

Olfactory dysfunction and asthma as risk factors for poor quality of life in upper airway diseases

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ABSTRACT

Background: The study of olfaction/quality of life (QoL) interaction has not been adequately discussed and remains to be further explored. Determination of clinical predictors for poor QoL may support consultation of respective patients. This study explores QoL of patients with olfactory dysfunction and evaluates associated clinical risk factors for QoL prediction.

Methods: One hundred eight patients suffering from chronic rhinosinusitis (CRS) and allergic rhinitis (AR) and 30 healthy subjects were studied. Olfactory function was evaluated using objective olfactory test. All patients completed six validated questionnaires either specific for olfaction (Questionnaire of Olfactory Deficits [QOD]) and for assessing psychological state (Zung Anxiety Scale [ZAS], State-Trait Anxiety Inventory, Zung Depression Scale, and Beck Depression Inventory [BDI]) or a generic one (Short Form 36).

Results: Significantly poorer QoL and more severe anxiety and depression symptoms were observed in anosmic (all $p < 0.001$) and hyposmic patients compared with controls. Anosmic patients presented significantly worse results compared with hyposmic and normosmic patients. However, higher scores were observed in hyposmic compared with normosmic patients only in the QOD, ZAS, and BDI scale. Patients with CRS presented significantly poorer QoL than patients with AR only. The presence of nasal polyps or concomitant AR in patients with CRS did not show any differentiation in the results. Asthma was associated with significantly worse scores in all the psychometric questionnaires.

Conclusion: Olfactory dysfunction was found to decrease QoL among patients. Anosmia, CRS disease, and asthma as clinical predictors were proved to be independently correlated with QoL, anxiety, and depression levels.

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Chronic rhinosinusitis (CRS) and allergic rhinitis (AR) are common chronic-associated upper airway diseases.^{1,2} Olfactory dysfunction, despite being a common symptom among these patients,^{1–3} is underestimated by patients and overlooked by doctors.^{4–6} Olfaction is known to be closely related to emotional processes and quality of life (QoL).^{7,8} To date, the effects of olfactory deficits on patient QoL has not been adequately discussed in literature^{9–22} and their results have raised many arguments because different kinds of questionnaires for QoL have been used and their methods of evaluating the olfactory performance have been based mainly on self-reporting symptoms. Accordingly, there is still need for further studies that concentrate on the risk factors for poor QoL of patients affected by CRS and AR. The use of standardized olfactory tests and validated questionnaires opens new horizons for evaluating the QoL of these patients.

The aims of our study were (i) to explore QoL of patients with olfactory dysfunction due to CRS and AR, (ii) to detect the prognostic value of clinical characteristics to QoL questionnaire results, and, finally, (iii) to explore differences in questionnaire results in asthmatic patients versus nonasthmatic patients and the latter's relationship with QoL.

MATERIALS AND METHODS

In this prospective study 108 patients (62 [57.4%] men; mean age, 39.78 ± 16.11 years) suffering from CRS (CRS with nasal polyps

[NPs] or CRS without NPs) and AR were included. Thirty healthy subjects (16 men; mean age, 37.03 ± 13.09 years), with no evidence of chronic upper airway diseases, who visited our hospital for routine health checkup, were recruited as controls.

The diagnosis was based on history, clinical examination, nasal endoscopy, sinus computed tomography scanning, skin-prick testing for atopy, test of pulmonary function, and olfactory testing. None of the subjects used oral or nasal corticosteroids and antibiotics 4 weeks before inclusion and oral antihistamines 1 week before skin-prick testing. All patients underwent a brief psychiatric interview to exclude those with preexisting major psychiatric disorder. The remaining patients filled in six questionnaires²³ either specific for olfaction-related QoL (Questionnaire of Olfactory Deficits [QOD]) and for assessing depression and anxiety symptoms (Beck Depression Inventory [BDI], Zung Depression Scale [ZDS], Zung Anxiety Scale [ZAS], and State and Trait Anxiety Inventory [STAI]) or a generic one (Short Form general health survey [SF-36]). The study protocol was approved by the local Institutional Review Board. All subjects signed informed consent. The study was performed in accordance with the Declaration of Helsinki/Hong Kong.

