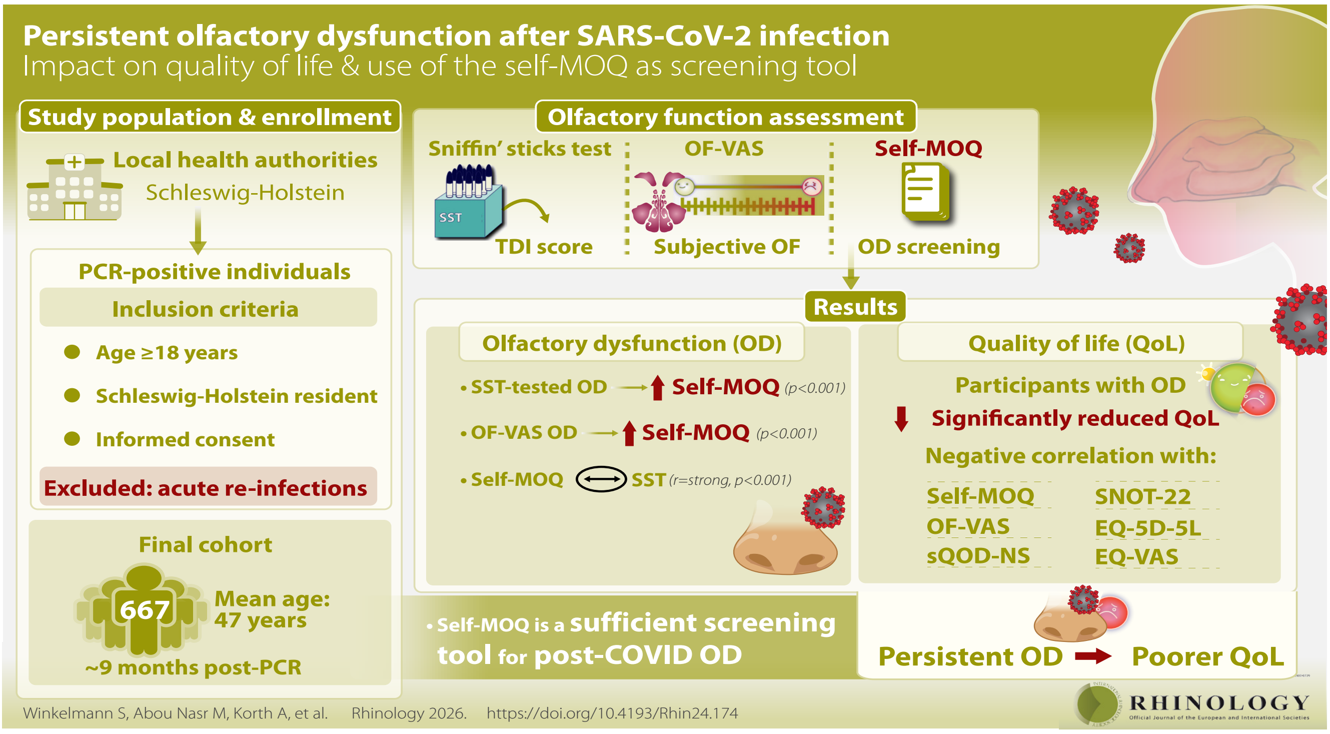
Relationship between olfactory function and quality of life in COVID-19 patients

Sanja Winkelmann[1,*], Maher Abou Nasr[1,*], Alia Korth[1], Bettina Voss[1], Naomi Behrend[1], Annett Pudszuhn[2], Philipp Schendzielorz[3], Corina Maetzler[4], Anne Hermes[5], Katrin Franzpoetter[5], Anne-Kathrin Ruß[6], Daniel Pape[7], Stefan Störk[8], Felipe A. Montellano[9,10], Martin Witzenrath[11], Thomas Keil[9,12,13], Michael Krawczak[6], Wolfgang Lieb[5], Stefan Schreiber[7], Thomas Bahmer[7,14], Martin Laudien[1], on behalf of the NAPKON study group

Rhinology 64: 4, 0 - 0, 2026
https://doi.org/10.4193/Rhin24.174



Abstract

Background: COVID-19 is associated with multiple long-term impairments that negatively affect patients' quality of life (QoL). Of these, olfactory dysfunction (OD), which is difficult to measure in practice, is likely to play an important role as it highly affects peoples' QoL.

Methods: In a population-based study, a total of 667 adult participants (mean age: 47 years) were examined nine months, on average, after positive PCR testing for SARS-CoV-2. Subjective olfactory function (OF) was quantified by means of a Visual Analogue Scales (OF-VAS). OF was tested by way of the Sniffin' Sticks Test (SST). The self-reported Mini Olfactory Questionnaire (self-MOQ) was used to screen for OD. The brief (short) version of the Questionnaire of Olfactory Disorders - Negative Statements (sQOD-NS), the sinonasal outcome Test-22 (SNOT-22), the EuroQoL 5-Dimension 5-Level (EQ-5D-5L), and the EuroQoL-VAS (EQ-VAS) were used to assess QoL.

Results: Participants with SST-tested OD or with OF-VAS-based subjective OD were characterized by significantly higher self-MOQ scores. Diagnoses of OD by self-MOQ or SST were found to be strongly correlated. Moreover, both the TDI score and the OF-VAS score were negatively correlated with the self-MOQ score. In addition to a significant reduction of QoL in participants with tested OD, the four questionnaires used in the present study also consistently highlighted a significant negative correlation between QoL and both, self-MOQ and OF-VAS score.

Conclusion: The self-MOQ is a sufficient screening tool for OD after SARS-CoV-2 infection. Patients with persistent OD show significantly poorer QoL than those without.
Clinical implications: Olfactory function can be assessed in patients with COVID-19 using a simple 5-item questionnaire (self-MOQ). Patients with OD show reduced QoL.
Capsule summary: In our population-based cross-sectional study of 667 patients with PCR-confirmed SARS-CoV-2 infection, participants with persistent OD had significantly poorer OF-related QoL. The self-MOQ is a simple, valid and reliable means to screen OD in patients with COVID-19.

Key words: SARS-CoV-2, COVID-19, olfactory dysfunction, quality of life, screening

Introduction

Human behavior is partially guided by our ability to smell. Olfaction plays a significant role in nutrition, avoidance of harm [1–3], appetite [4–6], mate selection [2], and in the interaction with social, sexual and marital partners [7].
The most common causes of smell loss are post-viral upper respiratory tract infection and sinonasal disease, followed by head trauma, toxin or drug exposure, and congenital anosmia [8].
Olfactory dysfunction (OD) is one of the common symptoms of coronavirus disease 2019 (COVID-19), with a higher prevalence observed among patients with mild rather than severe forms of the disease [9–13]. A systematic review suggested a pooled prevalence of OD in COVID-19 of 54% [14]. In most cases, OD lasts only a few weeks [10] but symptoms may as well persist for 9 months or longer after SARS-CoV-2-infection [15]. In the population-based study on olfactory perception disorders after SARS-CoV-2 infection, Winkelmann et al. showed a significantly higher proportion of subjects with OD in the population studied compared to a matched historical comparison cohort (15).
Reliable measurement of olfactory function (OF) is difficult, especially in large groups of patients. Tools used in clinical routine include standardized psychophysical tests such as, for example, the Sniffin' Sticks Test (SST, Burghart) and the University of Pennsylvania Smell Identification Test (UPSIT). However, these tests are time-consuming, relatively expensive, and not easily applicable in clinical routine. Additionally, little attention has been paid so far to validated questionnaires as a means of self-assessment of, or screening for, OF in COVID-19 [16–18].
Therefore, drawing upon one of the longest follow-ups of COVID-19 hitherto described (mean: 9 months), two hypotheses are examined in this study. Firstly, the self-MOQ is a simple but sufficient tool to screen for OD in the post-acute phase of COVID-19 and secondly, persistent OD after SARS-CoV-2 infection has a negative impact on different aspects of participants' QoL.

Materials and methods

This population-based study was conducted at the University Medical Centre Schleswig-Holstein at Kiel (Figure S1). It has been registered at the German registry for clinical studies (DRKS00023742), ClinicalTrials.gov (NTC04679584), and was approved by the local ethics committee (D537/20). All participants gave written informed consent before inclusion.

Objectives

The objectives of this study were as follows:
1) Identifying the sMOQ as a sufficient tool to screen for subjective and/or tested OD in COVID-19.
2) Analyzing participants' QoL, assessed by means of four different questionnaires displaying different aspects of QoL after SARS-CoV-2-infection.
3) Comparing QoL of different subgroups regarding OF, PCT, age and gender to evaluate the impact of subjective and tested OD on QoL in COVID-19.

Participants

Between November 2020 and April 2021, the local health authorities informed individuals with PCR-positive SARS-CoV-2-infection about our study.
The inclusion criteria comsprised a positive PCR test for SARS-CoV-2, age ≥ 18 years at the time of infection, residency in the federal state of Schleswig-Holstein, and an informed consent given to participate. Apart from an acute re-infection with SARS-CoV-2 no further exclusion criteria were set. Respondents were examined between November 2020 and June 2021. Dropouts were documented and statistical analyses were performed using complete data subsets only, as appropriate.

