuals with a history of immunodeficiency or autoimmune diseases were excluded from the study, as were those suspected of having olfactory loss resulting from head trauma or upper respiratory infections based on their medical history.

2.3. Procedures

Before the surgery, CT scans were accessible for every patient, and they were evaluated to assess the extent of chronic rhinosinusitis utilizing the Lund-Mackay staging system [5]. The severity of chronic rhinosinusitis on endoscopy was assessed according to the Lund-Kennedy endoscopic scale, also in all patients preoperatively [6]. A day prior to undergoing FESS, patients self-reported their perceived olfactory loss on a 3-point scale: 0 for a normal sense of smell, 1 for partial loss, and 2 for severe or total loss of smell function. Subsequently, they underwent quantitative olfactory testing employing the Sniffin' Sticks test (Burghardt®, Wedel, Germany) developed by Hummel in 1997 [7]. A trained clinical research coordinator, blinded to other study responses, administered all tests. The testing battery encompassed odor threshold, odor discrimination, and odor identification. The threshold assessment employed n-butanol dilutions in a single-staircase, triple-forced choice procedure. The discrimination test utilized sets of three pens, randomly presented, with two containing the same odorant and the third a different one. The identification test incorporated 16 odorants presented at suprathreshold intensity, utilizing a multiple-choice procedure. To prevent visual identification, all participants were blindfolded during the tests. The three test scores were reported independently: discrimination and identification were scored from 0 to 16, while threshold was scored from 1 to 16. The overall outcome was also consolidated into a combined score referred to as the "composite threshold-discrimination-identification score" (TDI), ranging from 1 to 48, with higher scores signifying superior olfactory performance.

2.4. Statistical Analyses

We conducted statistical analyses using a commercially available software program (IBM

Corporation's SPSS version 22). Descriptive statistics, such as means, standard deviations (SDs), and percentages, were employed to describe the study population across various parameters, including demographics, comorbidities, and disease severity measures specific to chronic rhinosinusitis (CRS). We investigated the impact of these variables on olfactory function through bivariate analysis. The preoperative olfactory assessment outcomes were then examined for associations with preoperative CT scores and endoscopy scores using Spearman rank-order correlations, while also assessing their correlation with self-reported olfactory results using ordinal logistic regression.

2.4.1. Age-adjusted prevalence

The prevalence of olfactory loss was then determined for the overall cohort using "age-adjusted" cut-offs. Age adjusted cut-offs were determined using data from a large population of normal subjects reported previously by Oleszkiewicz et al [8]. Subjects were placed into 18-20, 21-30, 31-40, 41-50, 51-60, and >60 year age groups. Total TDI scores were broken into normosmic, hyposmic, and anosmic categories. For individual olfactory domains (threshold, discrimination, identification), subjects were classified as having impaired olfaction if their individual scores was $\leq$ 10th percentile based on their age group.

2.4.2. Prevalence based on ideal olfaction

The prevalence of olfactory impairment was calculated for the entire group by using "ideal" thresholds. These thresholds were defined as the scores that would typically be anticipated in individuals aged 21-30 who have a normal sense of smell. We used expected TDI values to categorize individuals into normosmic, hyposmic, or anosmic groups. When it came to specific olfactory domains like threshold, discrimination, and identification, participants were deemed to have impaired olfaction if their individual scores fell at or below the 10th percentile when compared to the 21-30 year age group norms [8].

2.4.3. Relationship between psychophysical olfactory domains

We conducted a quantitative analysis to examine the connections between threshold, discrimination, identification, and the overall TDI scores, utilizing

Pearson's correlation coefficients. Furthermore, we categorized patients into two groups, distinguishing between those with normal and abnormal olfaction for each individual metric, and subsequently compared 4 x 4 tables across various olfactory measures.

III. RESULTS

A total of 40 patients with CRS were enrolled of which 52,5% were CRSsNP and 47,5% CRSwNP. The average age of the cohort was 49,12 years (SD = 12,74), with just over half male (55,0%). Baseline demographic and comorbidity data are listed in Table 1.

