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RESEARCH ARTICLE

A comparison of clinical features and executive functions between patients with obsessive compulsive disorder with and without misophonia

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ABSTRACT

Objective: The objective of this study was to compare patients with obsessive-compulsive disorder (OCD) with and without misophonia in terms of sociodemographic data, clinical features, and executive functions.

Method: This study included 39 patients with obsessive-compulsive disorder and misophonia, as well as 38 patients with obsessive-compulsive disorder without misophonia. A sociodemographic data form, the Yale-Brown Obsessive-Compulsive Scale, the Yale-Brown Obsessive-Compulsive Scale Symptom Checklist, a structured interview form for the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) Disorders, and the Hamilton Depression Rating Scale were administered to all patients. The executive functions of the patients were evaluated using the Digit Span Test, the Stroop Test, the Trail Making Test, the Verbal Fluency Test, the Wisconsin Card Sorting Test, and the Tower of London test.

Results: The obsessive-compulsive disorder group with misophonia had a higher rate of dirtiness obsession/cleaning compulsion, other compulsions, agoraphobia, and eating disorder comorbidities compared to the group without misophonia ($p<0.05$). Additionally, patients with misophonia had significantly higher Yale-Brown Obsessive-Compulsive Scale obsession scores ($p=0.016$). However, no difference was found between the groups in terms of executive functions ($p>0.05$).

Conclusion: The presence of high dirtiness obsessions, other compulsions, and agoraphobia comorbidity in in patients with obsessive-compulsive disorder and misophonia suggests an association with disgust sensitivity, sensory phenomena, and anxiety sensitivity, respectively, in obsessive-compulsive disorder. Contrary to expectations, the preservation of executive functions in misophonia can be interpreted as misophonia diverging from the OCD category.

Keywords: Comorbidity, executive functions, misophonia, obsessive-compulsive disorder

INTRODUCTION

Obsessive-compulsive disorder (OCD) is a mental disorder characterized by chronic, sometimes episodic, repetitive obsessions and/or compulsions that cause significant distress and time loss, as well as a notable deterioration in daily work, occupational functioning, and interpersonal relationships (1). The

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lifetime prevalence of OCD is estimated to be 2-3%, with an equal incidence in men and women during adulthood, typically manifesting in late adolescence and early adulthood (2). In the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), OCD is recognized as a distinct clinical entity separate from other psychopathologies, and it is no longer classified under anxiety disorders. Instead, OCD is classified under obsessive-compulsive and related disorders (OCRDs) in DSM-5, alongside diagnoses such as trichotillomania, skin picking disorder, hoarding disorder, and body dysmorphic disorder. This classification is based on similarities in clinical presentation, underlying etiologic factors, and neuropsychological processes (1).

Considering OCD as a single disease based on diagnostic classifications is insufficient for understanding OCD. OCD is accepted as a heterogeneous cluster in which various severe impairments can be observed in different cognitive areas due to its different clinical manifestations (such as early/late onset, symptom clusters, neurodevelopmental type) and overlapping phenomenologic and neurobiologic aspects with other psychopathologies such as autism and tic disorders (3–5). Impairment in fronto-striato-thalamo-cortical circuit functions in patients with OCD has been implicated in cognitive dysfunctions in OCD and conditions overlapping with other psychopathologies (6). Despite conflicting results in the literature, studies have reported that patients with OCD have impaired executive functions related to cognitive flexibility, inhibition, decision-making, and planning/problem-solving compared with healthy controls (7,8). Although cognitive impairments are not included in the diagnostic criteria of OCD, their adverse effects on the functioning of patients are known, and they are proposed to be endophenotypic features (9).

Misophonia was first described in the audiology literature in 2001 as an abnormal response to human sounds (10). Misophonia is seen with equal frequency in men and women, and its incidence has been found to be 6-20% (11,12) in university students and 13-18% in a community sample (13,14). Misophonia typically begins in childhood and adolescence, and affected individuals often have a family history of misophonia (15). Ordinary sounds such as clipping nails, brushing teeth, eating, breathing, smelling, speaking, sneezing, yawning, walking, chewing gum, laughing, snoring, whistling, television sound, or coughing are the sounds that make patients with misophonia uncomfortable or even angry (16). These sounds can cause intense anxiety or disgust and avoidance behavior, significantly affecting the individual's functioning (10,17).

