Reliability and validity of a brief version of the Questionnaire of Olfactory Disorders (brief QOD) in patients with olfactory dysfunction*

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Abstract

Background: The aim of this study was to determine the reliability and validity of the brief version of Questionnaire of Olfactory Disorders (brief QOD).

Methods: A total of 372 patients participated in this study. Olfactory function was examined using the Sniffin' Sticks test. The brief version of QOD, including 4 items concerning parosmia (QOD-P), 7 items concerning quality of life (QOD-QOL), and 3 visual analog scales to rate disease burden, awareness of the disorder and issues related to professional life (QOD-VAS), was used to assess subjective information on olfactory dysfunction. We evaluated the split-half reliability, internal consistency and validity of the brief QOD.

Results: The split-half reliability was 0.60 (QOD-P), 0.87 (QOD-QOL), and 0.66 (QOD-VAS), respectively. The Cronbach's α coefficient was 0.63 (QOD-P), 0.87 (QOD-QOL), and 0.71 (QOD-VAS), respectively. Olfactory function was found to be associated with QOD-P, QOD-QOL and QOD-VAS.

Conclusions: The brief QOD is a suitable scale for the assessment of subjective severity of olfactory dysfunction for purposes such as treatment counseling, disability assessment, treatment control, and research in patients with olfactory disorder.

Key words: questionnaire, olfactory disorders, quality of life, parosmia, reliability, validity

Introduction

In the general population, the prevalence of olfactory dysfunction is up to 22% depending on the population characteristics [(1)]. Olfactory dysfunction can be divided into quantitative (hyposmia or anosmia) and qualitative impairments (parosmia or phantosmia) [(2)]. Olfactory dysfunction may seriously decrease the quality of life, as olfaction plays an important role in many important areas such as food enjoyment, cooking, avoidance of danger, social interaction and working [(3,4)]. In order to provide a better treatment to this frequent disorder, it is important to measure and monitor the overall health status of this population.

Frasnelli and Hummel [(5)] developed the Questionnaire of Olfactory Disorders (QOD) as a self-report inventory that assesses subjective information on olfactory dysfunction. The QOD comprises four subscales: the 4-item parosmia scale (QOD-P), the 17-item quality of life scale (QOD-QOL), the 6-item socially desired scale ("lie scale", QOD-DS), and the 5-item visual analog scale (QOD-VAS). Due to its high degree of reliability and validity, the QOD is increasingly used by clinicians and researchers and has been translated into several languages including Chinese, English (UK and USA), Persian and Korean [(6–10)].

Although the original 32-item QOD has excellent psychometric properties, its utility as an evaluation tool in clinical and research settings is limited by its length. Previous studies suggested that the simplicity of questionnaires can increase response rates and

data quality [11,12]. Thus, in order for the QOD to have a broader clinical and research utility, it should be shorter. As an attempt to address this issue, Mattos and colleagues [13] developed a brief form of the QOD-QOL. It includes only 7 items and maintains consistency in measured olfactory-specific quality of life (QOL) with the 17-item QOD-QOL.

To date, there is extensive support for the validity of the QOD. Scores on the QOD-QOL have been found to be associated with olfactory function in patients with chronic rhinosinusitis and allergic rhinitis [14,15], post-traumatic brain injury [16], and in other patients [6–8]. In addition, Zou and colleagues [17] found that even if the measurable olfactory impairment seems to be similar, the olfactory-related QOL appears to differ among patients with different etiologies. However, Mattos and colleagues [13] only evaluated olfactory-related QOL in patients with chronic rhinosinusitis.

To the best of our knowledge, no published studies have examined the validity of the 7-item QOD-QOL in patients with different etiologies of olfactory dysfunction. In addition, Mattos and colleagues [13] only focused on the QOD-QOL, but did not include QOD-P and QOD-VAS. Evaluation of the psychometrics of these subscales appears useful for a better understanding of the patients' complaints. Therefore, the purpose of this study was to determine the psychometric properties of the short version QOD in relation to its various aspects.