Olfactory function was assessed using "Sniffin' Sticks" test package (Burghart, Wedel, Germany),²⁴ with specific tests for odor threshold, odor discrimination, and odor identification.²⁴ Results were aggregated to a combined "threshold-discrimination-identification (TDI) score."²⁴ The TDI score ranges from 0 to 48 (values of ≤ 15 represent anosmia, values between 16 and 34.5 represent hyposmia, and values > 34.5 represent normosmia).²⁵

QOD is a validated olfaction-specific questionnaire for QoL.²⁶ It consists of 25 four-scale statements (17 "negative," 2 "positive," and 6 "socially desired") with a maximum score of 57 points.²⁶ High scores indicate a strong impairment in QoL.

SF-36 represents a widely used generic health survey that assesses QoL in eight domains covering both physical and mental health from the patient's point of view with chronic diseases.^{27,28} Scores range from 0 to 100, with a higher score representing better functioning.^{27,28}

The other four questionnaires were used to assess QoL of patients describing specifically their psychological profile. Depressive symp-

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toms were assessed using the Greek validated versions of BDI²⁹ and ZDS.³⁰ BDI consists of 21 self-reporting items graded from 0 to 3, and a higher score indicates higher level of depression. Albeit its general use, BDI is considered a screening instrument and not a diagnostic tool. ZDS is another self-administered instrument measuring depression.³⁰ It consists of 20 items graded from 1 to 4 and assesses psychological and somatic depression. Higher scores indicate higher level of depression.

Anxiety was assessed with ZAS³¹ and STAI³² scales translated and validated in Greek. ZAS is a self-rating scale with a structure similar to ZDS.³¹ STAI is an instrument consisting of two parts, one that refers to anxiety due to a specific condition (state), and one that refers to the general tendency of the subject to react anxiously (trait).³² Each one of these parts has 20 questions, which are answered by choosing between grades 1–4.

Data statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS), Version 19.0 (SPSS, Inc., Chicago, IL). The scores of all questionnaires (QOD, SF-36, ZAS, STAI, ZDS, and BDI) were expressed as the mean and SD. Between groups differences of the scores of all tests were assessed by Student's *t*-test and one-way analysis of variance (ANOVA). *Post hoc* analysis was performed using Tukey's test; in particular, differences between the control group and the three distinct groups of olfactory function were examined by Dunnett's test. One-way analysis of covariance was performed to investigate the effect of olfactory deficit on questionnaires scores, adjusting for subjects' characteristics. Pearson's *r* correlation coefficient was used to assess the relation of QoL scores to TDI score. Because the distribution of BDI score was skewed (Kolmogorov-Smirnov test), the statistical analysis was performed on the log-transformed scores. Quantitative variables were expressed as frequencies and percentages (%) and analyzed using the chi-square test. We performed multivariate stepwise linear regression analysis on each scale score to explore which of the studied clinical factors were independently associated with these scores. All tests were two tailed, and statistical significance was considered for values of *p* < 0.05.

RESULTS

Demographics and disease characteristics of all patients and controls enrolled in the study are summarized in Table 1. There were no statistically significant differences in gender (*p* = 0.690), age (*p* = 0.393), socioeconomic status (SES; *p* = 0.299), smoking habits (*p* = 0.596), and duration of smoking (*p* = 0.135) between patients and controls. Regarding the quantitative assessment of subjects' olfactory function with the use of Sniffin' Sticks tests, patients presented statistically significant lower TDI scores compared with controls (27.45 ± 11.89 [range, 2–39.25] versus 38.93 ± 1.42 [range, 37–40]; *p* < 0.001). Based on this score, 68 (62.9%) patients presented olfactory dysfunction; 26 (24.1%) were anosmic and 42 (38.9%) were hyposmic patients. All of the subjects of the control group were normosmic patients. Among patients, higher frequency of anosmia was associated with female gender (32.6% versus 17.7%; *p* = 0.074), ages >55 years (48.3% versus 15.2%; *p* < 0.001), lower SES (50.0% versus 30.6% and 16.1% in medium and high social status; *p* = 0.011), CRS disease (34.4% versus 9.1% in AR; *p* = 0.003), the presence of asthma (60.0% versus 18.3%; *p* < 0.001), the shorter (≤10 years) duration of smoking (29.4% versus 14.3%; *p* = 0.001), and the longer (>5 years) duration of olfactory dysfunction (60.7% versus 19.4%; *p* = 0.001).