Misophonia is associated with various disorders such as OCD, specific phobia, post-traumatic stress disorder (PTSD), autism spectrum disorder, and mood disorders. Phenomenologically, misophonia is similar to OCD in that it focuses on a specific sound, leading to obsessive engagement with it and exhibiting avoidance behaviors to alleviate the discomfort associated with this sound (18). In a clinical sample study, OCD co-diagnosis was found in 3-11% of patients with misophonia, making OCD one of the most common diagnoses (10,19). Additionally, a significant correlation has been observed between obsessive-compulsive symptoms and the severity of misophonia, and the presence of either misophonia symptoms or an OCD diagnosis increases the risk of developing the other (11,19,20). Although the treatment of misophonia remains unclear, it has been reported that cognitive-behavioral therapy (CBT) is beneficial for individuals with misophonia (21), and exposure and response prevention therapies have been recommended, especially when misophonia co-occurs with OCD (22).

Some authors have suggested that misophonia should be classified under OCRDs as a separate psychiatric disorder. The recommended diagnostic criteria are as follows: (A) The presence or anticipation of a specific sound, produced by a human being (e.g., eating sounds, breathing sounds), provokes an impulsive aversive physical reaction that begins with irritation or disgust and quickly escalates to anger. (B) This anger triggers a profound sense of loss of self-control, occasionally leading to aggressive outbursts. (C) The person recognizes that the anger or disgust is excessive, unreasonable, or disproportionate to the circumstances or the provoking stressor. (D) The individual tends to either avoid the misophonic situation or endure encounters with the misophonic sound situation despite experiencing intense discomfort, anger, or disgust. (E) The person's anger, disgust, or avoidance causes significant distress (i.e., the person is bothered by their anger or disgust) or substantial interference in their daily life. (F) The person's anger, disgust, and avoidance are not better explained by another disorder, such as obsessive-compulsive disorder (e.g., disgust in someone with an obsession about contamination) or PTSD (10). However, due to

the lack of consensus on misophonia as a separate psychiatric disorder, it was not included in the DSM-5 diagnostic classification.

Although there are some findings supporting the relationship between misophonia and OCD, further studies are needed to examine the similarities between the two conditions in terms of etiological, epidemiological, neuropsychological processes, and treatment interventions for misophonia to find its place within the OCD spectrum. Some authors have claimed that the majority of patients with misophonia do not have comorbidities and that it represents a separate psychiatric disorder (22). However, insufficient research on this subject in the literature leaves it unclear whether misophonia is a distinct disease or a variant/subtype/premorbid condition of an existing disorder.

It has been suggested that there may be abnormalities in the connections between the auditory, autonomic, and limbic systems in the neurobiology of the disease. Specifically, abnormal functioning of the amygdala, a brain area associated with negative emotions, aversive learning, and attention processes, has been implicated (23). Recent studies have also highlighted abnormal activation of the anterior insula, which plays a major role in emotional processes and sensory perception (24). There are a few studies with small sample sizes that have investigated cognitive functions in misophonia (17,25–27). These neurocognitive studies have emphasized that misophonia might be associated with selective attention deficit rather than executive dysfunction. From this perspective, the preservation of executive functions in misophonia may be an important point of distinction from OCD, but more comprehensive studies are needed.

The lack of sufficient information, the absence of inclusion in diagnostic classifications, and the gaps in understanding the relationship between misophonia and OCD make misophonia an intriguing area that requires further research. We believe that the age of onset, clinical features, and comorbidity rates of patients with OCD and misophonia may differ, and they may exhibit poorer performance on neuropsychological tests. To the best of our knowledge, no study in the literature has identified differences in clinical features and executive functions between patients with OCD with and without misophonia. Our study aimed to compare patients with OCD with and without misophonia in terms of sociodemographic data, clinical features, and executive functions.