Materials and methods

Patients

In this study 401 patients with subjective complaints of olfactory disorder were recruited from the Smell and Taste Clinic, Department of Otorhinolaryngology, University Hospital Dresden, Dresden, Germany. Of the 401 patients, 372 patients completed the olfactory function test and the QOD (or at least one subscale) in German language, who represented the study sample used for analyses. All of them were thoroughly examined by experienced otorhinolaryngologists. The etiologies of olfactory disorder were idiopathic (134 patients; 36.0%), post-infectious (111 patients; 29.8%), sinonasal (47 patients; 12.6%), post-traumatic (56 patients; 15.0%), neurodegenerative (6 patients; 1.6%), congenital (10 patients; 2.7%), toxic (5 patients; 1.3%), postoperative (1 patents; 0.3%), after stroke (1 patients; 0.3%) and other (1 patient; 0.3%). In addition, 30 patients (8.1%) complained about phantosmia, 25 patients (6.7%) had parosmia, three patients (0.8%) suffered from phantosmia and parosmia, two patients had phantogeusia (0.5%).

This retrospective study was approved by the Ethics committee of the Medical Faculty at the University of Dresden Medical School.

Materials

Sniffin' Sticks test

Olfactory function was evaluated by the Sniffin' Sticks test, containing olfactory threshold (T), discrimination (D) and identification (I) tests [18]. Score for the threshold test range between 1 and 16, while the scores of the other two tests range between 0 and 16. The results of the three tests were calculated as a total TDI score (range 1-48), which was used to define functional anosmia (TDI ≤ 16), hyposmia (16 < TDI < 31), or normosmia (TDI ≥ 31). If the patients had only been assessed by the identification test, the I score was used to define functional anosmia (I ≤ 8), hyposmia (8 < I ≤ 11), or normosmia (I > 11)[19].

Brief version Questionnaire of Olfactory Disorders

The brief version QOD was oriented according to the version of Mattos et al. [13]. It comprises two parts (Table 1). The first part includes 11 items with two subscales: 4 items concerning parosmia (QOD-P) and 7 items concerning quality of life (QOD-QOL). The 7 items of QOD-QOL are selected according to Mattos et al. [13]. For each item, patients could report on a scale from 0-3, indicating whether they fully agree (3), partly agree (2), partly disagree (1), or completely disagree (0), respectively. The QOD-P and QOD-QOL scores range from 0-12 and 0-21, respectively. The second part includes three visual analog scales (QOD-VAS) concerning degree of burden, frequency of awareness of the chemosensory disorder and degree of workspace issues related to olfactory dysfunction, respectively. Each item score ranges from 0-10 (10 cm VAS, with left hand end defined as "not at all" (0 units), and its right hand end as "very strong/very frequent" (10 units). For each subscale a higher score indicates a worse impairment.

Statistical analysis

All statistical analyses were performed using the IBM SPSS 23.0 (IBM Corp., Armonk, NY, USA). Split-half reliability and validity were determined using Pearson's correlation analyses. Internal consistency was determined using Cronbach's α coefficient. One-way analysis of variance (ANOVA), followed by Bonferroni post-hoc tests, were used to examine differences in the QOD subscale scores among patients with anosmia, hyposmia and normosmia. One-way ANOVAs, followed Bonferroni post-hoc tests, were also used to compare the QOD subscale scores between patients with or without parosmia. Finally, the Spearman's correlation coefficients between the QOD subscale scores and age or duration of illness were calculated. We also used One-way ANOVAs followed Bonferroni post-hoc tests to examine the differences in the QOD subscale scores in patients with different causes.

Results

Demographics

Among the 372 patients (220 female, 152 male), 14 patients only finished the odor identification test, while all others finished the

Table 1. The brief version of Questionnaire of Olfactory Disorders (brief QOD).

Part 1. Parosmia (P) and quality of life (QOL)

To each question, please check one of the following 4 answers: "agree", "agree partly", "disagree partly", and "disagree". This questionnaire aims to record your first spontaneous reaction to the questions. This is not a test you may fail or pass. Please make sure not to miss one of the questions!

No.	Items	Agree	Agree partly	Disagree partly	Disagree
P 1	Food tastes different than it used to before my accident.	3	2	1	0
P 2	Sometimes I think I can smell something bad, even when other people can't.	3	2	1	0
P 3	Some of the smells that I find unpleasant, other people find pleasant.	3	2	1	0
P 4	One of my biggest problems is that odours smell different to what they used to before my sense of smell changed.	3	2	1	0
QOL 1	Because of the changes in my sense of smell, I go to restaurants less often than I used to.	3	2	1	0
QOL 2	I am worried that I will never get used to the changes in my sense of smell.	3	2	1	0
QOL 3	Because of the changes in my sense of smell, I try harder to relax.	3	2	1	0
QOL 4	The changes in my sense of smell make me feel isolated.	3	2	1	0
QOL5	Because of the changes in my sense of smell I eat less than I used to or more than I used to.	3	2	1	0
QOL 6	Because of the changes in my sense of smell I have problems with taking part in activities of daily life.	3	2	1	0
QOL 7	The changes in my sense of smell make me feel angry.	3	2	1	0