The scores of all psychometric questionnaires of patients and controls, in relation to olfactory function, are shown in Tables 2 and 3. Patients exhibited statistically significant higher scores in all questionnaires (QOD, 14.12 ± 9.76 versus 6.27 ± 0.78, *p* < 0.001; ZAS, 36.76 ± 9.40 versus 29.97 ± 6.16, *p* < 0.001; STAI, 41.85 ± 9.48 versus 34.83 ± 8.40, *p* < 0.001; ZDS, 37.68 ± 8.56 versus 28.43 ± 5.57, *p* < 0.001; BDI, 9.59 ± 7.89 versus 5.07 ± 3.56, *p* = 0.004) and lower score in SF-36 (71.88 ± 15.65 versus 86.86 ± 10.10, *p* < 0.001) compared with healthy controls. In the sequence, the scores of the control group were

Table 1 Demographics and disease characteristics of patients with olfactory dysfunction and healthy controls

	Control Group	Patients	<i>p</i> Value
Male gender, no. (%)	16 (53.3)	62 (57.4)	0.690
Age, yr; mean (SD)	37.03 (13.09)	39.78 (16.11)	0.393
SES, no. (%)			0.299
Low	1 (3.3)	10 (9.3)	
Medium	14 (46.7)	36 (33.3)	
High	15 (50.0)	62 (57.4)	
Smoking, no. (%)	9 (30.0)	38 (35.2)	0.596
Duration of smoking, yr; median (IQR)	7 (15–25)	10 (8–31.5)	0.135
Disease. No. (%)			
AR	—	44 (40.7)	
CRSsNP without AR	—	20 (18.5)	
CRSsNP with AR	—	14 (13.0)	
CRSwNP without AR	—	12 (11.1)	
CRSwNP with AR	—	18 (16.7)	
Asthma presence, no. (%)		15 (13.9)	
TDI score, mean (SD)	38.93 (1.42)	27.45 (11.89)	<0.001
Olfactory function, no. (%)			
Normosmic patients	—	40 (37.0)	
Hyposmic patients	—	42 (38.9)	
Anosmic patients	—	26 (24.1)	
Duration of olfactory dysfunction >5 yr, no. (%)	—	32 (29.9)	

AR = allergic rhinitis; CRSsNP = chronic rhinosinusitis without nasal polyp; CRSwNP = chronic rhinosinusitis with nasal polyp; IQR = interquartile range; SES = socioeconomic status; TDI = threshold discrimination identification.

compared separately with those of the three distinct groups of olfactory function; statistically significant worse QoL compared with controls were observed in anosmic (for all questionnaires; *p* < .001) and hyposmic (QOD, *p* < 0.001; SF-36, *p* < 0.001; ZAS, *p* = 0.002; STAI, *p* = 0.043; ZDS, *p* < 0.001; BDI, *p* = 0.013) patients; normosmic patients scored significantly higher than controls only in SF-36 (*p* = 0.041) and ZDS (*p* < 0.001). All of the aforementioned relationships persisted under an analysis of covariance, adjusting for subjects' characteristics, such as gender, age, SES, smoking habits, and duration of smoking.

Moreover, there were differences in the QoL scores between the subgroups of patients (anosmic, hyposmic, and normosmic patients); one-way ANOVA revealed statistically significant differences in the scores of all the questionnaires studied here between these subgroups of patients (all, *p* < 0.001). *Post hoc* analysis showed statistically significant worse scores in anosmic compared with hyposmic patients (QOD, *p* < 0.001; SF-36, *p* = 0.004; ZAS, *p* < 0.001; STAI, *p* < 0.001; ZDS, *p* < 0.001; BDI, *p* = 0.025) and normosmic patients (QOD, *p* < 0.001; SF-36, *p* < 0.001; ZAS, *p* < 0.001; STAI, *p* < 0.001; ZDS, *p* < 0.001; BDI, *p* < 0.001). Higher QOD, ZAS, and BDI scores were observed in hyposmic patients compared with normosmic patients (*p* < 0.001, *p* = 0.037, and *p* = 0.004, respectively); no statistically significant differences were found between hyposmic and normosmic patients in SF-36 (*p* = 0.076), STAI (*p* = 0.849), and ZDS (*p* = 0.989) scores (Tables 2 and 3). When the olfactory function was assessed by the quantitative TDI score, the following statistically significant correlations were found with the QoL scores (in descending order): QOD, *r* = −0.721 and *p* < 0.001; SF-36, *r* = 0.453 and *p* < 0.001; ZAS, *r* = −0.422 and *p* < 0.001; STAI, *r* = −0.398 and *p* < 0.001; BDI, *r* = −0.395 and *p* = 0.025; ZDS, *r* = −0.321 and *p* < 0.001.