METHOD

Participants

Patients who presented to the Health Sciences University Sisli Hamidiye Etfal Training and Research Hospital (Istanbul, Turkiye) Psychiatry Outpatient Clinic and were diagnosed with OCD according to the DSM-5 diagnostic criteria were included in the study. The participants were between the ages of 18-50 years, at least primary school graduates, and volunteers for the study. We re-evaluated the patients from a diagnostic perspective and assigned them to two separate groups based on the presence of misophonia. Considering the difference between the groups with a medium effect size (effect size=0.55), the alpha significance level was set at 0.05, and a sample size of 42 for each group was calculated to achieve 80% power (G*Power Version 3.1.6). Accordingly, it was planned to include 45 individuals in each group. Once the planned number of patients was reached for one group, no further patients were included in that group, while the patients referred to the other group continued to be evaluated until the desired number was reached. Six patients with moderate-to-severe depressive disorder and 12 patients who could not complete their neuropsychiatric tests were excluded from the study. A total of 77 patients (39 with OCD and misophonia, and 38 with OCD without misophonia) were included in the study. Individuals diagnosed with dementia, psychotic disorder, bipolar disorder, or intellectual disability according to the DSM-5 diagnostic criteria, as well as those with known chronic internal/neurological diseases (e.g., hypothyroidism, diabetes mellitus, epilepsy, multiple sclerosis, previous cerebrovascular disease, and malignancy) were excluded. Additionally, to minimize interference in the neuropsychological tests, patients with active alcohol and substance use disorders (28), those with a score of 17 or higher on the Hamilton Depression Rating Scale (HDRS) indicating moderate-to-severe depression (29), or those with an active suicide risk were also excluded.

The patients were diagnosed with misophonia after being evaluated according to the misophonia diagnostic criteria defined by Schröder et al. (10). A sociodemographic data form, the Yale-Brown Obsessive-Compulsive Scale (Y-BOCS) and Yale-Brown Obsessive-Compulsive Scale Symptom Checklist (YBOCS), and HDRS were administered to all participants through clinical interviews. The patients' comorbidities were evaluated using the Structured Clinical Interview for DSM-5 Disorders

(SCID-5-CV), a structured interview form. The following executive functioning tests were conducted on the participants: the Digit Span Test (DST), Stroop Test (ST), Trail Making Test (TMT), Verbal Fluency Test (VFT), Wisconsin Card Sorting Test (WCST), and the Tower of London (ToL) test. After explaining the purpose and design of the research to the participants, their consent was obtained. The study was approved by the Ethics Committee of the Health Sciences University Sisli Hamidiye Etfal Training and Research Hospital (Date and Number: 31.12.2019 - 2612).

Assessment Instruments

Sociodemographic Data Form

This form, completed by a physician during the interview, records the individual's age, sex (female/male), educational status [(a) primary school, (b) secondary school, (c) high school, (d) university, indicating the total number of years of study], marital status [(a) single, (b) married, (c) divorced, (d) widowed], employment status [(a) working, (b) unemployed, (c) retired, (d) student, (e) housewife], history of previous or ongoing physical illness, and age of onset of OCD and illness. It also includes questions about the duration of drug use, history of alcohol, cigarette, and substance use, and whether there is a history of mental illness in the family.

Hamilton Depression Rating Scale (HDRS)

Developed by Hamilton to assess the severity of depression in patients diagnosed with depression, this scale consists of 17 questions and is completed by the interviewer (30). The Turkish version of the HDRS was used in the study (31).

Yale-Brown Obsessive Compulsive Scale (Y-BOCS)

The Y-BOCS was developed by Goodman et al. (32,33) to measure the type and severity of obsessive-compulsive symptoms. It consists of a total of 19 items, with scores included for the first 10 items. Questions 1-5 evaluate obsessions, while questions 6-10 evaluate compulsions. The scale also includes a symptom checklist to investigate the distribution of symptoms. The Turkish version of the Y-BOCS was used in the study (34).

Digit Span Test (DST)

The DST was developed by Wechsler to measure attention and concentration (35). It consists of two parts: forward and backward digit span. In the forward digit span, participants are asked to repeat the numbers given to them in the same order. In the backward digit span, they are asked to repeat the numbers in reverse order. Test normative data were collected as part of the BILNOT battery (36).