Part 2. Visual analog scales (VAS)

VAS 1	Please use the scale below to rate how annoying the changes in your sense of smell are to you. Not at all ——— extremely
VAS 2	Please use the scale below to rate how often you become aware of the changes to your sense of smell Not at all ——— extremely
VAS 3	Please indicate on the scale below how severely the changes in your sense of smell affected your professional performance during the last month. Not at all ——— extremely

whole Sniffin' Sticks test. The demographics are shown in Table 2. The mean age was 57.4 ± 15.1 years. The duration of disorder was 36.4 ± 52.9 months. The mean scores of olfactory tests were as follows: 2.61 ± 2.21 (threshold), 8.51 ± 3.17 (discrimination), 8.26 ± 3.82 (identification) and 19.22 ± 7.74 (TDI). Based on the TDI or identification score, 149 patients (40.1%) were considered as functionally anosmic, 188 patients (50.5%) as hyposmic and 35 patients (9.4%) scored in the normosmia range, despite the presence of subjective complaints of olfactory dysfunction.

Reliability

Spearman–Brown split-half reliability and Cronbach's α coefficient were adopted for reliability analysis. The split-half reliability in all samples was 0.60 (QOD-P), 0.87 (QOD-QOL), and 0.66 (QOD-VAS), respectively. The Cronbach's α coefficient in all samples was 0.63 (QOD-P), 0.87 (QOD-QOL), and 0.71 (QOD-VAS), respectively. The reliabilities in the samples of individual causes are given in Table 3.

Validity

The QOD-P score was significantly correlated with olfactory discrimination ($r = 0.14$, $p = 0.012$) and TDI score ($r = 0.15$, $p = 0.007$)(Figure 1A), but not with olfactory threshold and identification (both $p > 0.05$). The QOD-QOL was significantly correlated with odor identification ($r = -0.11$, $p = 0.037$) (Figure 1C), but not with olfactory discrimination, threshold and TDI score (both $p > 0.05$). The QOD-VAS was significantly correlated with odor identification ($r = -0.17$, $p = 0.001$), discrimination ($r = -0.21$, $p < 0.001$), threshold ($r = -0.12$, $p = 0.035$) and TDI score ($r = -0.19$, $p = 0.001$) (Figure 1B).

Regarding the quantitative olfactory dysfunction, the one-way ANOVA results showed that QOD-P and QOD-VAS differed

Table 2. Patients' demographics.

Demographic	
Age (years; mean ± SD)	57.4 ± 15.1
Duration (months; mean ± SD)	36.4 ± 52.9
Sex [n(%)]	
Female	220 (59.2%)
Male	152 (40.9%)
Etiology [n(%)]	
Idiopathic	134 (36.0%)
Post-infectious	111 (29.8%)
Sinonasal	47 (12.6%)
Post-traumatic	56 (15.0%)
Neurodegenerative	6 (1.6%)
Congenital	10 (2.7%)
Toxic	5 (1.3%)
Postoperative	1 (0.3%)
Stroke	1 (0.3%)
Other	1 (0.3%)

Table 3. Reliability of the brief QOD subscales.

	QOD-P		QOD-QOL		QOD-VAS	
	Split-half	Cronbach's α	Split-half	Cronbach's α	Split-half	Cronbach's α
Idiopathic	0.51	0.60	0.87	0.87	0.68	0.76
Post-infectious	0.69	0.69	0.85	0.85	0.54	0.56
Sinonasal	0.61	0.56	0.86	0.85	0.79	0.77
Post-traumatic	0.51	0.54	0.87	0.88	0.49	0.50
Total sample	0.60	0.63	0.87	0.87	0.66	0.71

Notes: QOD-P: Questionnaire of Olfactory Disorders-parosmia; QOD-QOL: Questionnaire of Olfactory Disorders-quality of life; QOD-VAS: Questionnaire of Olfactory Disorders-visual analog scales.

significantly among anosmic, hyposmic and normosmic groups (QOD-P: $F(2, 354) = 3.87$, $p < 0.05$; QOD-VAS: $F(2, 317) = 9.24$, $p < 0.001$) (Figure 2A and 2C). Bonferroni post hoc testing revealed significantly higher QOD-P score in hyposmic group (4.04 ± 3.13) than anosmic (3.19 ± 2.81) and normosmic group (3.03 ± 2.84) (both $p < 0.05$). The QOD-VAS score in the normosmic group (12.29 ± 8.09) was lower than that one in anosmic (16.98 ± 7.82) and hyposmic (18.90 ± 7.47) groups (both $p < 0.05$). There was no statistically significant difference in QOD-QOL among anosmic, hyposmic and normosmic group ($F(2, 351) = 1.41$, $p > 0.05$) (Figure 2B).