Table 2 Scores of the psychometric questionnaires (QOD, SF-36, and Zung anxiety) in relation to the clinical characteristics of the patients

	QOD	p Value	SF-36	p Value	ZAS	p Value
Control group	6.27 (0.78)		86.86 (10.10)		29.97 (6.16)	
Patients	14.12 (9.76)	<0.001*	71.88 (15.65)	<0.001*	36.76 (9.40)	<0.001*
Disease		0.002		0.055		0.001
AR	9.77 (7.13)		77.35 (13.62)		32.09 (6.49)	
CRSsNP without AR	15.55 (9.43)		68.52 (19.00)		40.20 (11.44)	
CRSsNP with AR	15.93 (9.89)		68.10 (14.68)		39.71 (10.26)	
CRSwNP without AR	17.83 (11.31)		68.43 (9.52)		39.42 (10.94)	
CRSwNP with AR	19.28 (11.05)		67.46 (17.74)		40.28 (9.15)	
CRSwNP (total)	17.11 (10.24)	<0.001#	68.12 (15.95)	0.002#	39.97 (9.78)	<0.001#
Asthma		0.006		0.004		0.013
Absence	13.10 (8.70)		73.59 (15.11)		35.86 (9.13)	
Presence	20.47 (13.45)		61.26 (15.25)		42.33 (9.44)	
Smoking		0.506		0.842		0.511
No	13.66 (10.02)		71.66 (15.09)		37.20 (9.61)	
Yes	14.97 (9.32)		72.29 (16.85)		35.95 (9.08)	
Duration of smoking		0.667		0.336		0.072
≤ 10 yr	14.24 (11.07)		69.32 (19.03)		38.88 (10.76)	
>10 yr	15.57 (7.87)		74.69 (14.89)		33.57 (6.83)	
Olfactory function		<0.001		<0.001		<0.001
Normosmic patients	7.08 (2.30)		78.98 (14.20)		31.88 (7.69)	
Hyposmic patients	14.33 (7.05)		72.13 (14.38)		36.29 (7.92)	
Anosmic patients	24.62 (11.13)		60.54 (13.45)		45.04 (8.56)	
Duration of olfactory dysfunction		0.659		0.453		0.004
≤5 yr	17.75 (9.89)		69.00 (15.09)		35.81 (7.57)	
>5 yr	18.84 (10.46)		66.24 (15.09)		41.94 (9.16)	

*Statistical significance compared with control group; #statistical significance compared with AR.

AR = allergic rhinitis; CRSsNP = chronic rhinosinusitis without nasal polyp; CRSwNP = chronic rhinosinusitis with nasal polyp; QOD = Questionnaire of Olfactory Deficits; SF-36 = Short Form 36; ZAS = Zung Anxiety Scale.

The scores of all psychometric questionnaires in relation to patients' characteristics are also shown in Tables 2 and 3. One-way ANOVA revealed statistically significant association of patients' disease with all questionnaires, where patients with CRS presented significantly poorer QoL and more anxiety and depression symptoms than patients with AR. In total, the unified group of patients with CRS (because the presence of NPs or concomitant AR did not show any differentiation in the scores) presented highly significant increased scores in QOD ($p < 0.001$), ZAS ($p < 0.001$), STAI ($p = 0.001$), ZDS ($p = .001$), and BDI ($p < 0.001$) and decreased SF-36 ($p = 0.002$) scores.