Demographic information

Comprehensive telephone interviews as well as paper-based and online questionnaires were used to acquire data on participants' health (Table 1). Participants were asked to provide a COVID-19-specific medical history including course of disease, symptoms, treatment, and vaccination history.

Assessment of OF

OF Visual Analogue Scale (OF-VAS)
During their onsite visit, participants were asked to rate their OF prior to infection, during infection, and at the time of examinati-

Table 1. Demographics and basic characteristics of COVIDOM study sample (n=667).

bBsic characteristics	number (%)
Age (in years), median (IQR)	51.0 (34.0-59.0)
Total participants	667
Women	376 (56.4)
Men	290 (43.5)
n/a	1 (0.1)
Post-COVID time (T3-T2, in months), median (IQR)	9.2 (7.1-10.9)
Current smoker (at T3)	68 (10.6)
Pack years&, median (IQR)	5.0 (0.8-15.0)
Subjective OD (at T3)	277/608 (45.6)
Women	168/338 (49.7)
Men	109/270 (40.4)
Tested OD (at T3)	197/570 (34.2)
Women	107/320 (33.4)
Men	90/250 (36.0)

Results are given as number (%), unless otherwise indicated. OD, olfactory dysfunction; T2, time during acute SARS-CoV-2 infection; T3, time of examination; &includes current and former smokers (n=291).

on using a 10-point visual analog scale (OF-VAS). On the OF-VAS, a score of 0 indicates no OF while 10 indicates perfect OF. The time-dependent results were labelled T1, T2, and T3, respectively, and a lower OF-VAS score at T3 than at T1 was considered subjective OD. The time between positive PCR testing and T3 was labeled 'post COVID time' (PCT).

Sniffin' Sticks Test (SST)
Participants also underwent the psychophysical SST (Burghart Messtechnik GmbH, Germany) that targets odor threshold, discrimination, and identification. The three subtest results were also added up to form an overall TDI score [19]. A total TDI score <31 was considered tested OD whilst TDI ≥ 31 was labelled 'normosmia' [19].

Self-reported Mini Olfactory Questionnaire (self-MOQ)
Finally, participants completed the self-MOQ which comprises five true/false statements to screen for OD (20). Each agreement to a statement is scored by one point, and a higher overall score indicates worse OF. Self-MOQ scores have been categorized before as either normosmic (≤3), hyposmic (4) or anosmic (5) [20].

Assessment of QoL

Brief (short) version of the Questionnaire of Olfactory Disorders- Negative Statements (sQOD-NS)
The sQOD-NS comprises seven statements on olfactory-related QoL. Participants rate their agreement to each statement by an integer between 0 and 3, with lower overall scores reflecting worse olfaction-related QoL [21]. These statements can be grouped into social, anxiety, eating, and annoyance subdomains [21]. The sQOD-NS was completed only by study participants who reported OD upon an entry question.

Sinonasal Outcome Test-22 (SNOT-22)
QoL as related to sinonasal symptoms was assessed using the German version of the SNOT-22 questionnaire [22,23]. The SNOT-22 comprises 22 items covering four subdomains, namely nasal- , otologic symptom- , emotional- and sleep dysfunction-related QoL [24]. Especially Question 12 maps the olfactory function. Each item is rated by an integer between 0 ('no problem at all') and 5 ('worst possible symptom'). The overall score thus ranges from 0 to 110, with higher scores indicating a stronger impact upon QoL [24]. Additionally, SNOT-22 scores were categorized as either no (0 to 7), mild (8 to 20), moderate (21 to 50) or severe (>50) impact on QoL (MMS classification) [25].

EuroQoL 5-Dimension 5-Level (EQ-5D-5L)
The EQ-5D-5L comprises five items related to mobility, self-care, usual activities, pain/discomfort, and anxiety/depression, each of which is integer-scored ("leveled") between 1 (no problems) and 5 (extreme problems/unable to). The five EQ-5D-5L item ratings were transformed by a proprietary algorithm into a real-valued EQ-5D-5L index between 0 (worst possible health state) and 1 (best state), based upon a German value set [26].

EuroQoL-VAS (EQ-VAS)
The EQ-VAS score was used to grade the overall current health of participants by an integer between 0 (worst imaginable health) and 100 (best imaginable health) [27].

Statistics

Statistical analyses were performed using IBM SPSS Statistics Software (version 28.0.1.0, IBM). Frequency differences between groups were assessed for statistical significance with a chi-squared test. For metric variables, medians and interquartile ranges or, where appropriate, means and standard deviations were calculated and the statistical significance of group differences were assessed with a Mann Whitney U test for independent samples. Associations between variables were quantified by way of Spearman (dichotomous or ordinal variables) or Pearson correlation coefficients (continuous variables). P values <0.05 were deemed statistically significant.

Results

A total of 667 participants were recruited an average of 9 months after PCR-positive-SARS-CoV-2 infection (Table 1). Statistical analyses were performed on the 619 participants who did not suffer from an upper respiratory tract infection within two weeks before examination. The results of the self-MOQ, sQOD-NS, SNOT-22 and EQ-5D-5L index are summarized in Table 2.

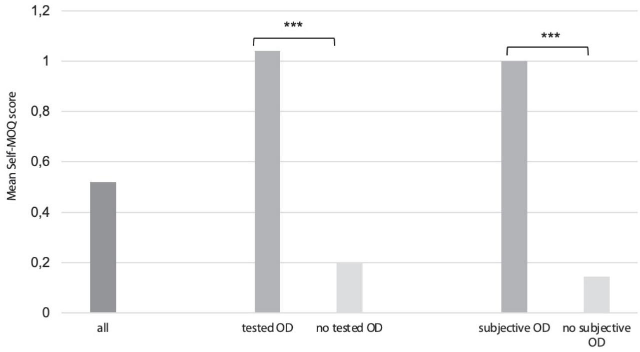


Figure 1. Mean Self-MOQ scores and U-test for group differences.

Self-MOQ

A total of 586 participants, 324 (55.3%) of whom were female and 262 (44.7%) were male, completed the self-MOQ (Table 2). Their median age was 51 years (IQR: 33.0 to 58.0).

Participants with tested or subjective OD had a significantly higher median self-MOQ score (indicating worse OF) than participants without tested (z=-7.930, p< 0.001) (Table 2) or subjective OD (z=-8.875, p<0.001) (Figure 1). The three SST subscores were found to be negatively correlated with the self-MOQ score, namely threshold (Spearman ρ=-0.211, p<0.001), discrimination (ρ= -0.267, p<0.001), identification (ρ=-0.368, p<0.001). Correlation between self-MOQ score and TDI score and OF-VAS score are displayed in Figures S2 and S3, respectively.

Upon subgroup analysis, the self-MOQ score was found to be significantly associated with the OF-VAS score, both for participants with (Spearman ρ=-0.560, p<0.001) and without (ρ=-0.285, p<0.001) subjective OD (Table 3) as well as for participants with (ρ=-0.361, p<0.001) and without (ρ=-0.110, p=0.43) tested OD. Finally, the self-MOQ score was negatively correlated with PCT (ρ=-0.085, p=0.041) but not with participant age (ρ=0.040, p=0.332).

Applying the self-MOQ score thresholds defined above, 557 of 586 participants (95.0%) were normosmic, 8 (1.4%) were hyposmic, and 21 (3.6%) were anosmic, with group-specific median TDI scores of 32.0 (IQR: 30.0 to 34.5), 24.5 (IQR: 22.0 to 25.0) and 27.0 (IQR: 24.0 to 30.0), respectively. A significant association was observed between the detection of dysosmia by either self-MOQ or SST (χ^2=25.144, 1 df, p<0.001).

In summary, the self-MOQ shows significant correlation with subjective as well as with tested OF and there are no differences in detecting dysosmia either by SST or self-MOQ.

sQOD-NS

A total of 156 participants (51.9% female, 48.1% male) with a median age of 52.0 years (IQR: 38.25 to 58.75) completed the sQOD-NS (Table 2).

The median sQOD-NS score did not differ significantly between participants with and without tested OD (z=-1.273, p=0.203) (Table 2). In contrast, participants with subjective OD had a significantly lower median sQOD-NS score (indicating lower QoL) than those without (z=-13.972, p=0.010) (Table 2, Figure S4).

A significant correlation was not found between the sQOD-NS and TDI scores of participants (Spearman ρ=0.118, p=0.179), but between their sQOD-NS and OF-VAS at T3 (ρ=0.391, p<0.001) (Table 4).

In detail, no significant correlation was found between the subdomain scores of the sQOD-NS and the TDI score, whereas the OF-VAS score at T3 was found to be negatively correlated with each subdomain score (social: ρ=0.384, p<0.001; eating: ρ=0.217, p=0.007; anxiety: ρ=0.304, p<0.001; annoyance: ρ=0.360, p<0.001). There was no significant correlation between mean sQOD-NS score and PCT (Spearman ρ=0.036, p=0.66) or between mean sQOD-NS score and age (ρ=0.04, p=0.962).