Regarding the qualitative olfactory dysfunction, the sample size of OD patients who had both phantosmia and parosmia (3 patients) and those with phantogeusia (2 patients) was small, so we just compared the differences on QOD scores among patients with parosmia, phantosmia and patients without any qualitative olfactory symptoms. The one-way ANOVA results showed that QOD-P differed significantly among these three groups ($F(2, 349) = 20.6$, $p < 0.001$). Bonferroni post hoc analysis revealed that the QOD-P score in patients without any qualitative olfactory impairment (3.22 ± 2.86) was lower than that one in parosmic patients (6.48 ± 2.69) and phantosmic patients (4.96 ± 2.60) (both $p < 0.05$). There was no statistically significant difference in QOD-QOL and QOD-VAS among these three groups (both $p > 0.05$).

Effects of Demographic Variables to QOD

There were no significant differences in QOD scores between female and male patients (all $p > 0.05$). Correctional analyses found that age was negatively related to QOD-QOL ($r=-0.17$, $p=0.002$), but not QOD-P and QOD-VAS ($p>0.05$). Disease duration was negatively related to QOD-P ($r=-0.12$, $p=0.029$) and QOD-QOL ($r=-0.13$, $p=0.017$), but not QOD-VAS ($p>0.05$).

Because of the small sample size of OD patients with other causes we just compared the differences in QOD scores among patients with idiopathic, post-viral, sinonasal and post-traumatic OD, (Table 4). The results showed that QOD-P, QOD-QOL, and QOD-VAS differed significantly among the groups (all $p < 0.05$). Bonferroni post hoc testing revealed significantly higher QOD-P scores in post-infectious than in sinonasal OD. The QOD-QOL in

Table 4. Differences in brief QOD scores among patients with different causes.

	Idiopathic	Post-infectious	Sinonasal	Post-traumatic	F	Post-hoc
QOD-P	3.48±3.02	4.33±3.24	2.72±2.38	3.78±2.73	3.51*	Post-infectious> Sinonasal
QOD-QOL	6.98±5.80	9.22±5.78	7.32±5.50	10.26±6.28	5.51**	Post-infectious> Idiopathic Post-traumatic> Idiopathic
QOD-VAS	15.79±8.28	18.29±7.10	18.83±7.53	19.81±6.59	4.20**	Post-traumatic> Idiopathic

Notes: QOD-P: Questionnaire of Olfactory Disorders-parosmia; QOD-QOL: Questionnaire of Olfactory Disorders-quality of life; QOD-VAS: Questionnaire of Olfactory Disorders-visual analog scales; * $P<0.05$, ** $P<0.01$.

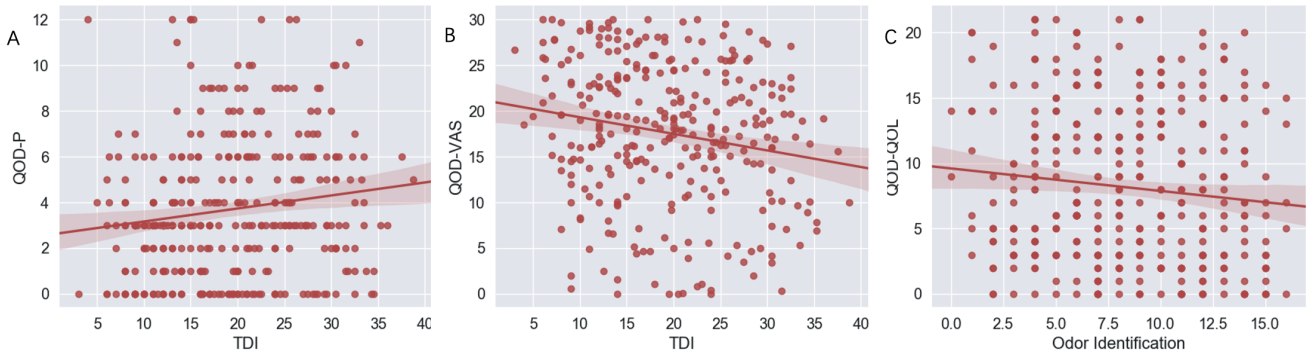

Figure 1. Relationship between olfactory functions and QOD scales. Notes: QOD: Questionnaire of Disorders; P: Parosmia; QOL: Quality of life; VAS: Visual analog scales; TDI: Sniffin' Sticks test total score; * $p < 0.05$; ** $p < 0.01$.