Furthermore, the presence of asthma was associated with statistically significantly worse scores in all the psychometric questionnaires (QOD, $p = 0.006$; SF-36, $p = 0.004$; ZAS, $p = 0.013$; STAI, $p = 0.002$; ZDS, $p = 0.017$; BDI, $p = 0.037$). Smoking did not show any significant association with the QoL of the patients (QOD, $p = 0.506$; SF-36, $p = 0.842$; ZAS, $p = 0.511$; STAI, $p = 0.494$; ZDS, $p = 0.767$; BDI, $p = 0.344$). Finally, patients with duration of olfactory dysfunction of >5 years presented worse scores in all of the psychometric questionnaires, although the statistical significance was reached for the ZAS ($p = 0.004$) and STAI ($p = 0.031$).

Our results of multivariate stepwise linear regression analysis on the six questionnaires revealed that anosmia remained independently associated with increased scores in the following: QOD (standardized regression coefficient $b = 0.739$), SF-36 ($b = -0.331$), ZAS ($b = 0.284$), STAI ($b = 0.361$), ZDS ($b = 0.300$), and BDI ($b = 0.388$), explaining the largest proportion of their variance (37.0, 19.1, 24.8, 25.7, 21.0, and 15.0%, respectively); the association of hyposmia with increased QOD ($b = 0.349$) and BDI scores ($b = 0.227$) also persisted in the multivariate regression analysis, explaining a further 10.6 and 8.0% of their variance, respectively. Furthermore, CRS also showed significant independent associations with increased scores in the following questionnaires: ZAS ($b = 0.281$), STAI ($b = 0.174$), and ZDS ($b = 0.228$),

explaining a further 5.2, 1.8, and 4.5% of their variance, respectively. The presence of asthma remained a significant independent determinant of decreased SF-36 ($b = -0.169$) scores, explaining a further 2.6% of its variance. The coefficients of the regression equations, which describe quantitatively the exact relationship of demographic and clinical characteristics and olfactory status of the patients with olfactory deficit with the questionnaires used, are given in Table 4. The findings of the hierarchical multivariate regression analysis were consistent with multivariate stepwise linear regression analysis.

DISCUSSION

Although the negative adverse effects of olfactory impairment on QoL and psychological state have been already discussed,⁹⁻²² the issue of olfaction/QoL interaction is worth pursuing in additional studies. Additionally, this is, to the best of our knowledge, the first study to provide clinical determinants for poor QoL and mood illness in patients with upper airway diseases.

We first evaluated the prognostic value of olfaction itself and its duration on patients' QoL and it was observed that it has an outstanding impact on QoL. Poor QoL seems to rise in higher levels as olfactory problems get more prominent. We found that anosmic patients presented the worst pronounced QoL as well as anxiety and depressive symptoms, whereas hyposmic patients seemed to follow a similar (but less intense) QoL pattern in all questionnaires, compared with healthy subjects. On the other hand, we did not find any significant effect on the examined QoL of patients with normative values of olfactory function. Olfactory function expressed both as a combined TDI score and as separate tests (odor threshold, odor discrimination, and odor identification) was negatively associated with QoL and mood state, according to all scale results (all, $p < 0.001$). Our findings as a whole indicate that QoL parallels smell impairment. This can be

Table 3 Scores of the psychometric questionnaires (STAI, ZDS, and BDI) in relation to the clinical characteristics of the patients