In summary, the sQOD-NS and its subdomains are significantly associated with subjective but not with tested OF.

Self-MOQ and sQOD-NS

Regarding the interdependence between self-MOQ and sQOD-NS, a significant correlation was found between the mean scores in all participants (Spearman ρ=-0.394, p< 0.001) (Table 4). Similarly, there was a significant correlation between the self-MOQ and sQOD-NS scores in all participants with subjective OD (ρ=-0.456, p=0.026), and in all participants with tested OD (ρ=-0.485, p<0.001).

SNOT-22

A total of 586 participants (56.0% female, 44.0% male) with a median age of 51.0 (IQR: 33.0 to 58.0) years completed the SNOT-22 (Table 2).

Participants with subjective OD yielded significantly higher SNOT-22-scores than those without subjective OD (z=-6.265, p<0.001). Such a difference was not observed between participants with or without tested OD (z=-1.757, p>0.05) (Figure S4).

Furthermore, a significant association was not seen between SNOT-22 and TDI scores (Spearman ρ=-0.77, p= 0.082), but between SNOT-22 and OF-VAS scores at T3 (ρ=-0.219, p<0.001) (Table 4). No significant association was found between the SNOT-22 score and PCT (Spearman ρ=-0.021, p= 0.617), or between the SNOT-22 score and participant age (ρ=0.006, p= 0.877).

According to the SNOT-22-based MMS classification, 121 of the 586 responders (20.6%) had experienced no impact on QoL whereas a mild, moderate or severe impact was reported by 208 (35.5%), 237 (40.4%) and 20 (3.4%), respectively. Participants with subjective OD (z=-13.972, p<0.001) or with tested OD (z=-8.139, p<0.001) scored question 12 of the SNOT-22 (which revolves around olfactory and gustatory function) significantly

Table 2. Results of questionnaires on OF and QOL.

	Self-MOQ			sQOD-NS			SNOT-22			EQ-5D-5L index		
	n	mean (SD)[&]	p-value	n	median (IQR)	p-value	n	median (IQR)	p-value	n	median (IQR)	p-value
all	586	0.52 (1.21)		156	17.5 (14.0-21.0)		586	18.0 (9.0-28.0)		592	0.93 (0.86-1.0)	
female	324	0.52 (1.21)	0.821[a]	81	18.0 (13.0-20.5)	0.668a	328	21.0 (11.0-32.0)	<0.001[a]	331	0.91 (0.82-0.97)	<0.001[a]
male	262	0.52 (1.22)		75	17.0 (14.0-21.0)		258	15.0 (7.0-25.0)		261	0.943 (0.89-1.0)	
tested OD	169	1.04 (1.57)	<0.001[b]	78	17.0 (13.75-20.0)	0.203b	168	20.0 (9.0-29.75)	0.079[b]	171	0.92 (0.86-1.0)	0.804[b]
no tested OD	338	0.20 (0.68)		53	19.0 (13.5-21.0)		338	16.0 (9.0-26.0)		339	0.94 (0.86-1.0)	
subjective OD	248	1.00 (1.56)	<0.001[b]	131	17.0 (13.0-20.0)	0.01b	256	23.0 (13.0-34.0)	<0.001[b]	261	0.86 (0.17)	<0.001[b]
no subjective OD	305	0.14 (0.63)		17	20.0 (17.5-21.0)		296	15.0 (7.0-24.0)		294	0.91 (0.13)	

[&] For illustrative purposes, mean and SD are given instead of median and IQR as the latter both equal zero. [a] U test of a sex difference in median scores. [b] U test of difference in median scores between presence or absence of tested/subjective OD. OF, olfactory function; QOL, quality of life; Self-MOQ, self-reported Mini Olfactory Questionnaire; SNOT-22, sinonasal outcome Test-22; sQOD-NS, brief (short) version of the Questionnaire of Olfactory Disorders- Negative Statements; EQ-5D-5L, EuroQol 5-Dimension 5-Level; n, number; SD, standard deviation; IQR, interquartile range; OD, olfactory dysfunction.

Table 3. Spearman correlation coefficients between self-MOQ score and either TDI or OF-VAS score.

	self-MOQ score and TDI score ρ (p-value)	self-MOQ score and OF-VAS score (T3) ρ (p-value)
all	-0.372 (<0.001)	-0.51 (<0.001)
female	-0.309 (<0.001)	-0.511 (<0.001)
male	-0.449 (<0.001)	-0.514 (<0.001)
tested OD	-0.361 (<0.001)	-
no tested OD	-0.11 (p=0.43)	-
subjective OD	-	-0.560 (<0.001)
no subjective OD	-	-0.285 (<0.001)

Self-MOQ, self-reported Mini Olfactory Questionnaire; OF, olfactory function; OD, olfactory dysfunction; TDI, threshold, discrimination, identification; OF-VAS, olfactory function-visual analogue scale

Table 4. Spearman correlation between questionnaire-based measurements of QOL (lines) and OF (columns) [a].

	TDI score[b]	OF-VAS score (T3)[b]	Self-MOQ score[b]
sQOD-NS score	0.118 (0.179)	0.391 (<0.001)	-0.394 (<0.001)
SNOT-22 score	-0.77 (0.082)	-0.219 (<0.001)	0.188 (<0.001)
EQ-5D-5L index	0.008 (0.854)	0.085 (0.039)	-0.095 (0.024)
EQ-VAS score	0.041 (0.354)	0.143 (<0.001)	-0.086 (0.043)

[a]by means of Spearman's ρ rank correlation. [b]Spearman's ρ (p-value). TDI, Threshold, Discrimination, Identification; OF-VAS, olfactory function-visual analogue scale; Self-MOQ, self-reported Mini Olfactory Questionnaire; sQOD-NS, brief (short) version of the Questionnaire of Olfactory Disorders- Negative Statements; SNOT-22, sinonasal Outcome Test-22; EQ-5D-5L, EuroQol 5-Dimension 5-Level; EQ-VAS, EuroQol-Visual Analogue Scale.

higher than those without. Moreover, the TDI score was significantly associated with the question 12 score (ρ=-0.353, p< 0.001) (Figure S5). Of the SST scores, discrimination (Spearman ρ=-0.161, p<0.001), identification (ρ=-0.179, p<0.001) and the summary TDI (Spearman ρ=-0.155, p<0.001) were correlated with the nasal subdomain score (Figure 2).

Like the sQOD-NS, the overall SNOT-22 scores are associated only with subjective but not with tested OF and OD, whereas olfaction related subscores correlate with both, subjective and tested OF and OD.

Self-MOQ and SNOT-22

A significant correlation between the self-MOQ and SNOT-22 scores was noted in all participants combined (Spearman ρ=0.188, p< 0.001) (Table 4). Along the same vein, participants with subjective OD alone also showed a significant correlation between the self-MOQ and SNOT-22 score in all participants (ρ=0.146, p=0.026) as well as in women (ρ=0.171, p=0.04)

EQ-5D-5L and EQ-VAS

A total of 592 participants with a median age of 51.0 years (IQR: 34.0 to 58.75) completed the EQ-5D-5L. Of these, 331 (55.9%) were female and 261 (44.1%) were male, and a significant sex difference was observed in terms of the median EQ-5D-5L index (z=-4.953, p<0.001) (Table 2).

No significant difference between participants with or without

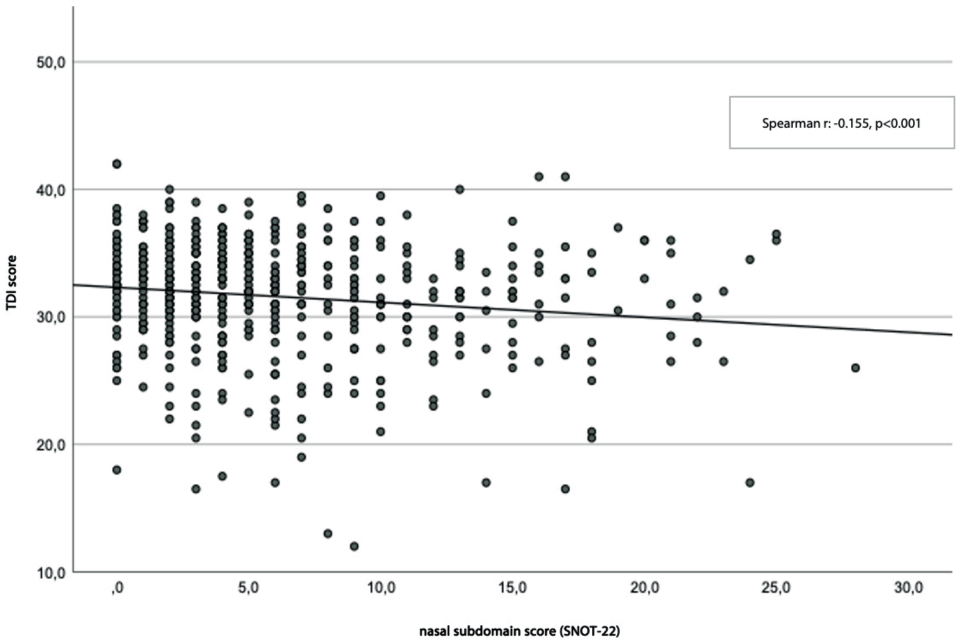


Figure 2. Correlation between TDI score and nasal subdomain score of the SNOT-22 (questions 1-7, 11, 12).

tested OD was found, neither for the median EQ-5D-5L index (z=-0.249, p=0.804) nor for the EQ-VAS score (z=-1.144, p= 0.252). On the contrary, participants with subjective OD had a significantly lower EQ-5D-5L index (z=-3.813, p<0.001) and EQ-VAS score (z=-3.968, p<0.001) than participants without subjective OD (Table 2).