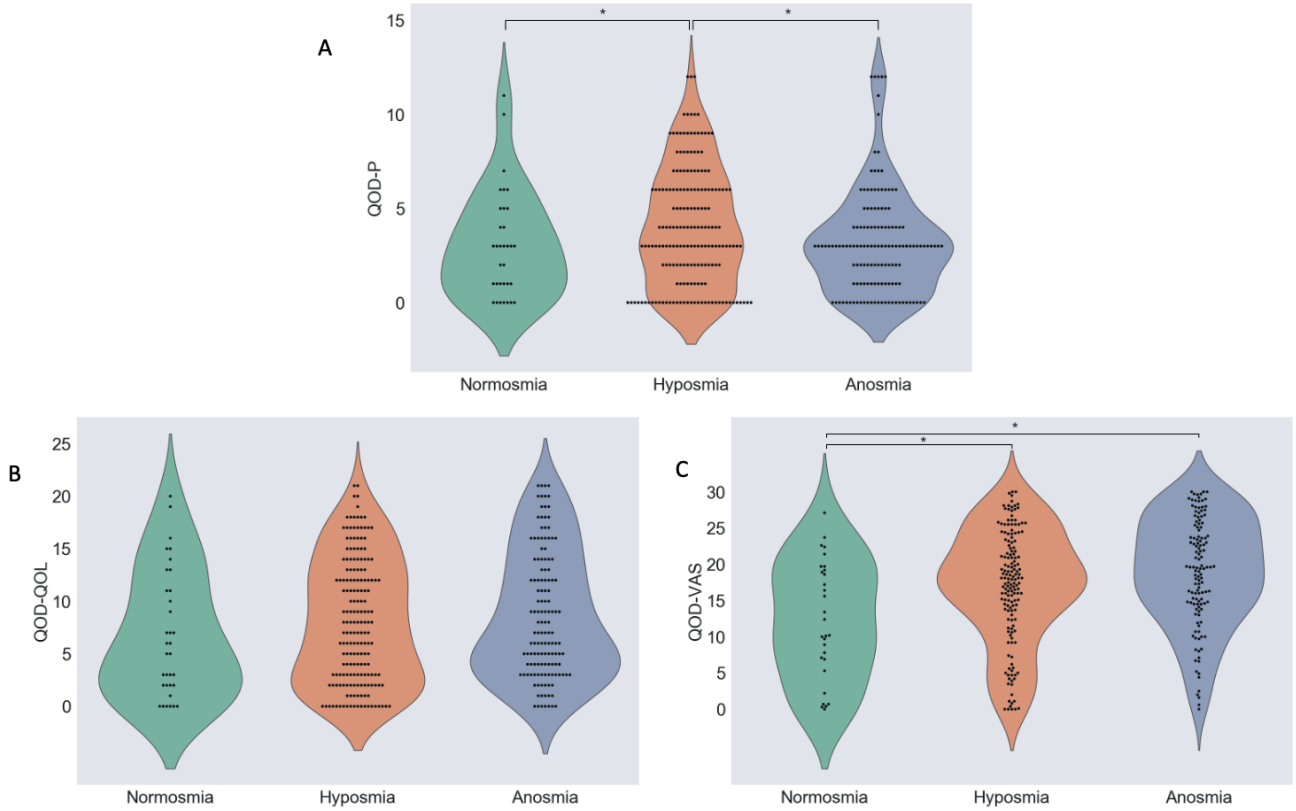

Figure 2. Differences on QOD among patients with olfactory disorders scoring in the anosmic, hyposmic and normosmic range. QOD: Questionnaire of Disorders; P: Parosmia; QOL: Quality of life; VAS: Visual analog scales; * $p < 0.05$.

the post-infectious and post-traumatic OD was higher than in idiopathic OD (all $p < 0.05$). The QOD-VAS in the idiopathic OD groups was lower than in post-traumatic OD groups ($p < 0.05$). No other difference in QOD was found among the groups (all $p > 0.05$).

Discussion

The aim of this study was to validate the various aspects of the short version of QOD in patients with olfactory disorders. The brief QOD showed suitable psychometric properties (reliability and validity) for assessing the subjective severity of olfactory dysfunction.