Table 1: Baseline demographic, comorbidity data and other measures

	All participants (n=40) Mean $\pm$ SD count (%)
Age (yr)	49,12 $\pm$ 12,74
Sex	
Male	22 (55.0)
Female	18 (45.0)
Asthma	3 (7.5)
Allergic rhinitis	7 (17.5)
Hypertention	8 (20.0)
Prior sinus surgery	2 (5.0)
Smoking status (yes/no)	6 (15.0)
Alcohol use (drinks/week)	0.69 (1.96)
Lund - Mackay CT score	12.17 (5.38)
Lund - Kennedy endoscopy score	6.90 (2.70)
	All participants (n=40) Median (min - max)
Severity of olfactory impairment	
TDI total score	26,25 (6.00 - 34.50)
Threshold	4.37 (1.00 - 11.00)
Discrimination	11.00 (4.00 - 15.00)
Identification	11.00 (1.00 - 11.00)

Overall, the cohort had a high degree of disease severity with mean CT score of 12.1 (SD = 5.4), endoscopy score of 6.9 (SD = 2.7). The overall

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median TDI score for the cohort was 26.2 (range: 6.0 - 34.5), with lower scores seen in the CRSwNP cohort as compared with CRSsNP, but this difference is not statistically significant (22.8 vs. 28.0; $P > 0.05$)

The study investigated the association between olfactory function and various factors including demographics, comorbidities, and disease severity, using bivariate analysis. However, neither CT scores nor endoscopy scores showed a significant relationship with the total TDI scores or their individual subdomains. Similarly, no significant association was found between comorbidities and the total TDI scores or any specific subdomain.

The age-adjusted prevalence of olfactory dysfunction is shown in Table 2. Based on total TDI scores, the distribution within the cohort was as follows: 45.0% were normosmic, 30.0% were hyposmic, and 25.0% were anosmic. Delving into individual domains, 62.5% of the cohort scored below the 10th percentile in the identification domain. This is higher than the threshold and discrimination domains, where 55.0% and 40.0% of the cohort fell below the 10th percentile, respectively.

When evaluating the prevalence of olfactory dysfunction using ideal cut-offs, the overall prevalence of anosmia using total TDI scores remains exactly the same. However, there was an increase in the prevalence of hyposmia when compared to normosmia, emphasizing the impact of using different cut-off criteria on the perceived prevalence of olfactory impairments (Table 2).

Table 2: Prevalence of olfactory dysfunction using age-appropriate cut-offs and ideal cut-offs

Tổng	Using age-appropriate cut-offs	Using ideal cut-off (21-30 years old)
	count (%)	count (%)
T	22 (55%)	28 (70%)
D	16 (40%)	21 (52,5%)
I	25 (62,5%)	27 (67,5%)
TDI		
Normosmia	21 (45,0%)	11 (27,5%)
Hyposmia	12 (30,0%)	19 (47,5%)
Anosmia	10 (25,0%)	10 (25,0%)

T, threshold; D, discrimination; I, identification; Age appropriate cut-offs: 36-55 years old: $T \leq 5.50$; $D \leq 10$; $I \leq 10$; $TDI \leq 28.5$ (hyposmia); $TDI \leq 15$ (anosmia); 21-30 years old: $T \leq 5.75$; $D \leq 11$; $I \leq 11$; $TDI \leq 30.75$ (hyposmia); $TDI \leq 15$ (anosmia); 31-40 year old: $T \leq 5.5$; $D \leq 10$; $I \leq 12$; $TDI \leq 30.5$ (hyposmia); $TDI \leq 15$ (anosmia); 41-50 year olds: $T \leq 5$; $D \leq 9$; $I \leq 11$; $TDI \leq 28.15$ (hyposmia); $TDI \leq 15$ (anosmia). 51-60 year olds: $T \leq 4$; $D \leq 10$; $I \leq 11$; $TDI \leq 27.25$ (hyposmia); $TDI \leq 15$ (anosmia); > 60 year olds: $T \leq 3.5$; $D \leq 9$; $I \leq 10$; $TDI \leq 24.88$ (hyposmia); $TDI \leq 15$ (anosmia). Ideal cut-off (21-30 years old): $T \leq 5.75$; $D \leq 11$; $I \leq 11$; $TDI \leq 30.75$ (hyposmia); $TDI \leq 15$ (anosmia)

In general, there was a statistically significant correlation between psychophysical olfactory measurements (Table 3, Figure 1). The strongest correlation was between discrimination score and total TDI score ($r_s = 0.919$, $P < 0.05$). Correlations among threshold, discrimination, and identification ranged from 0,411 to 0,804 and all were highly significant ($P < 0.05$).