Correlation between questionnaires on QoL and OF

None of the four questionnaires assessing QoL was significantly correlated with the TDI score, reflecting tested OF, but with the OF-VAS and self-MOQ score, both displaying subjective OF. Detailed results of spearman correlation can be found in Table 4.

Discussion

Objectives of the study

The self-MOQ, a previously validated screening tool for OD in clinical settings [20], was found to be significantly correlated with both subjective and objectively tested OF, and with three questionnaires on QoL (sQOD-NS, SNOT-22, EQ-5D-5L). This reaffirms the possible role of the self-MOQ as an easy-to-use tool to screen OD in former COVID-19 patients.

In addition, our study underlines the negative impact of subjective OD, as measured by the OF-VAS score, on participants' QoL several months after SARS-CoV-2 infection. Irrespective of whether olfactory-related aspects (sQOD-NS), sinonasal manifestation (SNOT-22) or overall health-related problems (EQ-5D-5L) were put into focus, the subjective experience of OD significantly influenced the overall well-being and, hence, the perceived QoL of study participants.

Relationship between OF and age or sex

Several studies have highlighted a decrease of general OF with age [20,28,29] that may be related to a reduced number of fibers in the olfactory bulb or olfactory receptor neurons [30–32]. Our study, though, did not find any correlation between age and OF when assessed by the self-MOQ in COVID-19. Moreover, neither study revealed an influence of sex on self-MOQ-assessed OF.

Relationship between QoL and age or sex

In the present study, no significant correlation was observed between sQOD-NS-based QoL and age or sex. Similarly, in a previous study of 205 patients with impaired OF, the sQOD-NS scores were not significantly higher in women than in men [33]. Regarding the SNOT-22, our study revealed a significantly worse QoL in women, which is in line with early findings [34–37]. No association between age and the SNOT-22 score was observed in 879 chronic rhinosinusitis (CRS) patients with post-endoscopic sinus surgery [38]. In a retrospective analysis of 403 adults with CRS post-endoscopic sinus surgery, the baseline SNOT-22 score changed significantly with age, with elderly patients (>60 years) reporting the lowest symptom burden and middle-aged patients (40-59 years) reporting the highest [39].

Self-MOQ as a screening tool for OD

We observed a strong correlation of the self-MOQ score with both, questionnaire-based subjective OF and SST-based tested OF. This result is in agreement with an association, previously reported in 285 patients with subjective OD [20], between the self-MOQ and both, the TDI score and its component subtest scores. The self-MOQ was also found to be correlated with OF in a small sample of SARS-CoV-positive/negative individuals examined 8 days after testing [40]. Our study, however, covers a much longer follow up. Finally, a significant negative correlation between the self-MOQ score and PCT was observed suggesting that the improvement of OF depends upon the time that elapsed since positive PCR testing. Although Zou et al. [20] did not observe a significant correlation between self-MOQ and the duration of illness in 285 patients with non-COVID-19-related subjective OD [20], COVID-19-associated OD appears to be well reflected by the self-MOQ during the full course of disease. The self-MOQ therefore suggests itself as a sufficient and efficient tool to screen for OD in COVID-19 patients.

Impact on QoL and relationship between OF and QoL

sQOD-NS

Although not statistically significant, a clear trend towards lower sQOD-NS scores, and hence poorer QoL, became apparent in our study among participants with tested OD. This is in agreement with a significant but weak correlation between the sQOD-NS and TDI scores of 205 patients with subjective changes in OF [33]. Additionally, lower sQOD-NS scores in participants with subjective OD were observed, which is in line with a study of over 1000 COVID-19 patients assessed 2 weeks after infection [41]. Our findings also fit with the observation of average sQOD-NS scores of 12.0 in 195 patients with subjectively resolved OD 9.5 months after the onset of COVID-19 symptoms, but only 10.7 in 93 patients with persistent subjective OD [42]. This trend compares well to our data even though the absolute sQOD-NS scores were lower. Better overall QoL in our study's participants could be attributed to several cohort-specific factors including lower age (47.6 vs 50.4 years).

SNOT-22

Adopting the MMS classification of the SNOT-22 score [25], participants in the present study experienced only a mild impact upon QoL, whereas a moderate impact was seen in those with tested or subjective OD. Dejaco et al. [24] observed a mean SNOT-22 score of 38.0 in 134 CRS patients [24] while Mattos et al. [43] similarly reported a mean of 46.5 in their study of 109 CRS patients [43]. Both results reflect a moderate impact of CRS upon QoL that is broadly comparable to the effect of OD in COVID-19 patients. One possible explanation for a higher SNOT-22 score in CRS might be the lack of morphological changes in the nasal cavity after SARS-CoV-2 infection [15].

Similar to the above results, but based upon a 10 times smaller cohort, Pendolino et al. found symptomatic patients with COVID-19-related OD to have a mean SNOT-22 score of 23 over 1 year after infection [44]. Moreover they outlined that patients with dysosmia scored significantly higher in the psychological subdomain and in question 12, but not in the nasal subdomain of SNOT-22 [44]. Although our study revealed a significant association of the nasal subdomain with both tested and subjective OD, lower scores in question 12 of the SNOT-22 were noted in participants with subjective or tested OD, which is in line with Pendolino et al. [44]. Notably, a small study of SARS-CoV-2 positive and negative patients examined 8 days after testing also yielded significantly worse scores for question 12 in the positive group [40].

The minimal clinically important difference (MCID) for total SNOT-22 scores in patients with CRS after endoscopic sinus surgery (ESS) was set before at 9.0 [45]. In our study, this MCID was not reached, neither when comparing participants with and without tested OD (21.3 vs 18.9) nor between those with and without subjective OD (24.3 vs 16.7). However, in another study of 247 CRS patients undergoing medical management [46], subjective improvement of symptoms was reported only upon improvement of the SNOT-22 nasal domain, irrespective of the MCID. This observation further supports our finding that the SNOT-22 nasal subdomain is a decisive determinant of QoL in COVID-19 patients.

In summary, patients reporting OD in COVID-19 are more likely to have higher SNOT-22 scores, and worse nasal subdomain scores, indicating reduced QoL.

EQ-5D-5L

In our study, female COVID-19 patients reported lower EQ-5D-5L scores than males, which is in agreement with earlier reports [26]. Notably, while the OF-VAS score was significantly correlated with the EQ-5D-5L score in our study, no such link was found between EQ-5D-5L and TDI.

For a better understanding, the EQ-5D-5L index of participants with subjective OD (0.86) is comparable to those of patients with migraine (0.892) [47] highlighting the extent of the burden and the negative impact of OD on QoL.

Strengths and limitations

Our study, in which a huge number of both symptomatic and asymptomatic post-COVID-19 patients were examined on a population-based manner, provides a good overall picture of the impact of COVID-19 on the quality of life.

A "motivational" bias is often difficult to avoid in studies of this type. However, the participants in our study were recruited early in the pandemic, so a key motivation could be an interest in being part of the group of people who find answers in the catastrophic infection situation. The discrepancy between subjectively observed odor function and measured odor function is a well-known but not well explained phenomenon in chemosensory science.

Our study also has some limitations with potential impact upon the validity of our findings, namely the absence of an objective method to quantify OD (e.g. functional MRI) and the reduced number of participants completing the sQOD-NS (owing to the entry question used). Furthermore, our investigation revealed a disparity between subjectively reported OD and tested OD. This disparity adds more complexity to the evaluation of OF after COVID-19.

Conclusion

Our study revealed that the self-MOQ is a sufficient, easy-to-use, time- and resource-efficient tool to screen for OD in COVID-19 patients at about 9 months after the original infection. Patients with subjective olfactory problems by that time are more likely to have worse QoL related to olfactory (sQOD-NS), sinonasal (SNOT-22) and general health aspects of well-being (EQ-5D-5L).