Stroop Test (ST)

The ST measures the ability to change perceptual setups in response to changing demands and under the influence of interference. In other words, it assesses focused attention and information processing speed (37). It is considered the most selective assessment of inappropriate stimulus inhibition and is sensitive to orbitofrontal cortex damage. The Turkish version of the ST was used in the study (38).

Verbal Fluency Test (VFT)

The VFT is used to assess sustained attention, fluency, and mental flexibility. The VFT was performed in Turkish using the letters K, A, and S. Norms for the Turkish version of the test were collected in a psychology graduate study (39).

Trail Making Test (TMT)

The TMT consists of two parts: A and B. It assesses attention, motor speed, visual scanning, cognitive flexibility, set-shifting, response inhibition, and susceptibility to interference (37,40). Part A of the TMT evaluates processing speed based on visual scanning ability, while part B evaluates the ability to shift between sets of stimuli, complex attention, and sequential processing (41).

Wisconsin Card Sorting Test (WCST)

The WCST evaluates skills such as perseveration, working memory, abstraction ability, conceptual flexibility, complex attention, maintaining attention, maintaining goal-directed behavior, and inhibiting inappropriate responses. The validity and reliability study of the test in Turkish society was conducted by Karakas et al. (42).

Tower of London Test (ToL)

The ToL was developed by Tim Shallice in 1982. It is an executive function test that is sensitive to planning and problem-solving skills (43). The Turkish validity and reliability studies for the ToL were conducted by Atalay et al. (43).

Statistical Analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) 20.0 for Windows. Descriptive statistics are presented as

Table 1: Comparison of sociodemographic data and clinical features of patients with OCD with and without misophonia

	OCD+misophonia (n=39)		OCD (n=38)		t/χ^2	p
	n	%	n	%		
Age, mean±SD	23.9±6		28.3±9.5		-1.849	0.064
Sex, female	23	56	24	63.2	0.142	0.707
Education, mean±SD	12.3±2.6		11.2±3.5		-0.763	0.445
Age of onset, mean±SD	15.9±7.5		19.5±8.6		1.952	0.055
Duration of disease, mean±SD	7.6±4.3		8.7±8		0.796	0.429
YBOCS-Obsession, mean±SD	13.6±2.3		12.1±2.7		-2.474	**0.016***
YBOCS-Compulsion, mean±SD	13.0±3.0		16.4±24.1		-0.579	0.563
YBOCS-Total, mean±SD	26.5±4.7		24.6±4.4		-1.861	0.069
HDRS, mean±SD	6.7±3.5		7.7±3.5		1.184	0.24
Pharmacotherapy	15	42.9	20	57.1	1.559	0.212
SSRI	13		20			
SSRI+ antipsychotic	2		–			
Obsession subtype						
Dirtiness/contamination	30	76.9	20	53	4.988	**0.026***
Doubt	22	56.4	18	47.4	0.63	0.427
Religious	9	23.1	11	28.9	0.345	0.557
Aggressive	11	28.2	7	18.4	1.029	0.31
Sexual	8	20.5	8	21.1	0.003	0.953
Somatic	7	17.9	6	15.8	0.064	0.8
Symmetry	16	41	13	34.2	0.381	0.537
Other	15	38.5	8	21.1	2.785	0.095
Compulsion subtype						
Cleaning	30	76.9	21	55.3	4.037	**0.045***
Checking	21	53.8	18	47.4	0.323	0.57
Counting	10	25.6	7	18.4	0.583	0.445
Ritualistic	17	43.6	10	26.3	2.522	0.112
Ordering	15	38.5	10	26.3	1.295	0.255
Other (rubbing/touching)	16	41	7	18.4	4.695	**0.03***

HDRS: Hamilton Depression Rating Scale; OCD: Obsessive-compulsive disorder; SSRI: Selective serotonin reuptake inhibitors; YBOCS: Yale-Brown Obsessive Compulsive Scale; *: p<0.05.

numbers and percentages for categorical variables, and as mean and standard deviation for numerical variables. Student's t-test was used to compare numerical variables between two independent groups for normally distributed data, while the Mann-Whitney U test was used for non-normally distributed data. The Chi-square test was used to analyze ratios between groups. Nonparametric analysis of covariance (ANCOVA) (Quades's) was used to compare neuropsychological test results while controlling for age and educational status. The statistical alpha significance level was set at $p<0.05$.