Table 3: Correlations between individual Sniffin' Stick components

	Threshold	Discrimination	Identification
Discrimination	0,804*		
Identification	0,411*	0,602*	
TDI total score	0,871*	0,919*	0,719*

T, threshold; D, discrimination; I, identification. * $P < 0.05$

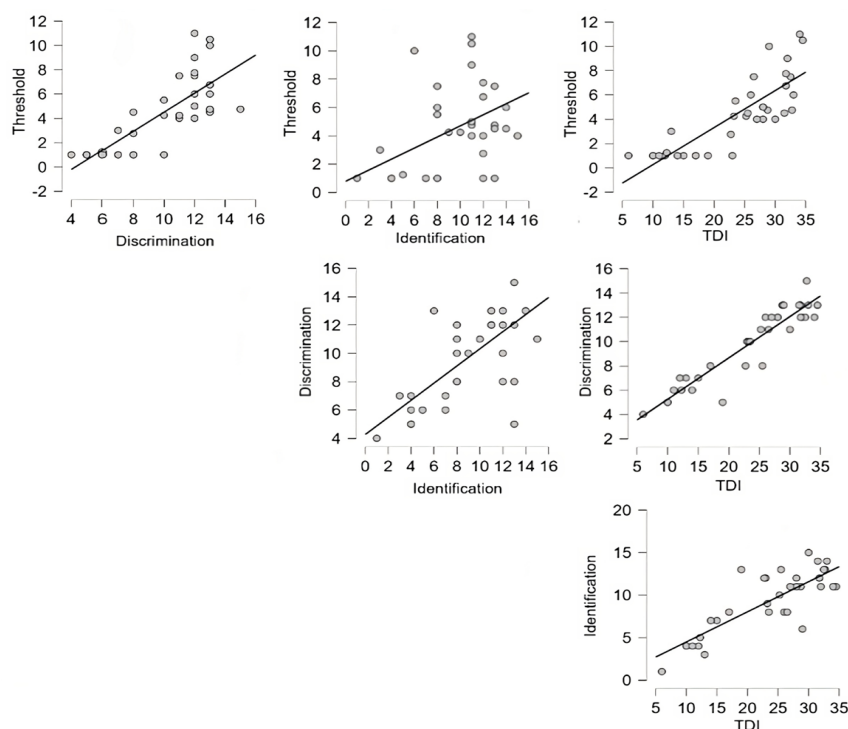


Figure 1: Scatter plots of correlations between individual Sniffin' Stick components

When examining 4×4 tables some relationships are readily apparent (Table 4). For the entire cohort, 91.7% patients with normal threshold also had normal discrimination scores. However, only 41.7% patients with normal threshold also had normal identification scores. For those patients with abnormal threshold, 71.4% had normal identification and 71.4% had normal discrimination. 95.2% of patients with abnormal discrimination also had abnormal threshold, and only 74.0% of those with abnormal identification also had abnormal threshold.

Table 4: Overlap between individual components of Sniffin' Sticks test.

	Normal I	Abnormal I
Normal T	5	7
Abnormal T	8	20
	Normal D	Abnormal D
Normal T	11	1
Abnormal T	8	20

Pre-operatively, the patients estimated their smell sensitivity to be normal in 42.5%, reduced in 47.5% and absent in 10.0%. The comparison between the self-ratings and the results of the olfactory tests showed that only 55.0% (22/40) of all patients estimated their smell of smell (Table 5). 31.0% (9/29) of all patients with chronic sinusitis presented with a false-positive estimation of their smell abilities, i.e., they were not aware of their smell deficits. All patients who had severe or total loss of smell function self-reportedly had olfactory test results corresponding to their self-assessment.

Table 5: Results of the olfactory tests and of the self-rating in the cohort (n=40)

		Sniffin' Sticks test results		
		Normosmia	Hyposmia	Anosmia
Self-rating	Normosmia	8	9	0
	Hyposmia	3	10	6
	Anosmia	0	0	4

IV. DISCUSSION

Our study found no correlation between nasal polyps TDI scores, contrary to other authors [9,10]. The explanation for this problem may be due to the small sample size and convenient sampling method, which cannot provide statistically significant results.