Abbreviations

COVID-19: coronavirus disease 2019; CRS: chronic rhinosinusitis; EQ-5D-5L: EuroQoL 5-Dimension 5-Level; EQ-VAS: EuroQoL-VAS; MCID: minimal clinically important difference; OF: olfactory function; OD: olfactory dysfunction; PCR: polymerase chain reaction; PCT: Post COVID time; QoL: quality of life; SST: Sniffin' Sticks Test; SARS-CoV-2: severe acute respiratory syndrome coronavirus type 2; SD: standard deviation; self-MOQ: self-reported Mini Olfactory Questionnaire; sQOD-NS: brief (short) version of the Questionnaire of Olfactory Disorders- Negative Statements; SNOT-22: sinonasal outcome Test-22; T1: time period before SARS-CoV-2 infection; T2: time period of acute SARS-CoV-2 Infection; T3: time of examination; VAS: visual analogue scale.

Author contributions

Conceptualization: SW, WL, SSc,TB, ML; Data Curation: SW, CM, AH, KF, AKR, DP, MK, WL, SSc, TB, ML; Formal Analysis: SW, CM, AH, KF, AKR, DP, MK, WL, SSc, TB, ML; Funding Acquisition: AP, PS, SSt, FAP, MW, ML; Investigation: SW, AK, BV, ML, Methodology: SW, MAN, CM, AH, KF, AKR, DP, MK, WL, SSc, TB, ML; Project Administration: MK, ML; Resources: CM, AH, KF, AKR, DP, MK, WL, SSt, FAP, MW, TK, MK, WL, SSc, TB, ML; Software, Supervision: CM, AH, KF, AKR, DP, MK, ML; Validation: SW, CM, AH, KF, AKR, DP, MK, ML; Visualization: ML; Writing: SW, MAN, AK, BV, NB, MK; Writing – Review & Editing: SW, MAN, AP, PS, CM, AH, KF, AKR, DP, SSt, FAP, MW, TK, MK, WL, SSc, TB, ML.

Acknowledgments

We express our deep gratitude to all COVIDOM study participants. We also thank the COVIDOM team at the University Hospital Schleswig-Holstein Campus Kiel, Germany, for their ceaseless support in terms of study logistics, contact management, and data acquisition, particularly Jana Enderle, Irene Lehmann, Lennart Reinke and Lukas Tittmann, University Hospital Schleswig-Holstein Kiel, Kiel, Germany. It has been a great pleasure to collaborate with Thomas Hummel, Smell & Taste Clinic, Department of Otorhinolaryngology, TU Dresden, Germany, to whom we are most grateful for useful discussion.

We are indebted to the NAPKON infrastructure for making COVIDOM possible, particularly the Interaction Core Unit (ICU), the Epidemiological Core Unit (ECU), the NAPKON steering committee and the NAPKON use and access committee:

1. Lilian Krist and Julia Fricke, Institute for Social Medicine, Epidemiology and Health Economics, Charité-Universitätsmedizin Berlin, Berlin, Germany.
2. Jens-Peter Reese, Institute of Clinical Epidemiology and Biometry, University of Würzburg, Würzburg, Germany.
3. Peter Heuschmann, Institute of Clinical Epidemiology and Biometry, University of Würzburg, Germany and Department Internal Medicine I, University Hospital Würzburg, Würzburg, Germany.
4. University Hospital Frankfurt, Frankfurt (Appel K), University Medicine Greifswald, Greifswald (Bahls T), University of Würzburg, Würzburg (Bauer C), University Hospital Cologne, Cologne (Brechtel M), University Medicine Göttingen, Göttingen (Chaplinskaya I), University of Würzburg, Würzburg (Fiessler C), University Hospital Cologne, Cologne (Fuhrmann S), University of Würzburg, Würzburg (Goester M), University of Würzburg, Würzburg (Grau A), University Medicine Göttingen, Göttingen (Hanß S), German Center for Cardiovascular Diseases (DZHK), Berlin (Hoffmann J), University Medicine Greifswald, Greifswald (Hoffmann W), University Hospital Cologne, Cologne (Hopff SM), University of Würzburg, Würzburg (Jiru-Hillmann S), University of Würzburg, Würzburg (Kammerer K), University of Würzburg, Würzburg (Kohls M), Helmholtz Center Munich, Munich (Kraus M), University Medicine Göttingen, Göttingen (Krefting D), University Hospital Cologne, Cologne (Lee C), Charité - Universitätsmedizin Berlin, Berlin (Lorbeer R), University of Würzburg, Würzburg (Miljukov O), University Medicine Greifswald, Greifswald (Nauck M), University Hospital Cologne, Cologne (Nunnendorf M), University Medicine Göttingen, Göttingen (Pape C), University Medicine Greifswald, Greifswald (Schäfer C), Charité - Universitätsmedizin Berlin, Berlin (Schaller J), University Medicine Greifswald, Greifswald (Schattschneider M), University Hospital Cologne, Cologne (Schmidt Ibanez C), University Hospital Frankfurt, Frankfurt (Schneider J), University Medicine Greifswald, Greifswald (Stahl D), University of Würzburg, Würzburg (Ungethuem K), University Medicine Greifswald, Greifswald (Valtentin H), University Hospital Cologne and University Hospital Frankfurt, Cologne and Frankfurt (Vehreschild J), University Hospital Giessen and Marburg, Giessen (Herold S), Charité - Universitätsmedizin Berlin, Berlin (Heyder R), Hannover Unified Biobank, Hannover Medical School, Hannover (Illig T), Robert Koch Institute, Department of Epidemiology and Health Monitoring, Berlin (Neuhauser H), Jena University Hospital, Jena (von Lilienfeld-Toal M), University Medicine Göttingen, Göttingen (Blaschke S), Lahn-Dill-Clinics, Wetzlar (Ellert C), LMU Clinic, Ludwig-Maximilians University of Munich, Munich (Frank S), University Hospital Schleswig-Holstein, Kiel (Friedrichs A), Uni-

versity Hospital Würzburg, Würzburg (Meybohm P), LMU Clinic, Ludwig-Maximilians University of Munich, Munich (Milger K), University Medicine Oldenburg, Oldenburg (Petersmann A), University Hospital, Technical University Munich , Munich (Schmidt G), University Hospital Essen, Essen (Witzke O).

Conflict of interest

The authors have no conflicts of interest to disclose. Several authors declare the receipt of grants, royalties or licenses, fees for consultation, honoraria for lectures or presentations, payment for expert testimony, support for attending meetings, and other financial activities during the past 36 months. These are not however in conflict with the present work.