	STAI	p Value	ZDS	p Value	BDI	p Value
Control group	34.83 (8.40)		28.43 (5.57)		5.07 (3.56)	
Patients	41.85 (9.48)	<0.001*	37.68 (8.56)	<0.001*	9.59 (7.89)	0.004*
Disease		0.027		0.018		0.009
AR	38.32 (7.81)		34.32 (6.50)		6.45 (5.31)	
CRSsNP without AR	43.40 (10.36)		39.80 (10.13)		10.36 (8.04)	
CRSsNP with AR	44.00 (11.33)		39.64 (10.13)		11.92 (8.64)	
CRSwNP without AR	44.42 (9.54)		39.67 (9.59)		13.33 (9.06)	
CRSwNP with AR	45.39 (9.83)		40.67 (7.21)		12.28 (9.58)	
CRSwNP (total)	44.28 (9.82)	0.001#	39.98 (9.08)	<0.001#	11.75 (8.66)	<0.001#
Asthma		0.002		0.017		0.037
Absence	40.73 (9.24)		36.89 (8.28)		9.13 (8.19)	
Presence	48.80 (8.13)		42.53 (8.95)		12.47 (5.04)	
Smoking		0.494		0.767		0.344
No	42.31 (9.68)		37.86 (8.78)		9.90 (9.68)	
Yes	41.00 (9.17)		35.34 (8.25)		9.03 (7.66)	
Duration of smoking		0.031		0.003		0.680
≤10 yr	44.53 (8.99)		41.94 (9.22)		9.12 (9.26)	
>10 yr	38.14 (8.47)		33.62 (5.04)		8.95 (6.33)	
Olfactory function		<0.001		<0.001		<0.001
Normosmic patients	38.65 (7.86)		35.35 (8.64)		5.23 (4.12)	
Hyposmic patients	39.64 (8.64)		35.60 (6.08)		10.69 (9.31)	
Anosmic patients	50.35 (8.15)		44.62 (8.42)		14.54 (6.32)	
Duration of olfactory dysfunction		0.031		0.114		0.148
≤5 yr	41.31 (9.15)		37.63 (7.76)		10.25 (6.32)	
>5 yr	46.47 (10.13)		40.83 (8.70)		13.19 (9.99)	

*Statistical significance compared to control group; #statistical significance compared to AR.

AR = allergic rhinitis; BDI = Beck Depression Inventory; CRSsNP = chronic rhinosinusitis without nasal polyp; CRSwNP = chronic rhinosinusitis with nasal polyp; STAI = State-Trait Anxiety Inventory; ZDS = Zung Depression Scale.

explained either from the psychosocial burden of the stressful condition of anosmia, which affects many manifestations of everyday life (e.g., lack of pleasure of taste, etc.) or from the neurocognitive aspect (e.g., association between both emotional state and olfactory disorders with amygdala).⁸ However, duration of olfactory loss (over 5 years) presented a moderate significant correlation only for mood scales (ZAS, STAI, ZDS, and BDI). This is in accordance with a recent study of Temmel *et al.*¹⁴ and emphasizes the significance of smells, irrespective to duration, in everyday life. Moreover, anosmia was associated with patients' low SES. This can be related to less access to medical and surgical treatments because these patients may be less concerned, visit a doctor probably later, and may be less dependable in following recommended treatment. This is in accordance with our finding that duration of anosmia was significantly longer among patients with low compared SES with those with high SES (median duration, 6.5 years versus 2.5 years; $p = 0.045$, respectively). Our results are in agreement with the findings of previous studies^{9–20} that revealed that subjects with severely impaired olfactory function have a significantly higher degree of depression and decreased QoL compared with subjects with normal to moderately impaired olfaction. However, some discrepancies in the published studies on this issue are evident. Recently, Temmel *et al.*¹⁴ found complaint scores in hyposmic patients higher than in anosmic patients, differing on this issue from the present study. On the contrary, Litvack *et al.*²¹ and Seo *et al.*²² found that olfactory sensitivity is not associated with poor QoL. However, these studies referred to the effects of olfactory dysfunction due to various causes on QoL, whereas in our study we explored the relation of anosmia specifically due to CRS and AR with patients' QoL.

The significance of olfactory function for QoL was also found to be correlated with disease severity. The more severe the disease is, the poorer results for QoL and anxiety and depression symptoms are found in all psychometric tests. Although in each separate group of patients we found a significant negative impact of olfactory dysfunction

on QoL and mood state results, the appearance of poor levels of QoL and mood health was significantly most frequent among CRS patients compared with those suffering only from AR in all questionnaires. However, despite the significant association between disease severity and all scales, multivariate linear regression analysis showed that these associations remained significant only for mood scales (ZAS, STAI, and ZDS), whereas they became nonsignificant for olfaction-specific QOD questionnaire and the generic SF-36 one, when mainly olfaction was taken into account (because there were higher frequencies of anosmia, –34.4% versus 9.1%, $p = 0.003$, in CRS patients compared with AR patients). Also, despite the negative effects of smoking on olfactory function,³³ there was no significant impact of smoking habits as well as its duration on QoL results.