Our study has shown that the split-half reliability was 0.60, 0.87, and 0.66 for QOD-P, QOD-QOL, and QOD-VAS in all samples. The Cronbach's α coefficients were 0.63, 0.87, and 0.71 for QOD-P, QOD-QOL, and QOD-VAS in all samples. These results reflect that the brief version of QOD is acceptably or excellently reliable. These findings are comparable to the psychometric properties of the full version QOD [6,7,10]. When examining the reliabilities in samples of individual causes, the results showed that the QOD-

QOL is highly reliable (0.85-0.87), but the reliabilities of QOD-P and QOD-VAS are relatively lower (0.49-0.79). The relatively small sample size may have partly contributed to the lower reliability of QOD-P and QOD-VAS. In addition, the numbers of scale steps and items are important factors affecting reliability, that is, the reliability can be increased by selecting numbers of scale steps and items properly [20,21]. Changing the scale steps of QOD-P from 4 to 7 or more may obtain higher reliability in the future studies. As for the QOD-P, another reason for the lower reliability may be that parosmia generally occurs during the recovery period, but not the entire course of the disease [7]. This suggests that evaluation of qualitative olfactory dysfunction remains a challenge.

Regarding the QOD-P, there were significant differences among patients with anosmia, hyposmia, and normosmia. Hyposmic patients showed higher QOD-P than patients with anosmia and normosmia, which was consistent with the findings that parosmia is most frequent in hyposmic patients and is associated with better clinical outcome in terms of spontaneous olfactory recovery and receiving smell training [22–24]. Regarding the QOD-VAS, although the number of items was reduced from 5 to 3, our results still showed that patients with anosmia and hyposmia exhibited higher levels of VAS than patients with normosmia. However, regarding the QOD-QOL, when the number of items was reduced to 7, there were no significant differences in QOD QOL among patients with anosmia, hyposmia and normosmia, which was inconsistent with several previous studies [14,25,26], but consistent with the findings of Choi et al. [6]. Nonetheless, olfactory function was found to be associated with QOD-QOL, as well as QOD-P and QOD-VAS in the present study, which is consistent with previous work [15,16,27]. Overall, the results demonstrate that the short version QOD has a good validity. However, it is worth considering that the results of the brief QOD were not strongly correlated with the results of the Sniffin' Sticks test. This indicates that the brief QOD and the Sniffin' Sticks test measure different domains of the olfactory disorder. Therefore, it is recommended to use both tools when assessing patients with olfactory disorders.

Furthermore, we investigated the effects of demographic variables on the brief QOD subscales. The results were largely in line with our previous study [17], which investigated the differences in the original 32-item QOD among patients with OD of different causes. In the present study, disease duration was negatively related to QOD-P and QOD-QOL, which may be interpreted as adjustment [28]. In addition, age was negatively correlated with QOD-QOL, which was also in line with our previous study [17]. Considering the causes of OD, we found that post-infectious OD showed higher QOD-P scores than sinonasal OD. Whitcroft et al. [29] showed that parosmia occurs infrequently in patients with sinonasal OD, but more frequently in patients with post-viral and post-traumatic OD. In addition, idiopathic OD showed better QOD-QOL than post-infectious and posttraumatic OD, and better QOD-VAS than posttraumatic OD. These differences may be due to the sudden onset of OD after infection and trauma, which makes it more difficult for the patients to adapt and cope with the situation [2,17].

A limitation of the present study is that the sample sizes of OD patients with some causes, such as neurodegenerative, congenital and toxic, were small. Another limitation is that the reliabilities of QOD-P and QOD-VAS are relatively lower, and we did not examine the test-retest reliability of the brief QOD. Further studies are needed to address these issues.

Conclusion

The QOD could be reduced from 26 (excluding socially desired statements) to 14 items, while still showing good reliability and validity, and suggest that it is a suitable scale for the assessment of subjective severity of olfactory dysfunction in patients with olfactory disorders. Overall, the brief QOD could be used in patients with olfactory disorders as an assessment tool for purposes such as treatment counseling, disability assessment, treatment control, and research purposes.

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Authorship contribution

LZ: designed the study, analyzed the results, wrote the manuscript, critical revision of content; AH: designed the study,acquired data, critical revision of manuscript; SM: acquired data, critical revision of manuscript; NG: acquired data, critical revision of manuscript; TH: designed the study, acquired data, analyzed results, critical revision of manuscript

Conflict of interest

No conflict of interest.

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