Funding

No Funding

References

1. Miwa T, Furukawa M, Tsukatani T, Costanzo RM, DiNardo LJ, Reiter ER. Impact of olfactory impairment on quality of life and disability. Arch Otolaryngol Neck Surg. 2001 May 1;127(5):497–503.
2. Stevenson RJ. An initial evaluation of the functions of human olfaction. Chem Senses. 2010 Jan 1;35(1):3–20.
3. Temmel AFP, Quint C, Schickinger-Fischer B, Klimek L, Stoller E, Hummel T. Characteristics of olfactory disorders in relation to major causes of olfactory loss. Arch Otolaryngol Neck Surg. 2002 Jun 1;128(6):635–41.
4. Blomqvist EH, Brämerson A, Stjärne P, Nordin S. Consequences of olfactory loss and adopted coping strategies. Rhinology. 2004 Dec;42(4):189-94.
5. Ferris AM, Duffy VB. Effect of olfactory deficits on nutritional status: does age predict persons at risk? Ann N Y Acad Sci. 1989;561(1):113–23.
6. Nordin S, Hedén Blomqvist E, Olsson P, Stjärne P, Ehnhage A. Effects of smell loss on daily life and adopted coping strategies in patients with nasal polyposis with asthma. Acta Otolaryngol (Stockh). 2011 Aug 1;131(8):826–32.
7. Bratman GN, Bembibre C, Daily GC, et al. Nature and human well-being: the olfactory pathway. Sci Adv. 2024 May 17;10(20):eadn3028.
8. Patel ZM, Holbrook EH, Turner JH, et al. International consensus statement on allergy and rhinology: Olfaction. Int Forum Allergy Rhinol. 2022 Apr;12(4):327–680.
9. Haehner A, Draf J, Dräger S, de With K, Hummel T. Predictive value of sudden olfactory loss in the diagnosis of COVID-19. ORL. 2020;82(4):175–80.
10. Lechien JR, Chiesa-Estomba CM, Place S, et al. Clinical and epidemiological characteristics of 1420 European patients with mild-to-moderate coronavirus disease 2019. J Intern Med. 2020 Sep;288(3):335–44.
11. Luers JC, Rokohl AC, Loreck N, et al. Olfactory and gustatory dysfunction in coronavirus disease 19 (COVID-19). Clin Infect Dis Off Publ Infect Dis Soc Am. 2020 May 1;ciaa525.
12. Niklassen AS, Draf J, Huart C, et al. COVID-19: recovery from chemosensory dysfunction: a multicentre study on smell and taste. The Laryngoscope. 2021;131(5):1095–100.
13. Parma V, Ohla K, Veldhuizen MG, et al. More than smell – COVID-19 is associated with severe impairment of smell, taste, and chemesthesis. Chem Senses. 2020 Jun 20;bjaa041.
14. Wu D, Wang VY, Chen YH, Ku CH, Wang PC. The prevalence of olfactory and gustatory dysfunction in COVID-19 - A systematic review. Auris Nasus Larynx. 2022 Apr 1;49(2):165–75.
15. Winkelmann S, Korth A, Voss B, et al. Persisting chemosensory dysfunction in COVID-19 - a cross-sectional population-based survey. Rhinol J. 2022 Oct 27;0(0):0–0.
16. Malaty J, Malaty IAC. Smell and taste disorders in primary care. Am Fam Physician. 2013 Dec 15;88(12):852–9.
17. Hummel T, Podlesek D. Clinical assessment of olfactory function. Chem Senses. 2021 Jan 1;46:bjab053.
18. Rouadi PW, Idriss SA, Bousquet J. Olfactory and taste dysfunctions in COVID-19. Curr Opin Allergy Clin Immunol. 2021 Jun 1;21(3):229-244.
19. Oleszkiewicz A, Schriever VA, Croy I, Hähner A, Hummel T. Updated Sniffin' Sticks normative data based on an extended sample of 9139 subjects. Eur Arch Otorhinolaryngol. 2019 Mar;276(3):719–28.
20. Zou L, Linden L, Cuevas M, et al. Self-reported mini olfactory questionnaire (Self-MOQ): A simple and useful measurement for the screening of olfactory dysfunction. Laryngoscope. 2020 Dec;130(12):E786-E790.
21. Mattos JL, Edwards C, Schlosser RJ, et al. A brief version of the questionnaire of olfactory disorders in patients with chronic rhinosinusitis. Int Forum Allergy Rhinol. 2019 Oct;9(10):1144–50.
22. Albrecht T, Beule AG, Hildenbrand T, et al. Cross-cultural adaptation and validation of the 22-item sinonasal outcome test (SNOT-22) in German-speaking patients: a prospective, multicenter cohort study. Eur Arch Otorhinolaryngol. 2022 May;279(5):2433–9.
23. Baumann I, Plinkert PK, De Maddalena H. Entwicklung einer Bewertungsskala für den Sino-Nasal Outcome Test-20 German adapted Version (SNOT-20 GAV). HNO. 2008 Aug;56(8):784–8.
24. Dejaco D, Riedl D, Huber A, et al. The SNOT-22 factorial structure in European patients with chronic rhinosinusitis: new clinical insights. Eur Arch Otorhinolaryngol. 2019 May;276(5):1355–65.
25. Toma S, Hopkins C. Stratification of SNOT-22 scores into mild, moderate or severe and relationship with other subjective instruments. Rhinology 2016 Jun 1;54(2):129–33.
26. Huber M, Felix J, Vogelmann M, Leidl R. Health-related quality of life of the general German population in 2015: results from the EQ-5D-5L. Int J Environ Res Public Health. 2017 Apr 16;14(4):426.
27. Feng YS, Kohlmann T, Janssen MF, Buchholz I. Psychometric properties of the EQ-5D-5L: a systematic review of the literature. Qual Life Res. 2021 Mar;30(3):647–73.
28. Hummel T, Kobal G, Gudziol H, Mackay-Sim A. Normative data for the "Sniffin' Sticks" including tests of odor identification, odor discrimination, and olfactory thresholds: an upgrade based on a group of more than 3,000 subjects. Eur Arch Otorhinolaryngol. 2007 Mar 1;264(3):237–43.
29. Masala C, Cavazzana A, Sanna F, et al. Correlation between olfactory function, age, sex, and cognitive reserve index in the Italian population. Eur Arch Otorhinolaryngol. 2022 Oct;279(10):4943–52.
30. Boyce JM, Shone GR. Effects of ageing on smell and taste. Postgrad Med J. 2006 Apr;82(966):239–41.
31. Buschhüter D, Smitka M, Puschmann S, et al. Correlation between olfactory bulb volume and olfactory function. NeuroImage. 2008 Aug 15;42(2):498–502.
32. Doty RL, Shaman P, Applebaum SL, Giberson R, Siksorski L, Rosenberg L. Smell identification ability: changes with age. Science. 1984 Dec 21;226(4681):1441–3.
33. Frasnelli J, Hummel T. Olfactory dysfunction and daily life. Eur Arch Otorhinolaryngol. 2005 Mar;262(3):231–5.
34. Klopfenstein T, Kadiane-Oussou NJ, Toko L, et al. Features of anosmia in COVID-19. Med Mal Infect. 2020 Aug;50(5):436–9.
35. Lechien JR, Chiesa-Estomba CM, De Siati DR, et al. Olfactory and gustatory dysfunctions as a clinical presentation of mild-to-moderate forms of the coronavirus disease (COVID-19): a multicenter European study. Eur Arch Otorhinolaryngol. 2020;277(8):2251–61.
36. Lee DY, Lee WH, Wee JH, Kim JW. Prognosis of postviral olfactory loss: follow-up study for longer than one year. Am J Rhinol Allergy. 2014;28(5):419–22.
37. Meini S, Suardi LR, Busoni M, Roberts AT,

Fortini A. Olfactory and gustatory dysfunctions in 100 patients hospitalized for COVID-19: sex differences and recovery time in real-life. Eur Arch Otorhinolaryngol. 2020;277(12):3519–23.
38. Soler ZM, Jones R, Le P, et al. SNOT-22 Outcomes after sinus surgery: a systematic review and meta-analysis. Laryngoscope. 2018 Mar;128(3):581–92.
39. Yancey KL, Lowery AS, Chandra RK, Chowdhury NI, Turner JH. Advanced age adversely affects chronic rhinosinusitis surgical outcomes. Int Forum Allergy Rhinol. 2019 Oct;9(10):1125–34.
40. Rubel K, Sharma D, Campiti V, et al. COVID-19 status differentially affects olfaction: a prospective case-control study. OTO Open. 2020 Oct;4(4):2473974X2097017.
41. Ninchritz-Becerra E, Soriano-Reixach MM, Mayo-Yánez M, et al. Subjective evaluation of smell and taste dysfunction in patients with mild COVID-19 in Spain. Med Clin (Barc). 2021 Jan 22;156(2):61-64.
42. Tipirdamaz C, Zayet S, Osman M, et al. Asthma and cacosmia could be predictive factors of olfactory dysfunction persistence 9 months after SARS-CoV-2 infection: the ANOSVID study. Life. 2022 Jun 21;12(7):929.
43. Mattos JL, Schlosser RJ, Storck KA, Soler ZM. Understanding the relationship between olfactory-specific quality of life, objective olfactory loss, and patient factors in chronic rhinosinusitis: Relationship between olfactory quality of life and objective smell loss. Int Forum Allergy Rhinol. 2017 Jul;7(7):734–40.
44. Pendolino AL, Tan HQM, Choi D, Ottaviano G, Andrews PJ. Long-term quality-of-life impairment in patients with more than 1-year COVID-19–related olfactory dysfunction. Int Forum Allergy Rhinol. 2022 Aug 23;alr.23071.
45. Hopkins C, Gillett S, Slack R, Lund VJ, Browne JP. Psychometric validity of the 22-item Sinonasal Outcome Test. Clin Otolaryngol. 2009;34(5):447–54.
46. Phillips KM, Hoehle LP, Caradonna DS, Gray ST, Sedaghat AR. Determinants of noticeable symptom improvement despite sub-MCID change in SNOT-22 score after treatment for chronic rhinosinusitis. Int Forum Allergy Rhinol. 2019;9(5):508–13.
47. Domitrz I, Golicki D. Health-related quality of life in migraine: EQ-5D-5L-based study in routine clinical practice. J Clin Med. 2022 Nov 24;11(23):6925.

Prof. Martin Laudien
Department of Otorhinolaryngology
Head and Neck Surgery
Arnold-Heller-Str.3
Haus B1
24105 Kiel
Germany

Tel: +49 431 50021701
Fax: +49 431 500 21704
E-mail: martin.laudien@uksh.de

Sanja Winkelmann[1,*], Maher Abou Nasr[1,*], Alia Korth[1], Bettina Voss[1], Naomi Behrend[1], Annett Pudszuhn[2], Philipp Schendzielorz[3], Corina Maetzler[4], Anne Hermes[5], Katrin Franzpoetter[5], Anne-Kathrin Ruß[6], Daniel Pape[7], Stefan Störk[8], Felipe A. Montellano[9,10], Martin Witzenrath[11], Thomas Keil[9,12,13], Michael Krawczak[6], Wolfgang Lieb[5], Stefan Schreiber[7], Thomas Bahmer[7,14], Martin Laudien[1], on behalf of the NAPKON study group