Finally, asthmatic patients presented significantly worse QoL and depressive mood compared with nonasthmatic patients. However, despite the significant association between asthma and all scales, multivariate linear regression analysis showed that it remained an independent risk factor only for the generic health survey (SF-36; because there were higher frequencies of anosmia, –60.0% versus 18.3%, $p < 0.001$, in asthmatic patients compared with nonasthmatic patients).

CONCLUSION

There is a strong relationship between olfactory dysfunction and poor QoL, as well as anxiety or depressive symptoms in patients suffering from CRS or AR. This means that when dealing with patients with olfactory impairment we should be concerned not only for the rhinologic symptoms, but also for the QoL of these patients. The QoL instruments have been proven to be very useful tools for physicians in everyday clinical practice during consultation for treatment, in the evaluation of the course of the disorder, for therapy evaluation, as well as for research purposes. Anosmia, CRS disease, and asthma

Table 4 Results of multivariate linear regression analysis for the association of the psychometric questionnaires for QoL and mood state of patients with olfactory dysfunction with their demographics, clinical characteristics, and olfactory status

	Coefficient (SE)	Standardized Coefficient	T Statistic	p Value
QOD				
Olfactory function				
Hyposmia	6.953 (1.557)	0.349	4.466	<0.001
Anosmia	16.799 (1.802)	0.739	9.322	<0.001
Female gender	2.944 (1.392)	0.150	2.115	0.037
Constant	6.118 (1.198)		5.107	<0.001
SF-36				
Low/medium social status	−11.750 (2.610)	−0.366	−4.360	<0.001
Anosmia	−9.908 (3.206)	−0.331	−3.091	0.003
Presence of asthma	−7.636 (3.872)	−0.169	−1.972	0.050
Constant	80.328 (1.762)		45.592	<0.001
ZAS				
Anosmia	6.214 (1.877)	0.284	3.311	0.001
Female gender	5.750 (1.477)	0.304	3.892	<0.001
CRSwNP	5.360 (1.586)	0.281	3.379	0.001
Low social status	4.806 (2.539)	0.149	2.009	0.047
Constant	29.193 (1.238)		23.578	<0.001
STAI				
Female gender	7.030 (1.426)	0.368	4.931	<0.001
Anosmia	7.965 (1.743)	0.361	4.571	<0.001
CRSwNP	3.340 (1.500)	0.174	2.226	0.028
Low social status	5.403 (2.477)	0.166	2.181	0.031
Constant	34.461 (1.208)		28.520	<0.001
ZDS				
Anosmia	5.973 (1.666)	0.300	3.585	0.001
Female gender	4.846 (1.363)	0.281	3.555	0.001
CRSwNP	3.957 (1.435)	0.228	2.758	0.007
Low social status	6.716 (2.368)	0.228	2.836	0.006
Constant	31.207 (1.155)		27.015	<0.001
BDI				
Olfactory function				
Hyposmia	0.175 (0.074)	0.227	2.354	0.020
Anosmia	0.341 (0.089)	0.388	3.852	<0.001
Female gender	0.192 (0.065)	0.253	2.963	0.004
Low/medium social status	0.122 (0.067)	0.161	1.999	0.048
Constant	0.605 (0.055)		10.968	<0.001

The R^2 of regression was 49.8% (48.3% adjusted) for QOD, 32.1% (30.1% adjusted) for SF-36, 42.0% (39.7% adjusted) for ZAS, 45.4% (43.2% adjusted) for STAI, 38.8% (36.4% adjusted) for ZDS, and 31.1% (28.4% adjusted) for BDI. The logarithmic transformation of BDI scores was used. Only variables that maintained statistical significance in multivariate stepwise linear regression are shown; all variables are binary (no = 0; yes = 1; with the exception of olfactory function).

BDI = Beck Depression Inventory; CRSwNP = chronic rhinosinusitis with nasal polyp; STAI = State-Trait Anxiety Inventory; ZDS = Zung Depression Scale; QOD = Questionnaire of Olfactory Deficits; SF-36 = Short Form 36; ZAS = Zung Anxiety Scale; QoL = quality of life.

proved to be clinical risk factors for poor QoL and mood illness. The evaluation of prognostic factors for posttreatment olfactory results and patients' QoL recovery is a matter of future studies with great clinical importance.^{34–36}

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