RESULTS

Demographic Features

Of the patients with OCD (n=77), 61% (n=47) were female, and 39% (n=30) were male. The mean age was 26.1±8.2 years, and the mean years of education were 11.8±3.1 years. Regarding marital status, 75.3% (n=58) were single, 23.4% (n=18) were married, and 1.3% (n=1) were widowed. In terms of employment status, 48.1% (n=37) were students, 27.3% (n=21) were working, 14.3% (n=11) were unemployed, and 10.4% (n=8) were housewives. Half (50.6%) of the

Table 2: Comparison of patients with and without misophonia in terms of comorbidities

	OCD+misophonia (n=39)		OCD (n=38)		p
	n	%	n	%	
At least one psychiatric comorbid disorder	32	82.1	27	71.1	0.254
Depressive disorder	7	17.9	6	15.8	0.8
Dysthymic disorder	2	5.1	2	5.3	1
Premenstrual dysphoric disorder	6	15.4	4	10.5	0.737
Anxiety disorder	23	59	15	39.5	0.087
Panic disorder	4	10.3	1	2.6	0.358
Agoraphobia	10	25.6	3	7.9	**0.038***
Adult separation anxiety disorder	5	12.8	2	5.3	0.431
Social anxiety disorder	7	17.9	3	7.9	0.189
Specific phobia	5	12.8	1	2.6	0.2
Generalized anxiety disorder	5	12.8	5	13.2	0.966
Other specified anxiety disorder	4	10.3	5	13.2	0.754
Obsessive-compulsive related disorders	14	35.9	11	28.9	0.515
Body dysmorphic disorder	1	2.6	–	–	1
Hoarding	5	12.8	4	10.5	1
Trichotillomania			2	5.3	0.24
Skin picking disorder	2	5.1	1	2.6	1
Onychophagia	7	17.9	6	15.8	0.8
Binge eating disorder	6	15.4			**0.025***
Posttraumatic stress disorder			2	5.3	0.24
Gambling addiction	2	5.1			0.241
Tic disorder	2	5.1			0.494
Attention-deficit/hyperactivity disorder	8	20.5	8	21.1	1
Hypochondriasis	1	2.6	1	2.6	1

*: p<0.05.

patients (n=39) were diagnosed for the first time. The mean age of disease onset was 17.7±8.2 years, the mean disease duration was 8.1±6.4 years, the mean HDRS score was 7.2±3.5, YBOCS-compulsion scores were 14.9±17.5, YBOCS-obsession scores were 12.9±2.6, and the mean YBOCS-total score was 25.6±4.6. Just over one-quarter (27.3%) (n=21) of the patients were smokers.

Patients with OCD with and without Misophonia

Table 1 compares the clinical features of patients with OCD with and without misophonia. There were no significant differences between the two groups in terms of age, sex, and education (p>0.05). The mean age of disease onset was lower in patients with misophonia compared to the group without misophonia, showing a significant trend (t=1.952, p=0.055). Patients with misophonia had significantly higher Y-BOCS obsession scores than those without misophonia (t=-2.474, p=0.016). There were no significant differences between patients with and without misophonia in HDRS, Y-BOCS compulsion score, Y-BOCS total score, disease duration, and drug use (p>0.05). Patients with OCD and misophonia had significantly higher rates of cleaning obsessions and other compulsions (excessive asking and touching) compared to those without misophonia (p<0.05). There was no difference between the groups in other types of obsessions and compulsions (p>0.05).