Rhinology 64: 4, 0 - 0, 2026
https://doi.org/10.4193/Rhin24.174

Received for publication:
April 23, 2024
Accepted: February 25, 2026

[1] Department of Otorhinolaryngology, Head and Neck Surgery, Kiel University, University Medical Centre Schleswig-Holstein, Kiel, Germany
[2] Department of Otorhinolaryngology, Head and Neck Surgery, Charité-Universitätsmedizin Berlin, Corporate Member of Freie Universität Berlin, Humboldt-Universität zu Berlin and Berlin Institute of Health, Campus Benjamin Franklin, Berlin, Germany
3 Department of Oto-Rhino-Laryngology, Plastic, Aesthetic and Reconstructive Head and Neck Surgery and the Comprehensive Hearing Center, University of Würzburg, Würzburg, Germany
[4] Neurology Department, University Medical Center Schleswig-Holstein Campus Kiel, Kiel, Germany
[5] Institute of Epidemiology, Kiel University, University Medical Center Schleswig-Holstein, Kiel, Germany
[6] Institute of Medical Informatics and Statistics, Kiel University, University Medical Centre Schleswig-Holstein, Kiel, Germany
[7] Internal Medicine Department I, University Medical Center Schleswig-Holstein Campus Kiel, Kiel, Germany
[8] Comprehensive Heart Failure Center and Dept. Internal Medicine I, University Hospital Würzburg, Würzburg, Germany
[9] Institute of Clinical Epidemiology and Biometry, University of Würzburg, Würzburg, Germany
[10] Department of Neurology, University Hospital Würzburg, Würzburg, Germany
[11] Department of Infectious Diseases and Respiratory Medicine, Charité – Universitätsmedizin Berlin, Corporate Member of Freie Universität Berlin and Humboldt-Universität zu Berlin, Berlin, Germany
[12] Institute of Social Medicine, Epidemiology and Health Economics, Charité-Universitätsmedizin Berlin, Berlin, Germany
[13] State Institute of Health I, Bavarian Health and Food Safety Authority, Erlangen, Germany
[14] German Center for Lung Research (DZL), Airway Research Center North (ARCN), Grosshansdorf, Germany

* equal contribution

Associate Editor:
Basile Landis

This manuscript contains online supplementary material

SUPPLEMENTARY MATERIAL

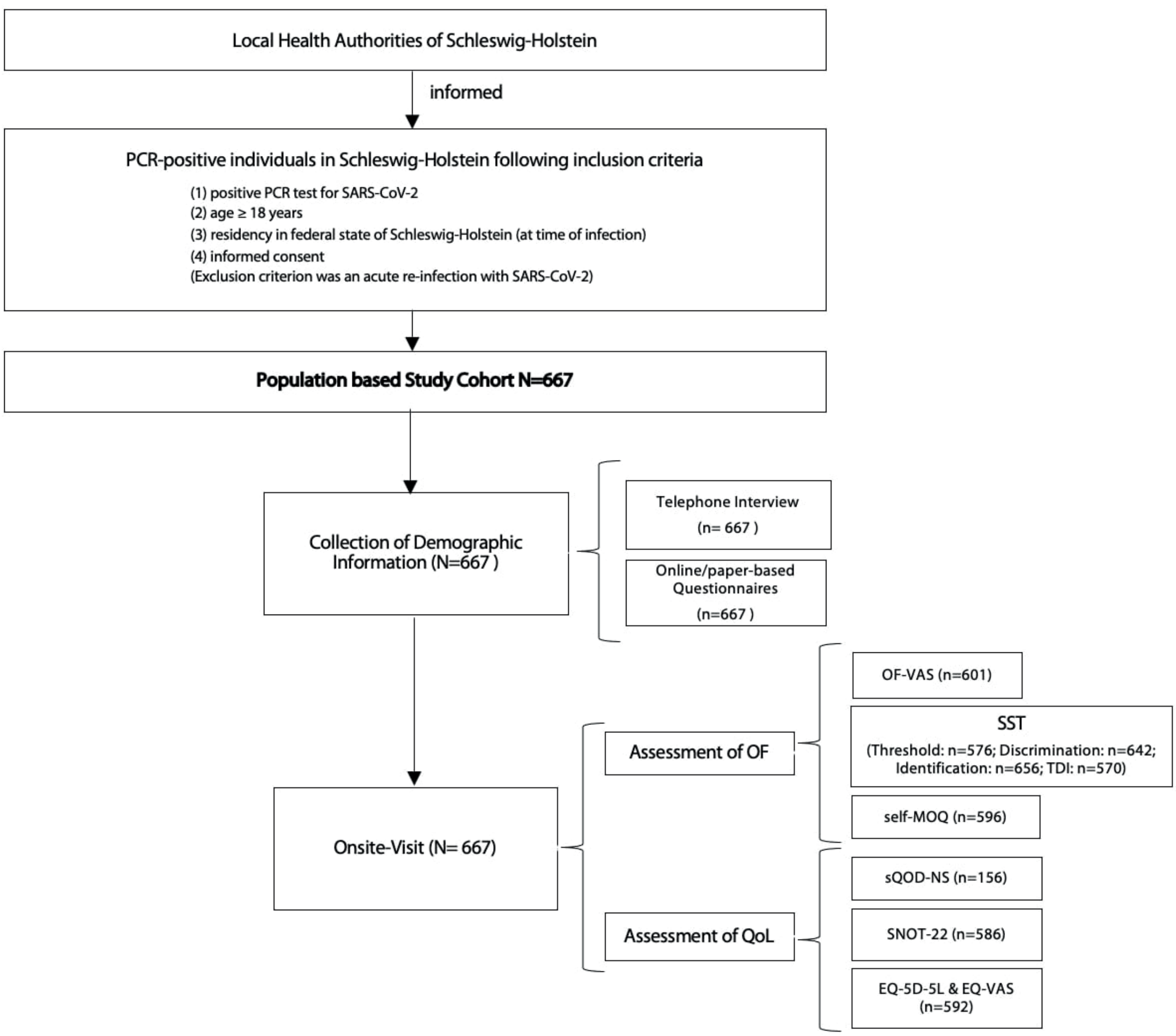


Figure S1. Process of participants' inclusion and examination.

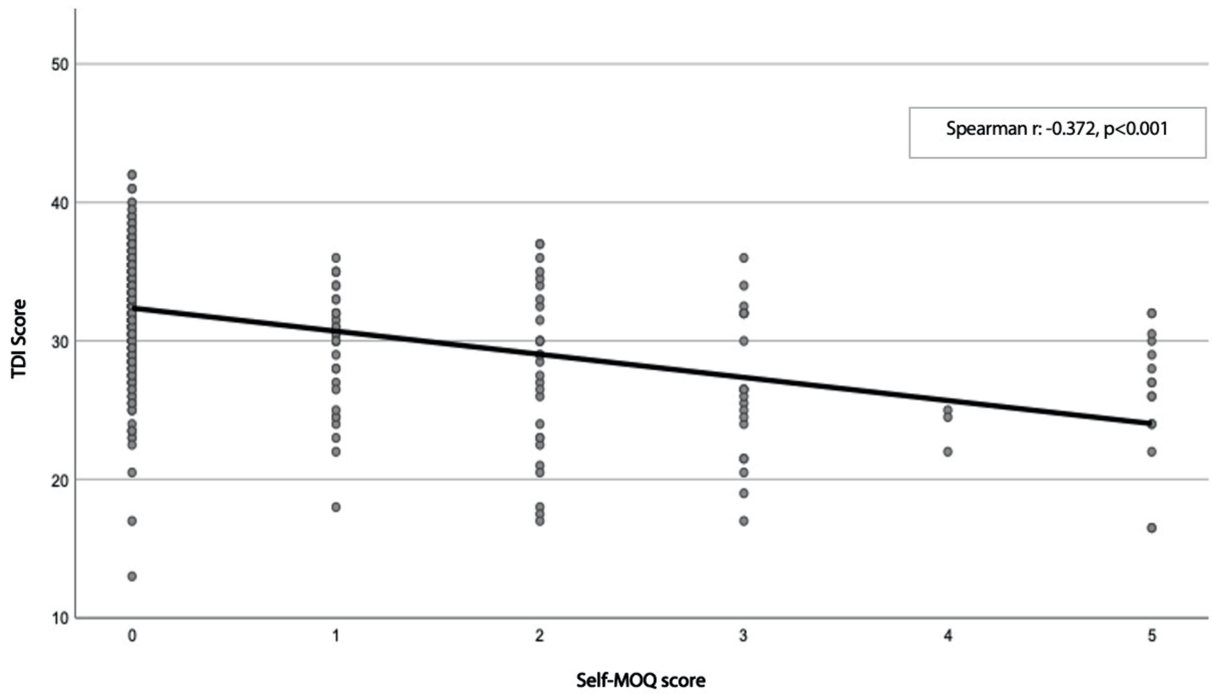


Figure S2. Correlation between TDI score and Self-MOQ score.