The prevalence of olfactory loss in our study exhibited variation depending on the choice of cut-offs-age-adjusted or ideal-for defining normal and abnormal olfactory function. Notably, a higher prevalence of olfactory loss was observed when ideal cut-offs were employed to delineate normosmia. In alignment with Soler et al.'s recommendation [9], we concur with the adoption of ideal thresholds as the standard for diagnosing olfactory disorders. This approach is akin to the methodologies used in assessing other sensory functions, such as hearing (via audiograms) and vision (through visual acuity tests), where standard thresholds are applied based on healthy adult age groups.

The study revealed that the prevalence of olfactory dysfunction differed significantly among the specific olfactory domains, with the most pronounced loss observed in threshold levels. When ideal cut-offs were applied, a substantial 70% of the cohort was found to have threshold levels falling below the 10th percentile. In contrast, the prevalence of impairment in the discrimination domain was lower, recorded at 52.5%. These results highlight a crucial point: diagnostic methods that solely focus on reporting discrimination scores might not fully capture the extent of olfactory loss in individuals with CRS. Furthermore, the study also noted a moderate to strong correlation between different olfactory domains within the cohort. This finding aligns with observations reported in both normative populations and those with CRS [8,9]. It underscores the interconnected nature of various aspects of olfactory function.

Within this cohort, essentially all patients with normal threshold testing also had normal discrimination scores. However, only 41.7% (5/12) of patients with normal odor thresholds had normal identification scores. In the study by Soler et al [9], nearly 100% of patients with normal threshold scores having normal discrimination scores and identification scores. The difference of our results

from this author may be due to the identification test having an unfamiliar odor to Vietnamese people, leading to false negative results. The discrimination test (also a suprathreshold test) does not require participants to be previously familiar with the odor, making the results less biased. In fact, when evaluating the rate of familiarity with odors in the identification test set with the same research group, we noted that there were 6 types of odors with a familiarity rate < 75%: blackberry, fir, raspberry, mustard, rum, and sauerkraut. Recently, Tran et al. have just completed the validation and presented normative data for the Vietnamese smell identification test, which will be helpful for future olfactory assessment studies in Vietnam population [11].

Based on our findings, once a normal threshold level is established in a CRS patient, conducting additional suprathreshold testing for discrimination appears to be unnecessary. This is because patients who demonstrate normal threshold levels typically also show normal discrimination scores. Conversely, patients with abnormal discrimination scores almost invariably exhibit abnormal threshold levels as well. Hence, conducting further threshold testing in this CRS subgroup seems redundant. However, for those patients who present with abnormal threshold scores, additional suprathreshold testing for discrimination could be informative. The impact of threshold impairments on discrimination varies, and such testing can provide valuable insights into the extent of olfactory dysfunction. Similarly, CRS patients with normal discrimination scores might still benefit from threshold testing, as a significant portion of them are likely to experience declines in this domain. Regarding the relationship between threshold testing and identification testing, the study does not provide conclusive evidence. Yet, it is plausible that a similar pattern would emerge if a validated set of identification tests were employed. These findings may not hold true in other populations, particularly those with neurocognitive defects that affect memory-dependent tasks like olfactory discrimination and identification [12,13].

The heterogeneity between subjective and objective olfactory assessments is consistent with the findings of previous studies, in both normal and CRS populations [14,15]. The above results

emphasize the limitations of self-assessment of olfactory function: the risk of late or incorrect diagnosis and delayed intervention if relying only on subjective assessment methods. The Position Paper on Olfactory Disorders outlines the importance of objective assessment of olfactory dysfunction, which helps make a more accurate diagnosis and aids in tailoring treatment strategies [4].

V. CONCLUSION

Olfactory dysfunction is a common finding in patients with CRS, particularly those with polyps and asthma. Although correlations exist across olfactory domains in CRS, the prevalence of olfactory loss varies based on the domain of olfaction tested and whether age-adjusted or ideal normative values are used to define normal. Subjective olfactory assessment has low reliability, and the need for objective olfactory assessment in assessing odor in patients with chronic rhinosinusitis.

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Conflicts of interests

All authors declare that there is no conflict of interest associated with this study.

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