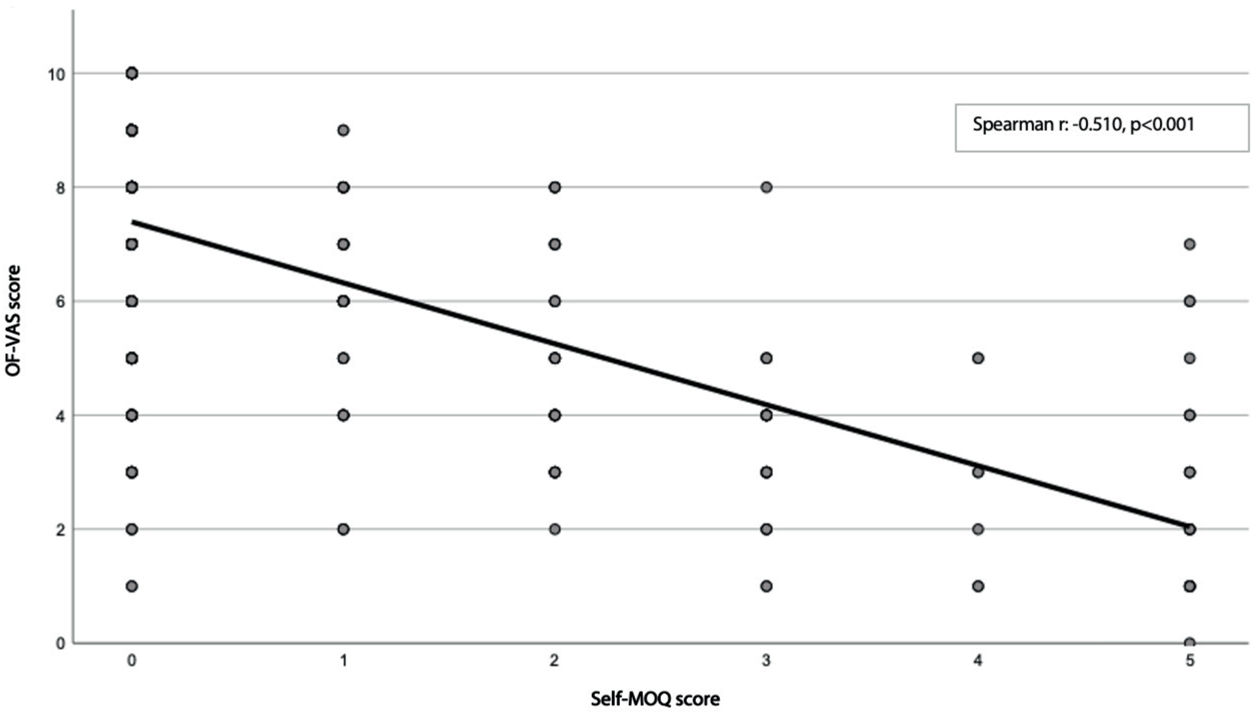


Figure S3. Correlation between OF-VAS score at T3 and Self-MOQ score.

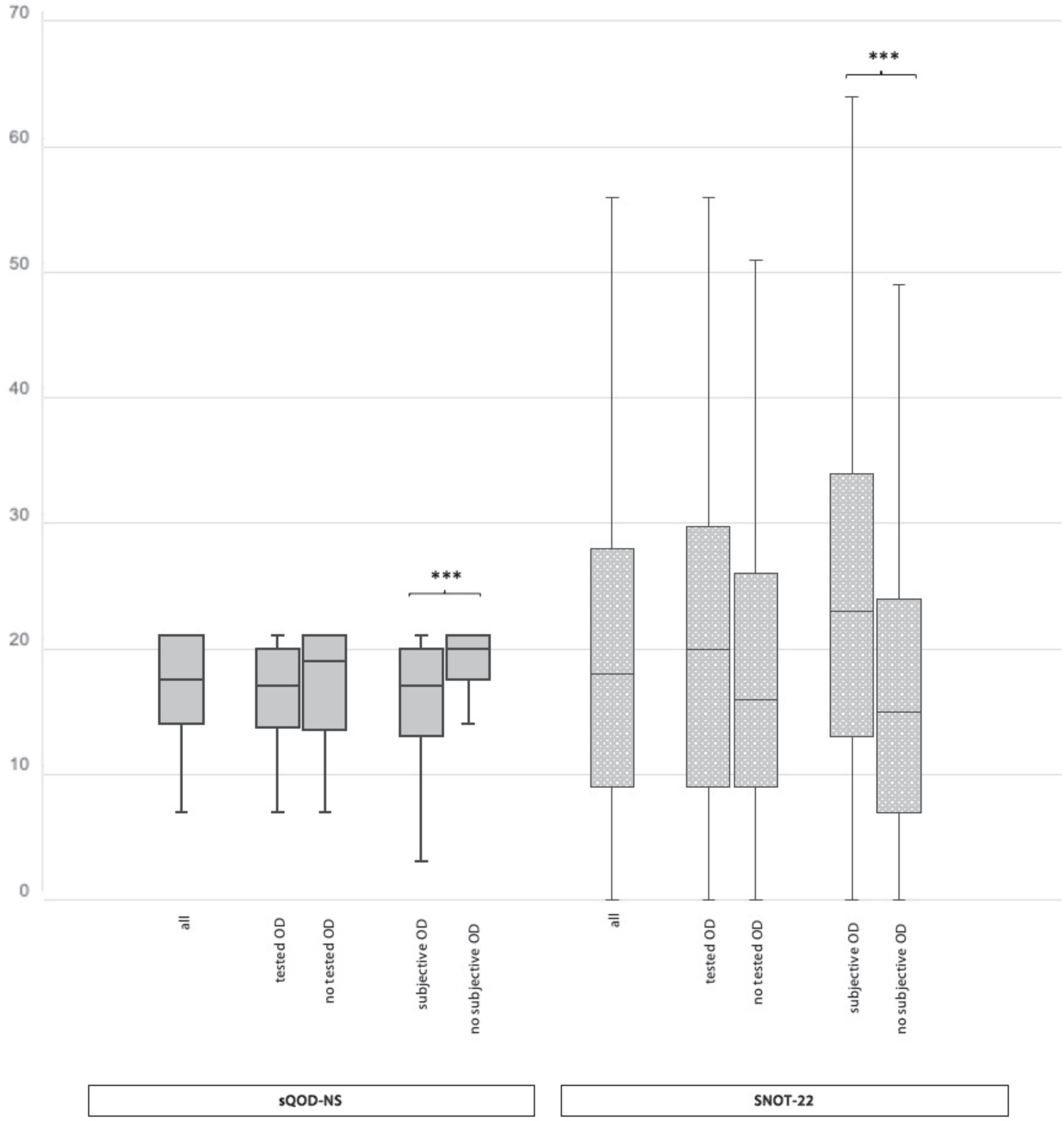


Figure S4. Median sQOD-NS and SNOT-22 scores with U test for group differences.

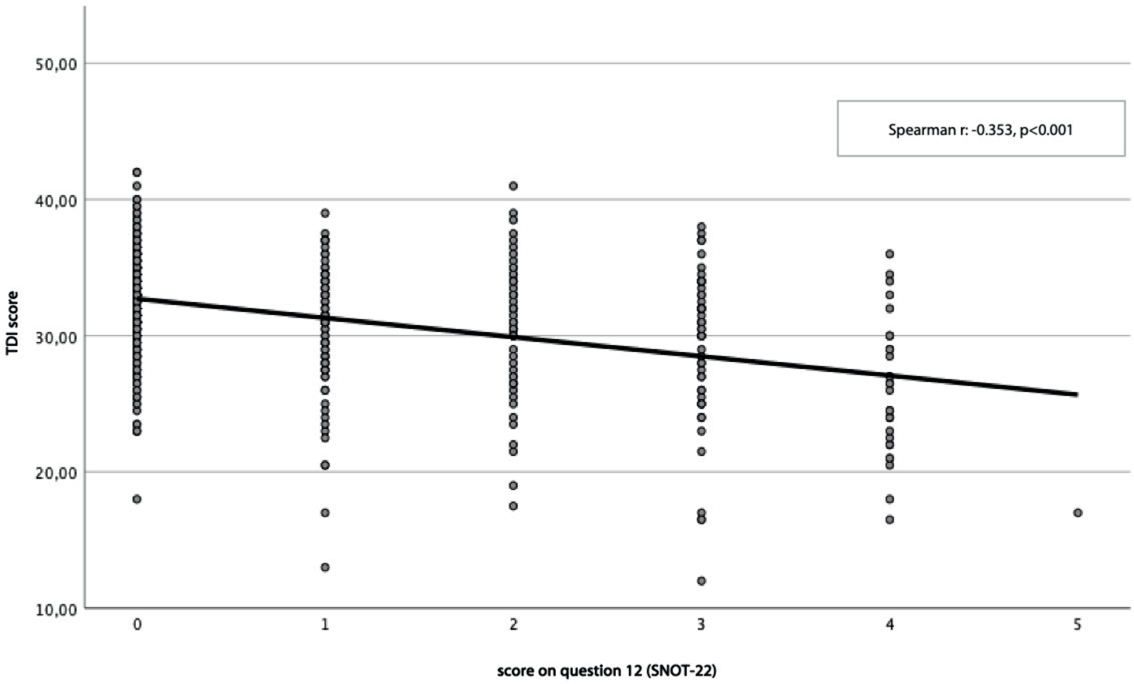


Figure S5. Correlation between TDI score and score on question 12 of the SNOT-22.