Among all patients with OCD, 49.3% had at least one anxiety disorder, 32.5% had at least one diagnosis from the Obsessive-Compulsive and Related Disorders category, and 16.9% had at least one comorbidity of depressive disorders (dysthymic disorder and premenstrual dysphoric disorder). There was no significant difference in the comorbidity rates between patients with misophonia and those

Table 3: Comparison of executive functions between patients with OCD with and without misophonia

	OCD+ misophonia (n=39)	OCD (n=38)	t, Z	p	F	p*
ST - Interference time (sec)	41.8±2.5	42.1±2.4	0.478	0.713	0.184	0.669
VFT - Semantic fluency – animal names	20.1±0.9	22.1±0.8	-1.426	0.154	1.436	0.235
VFT - Phonetic fluency: K–A–S	36.1±2.1	38.1±2	-0.149	0.882	0.123	0.727
DST - Forward	6.3±1.2	6±1.2	-0.842	0.4	0.094	0.761
DST - Backward	4.2±1	4±1	-0.849	0.396	0.005	0.946
TMT-A	38±14.4	46.2±16.6	-2.069	**0.039**	1.66	0.202
TMT-B	78.4±25.3	92±39.1	-1.335	0.182	0.817	0.369
TMT - B-A (interference time)	41.2±19.2	46.4±29.7	-0.775	0.439	0.108	0.744
WCST - Completed category	6.3±2.8	5.1±3.1	-1.464	0.143	0.617	0.414
WCST - Perseverative error percentage	16.9±10.2	20.1±12.3	-1.424	0.155	0.159	0.691
WCST - Failures to maintain set	1.1±1.1	1.5±1.4	-1.429	0.153	1.77	0.187
WCST - Conceptual level response	0.6±0.2	0.8±1.2	-0.892	0.372	0.909	0.344
ToL - Total move score	40.7±18.7	43.1±19.2	0.659	0.512	1.243	0.269
ToL - Total correct score	2.9±1.8	3±1.9	-0.233	0.816	0.048	0.828
ToL - Total initiation time	37.1±21.6	36.5±16.1	-0.056	0.955	0.199	0.657
ToL - Total application time	200.3±92.5	249.3±111.3	-2.670	**0.008**	2.826	0.097
ToL - Total time violations	0.5±1.4	0.8±1.1	-2.305	**0.021**	0.371	0.544

DST: Digit Span Test; OCD: Obsessive-compulsive disorder; ST: Stroop test, TMT: Trail making test; ToL: Tower of London, VFT: Verbal Fluency Test, WCST: Wisconsin Card Sorting Test; *: ANCOVA analysis was performed by fixing age and educational status.

without (p=0.254). Patients with misophonia had significantly higher rates of agoraphobia (p=0.038) and eating disorders (p=0.025) compared to patients without misophonia. There was no significant difference between the two groups regarding other comorbidities (p>0.05). The comparison of patients with and without misophonia in terms of comorbidities is presented in Table 2.

Neuropsychological Test Findings

The comparison of neuropsychological test results between patients with OCD with and without misophonia is shown in Table 3. Patients with OCD and misophonia had significantly lower scores in TMT-A (p=0.039), ToL application time (p=0.008), and ToL time violations (p=0.021) compared to patients without misophonia. There was no significant difference between the two groups in terms of ST-interference time, WCST, VFT, DST, TMT-B, TMT interference time, and other parameters of the ToL (p>0.05). After conducting ANCOVA analysis while controlling for age and years of education, the significant differences in TMT-A, ToL application time, and ToL time violations between patients with OCD with and without misophonia disappeared (p>0.05).

DISCUSSION

Our study compared patients with OCD with and without comorbid misophonia in terms of sociodemographic and clinical characteristics, as well as executive functions. It is the first study in this field. Our findings demonstrated that patients with OCD and misophonia had significantly higher Y-BOCS-obsession scores, dirtiness obsession/cleaning compulsions, other compulsion subtypes, agoraphobia, and eating disorder comorbidities compared to those without misophonia. However, in further analyses where age and educational status were controlled, no differences were found between the groups in terms of executive functions.

According to our findings, patients with OCD and misophonia had significantly higher rates of dirtiness obsession/cleaning compulsion compared to those without misophonia. Misophonia can be triggered by intolerable and disturbing stimuli such as chewing, smacking, and burping, depending on individual sensitivity (44). People with misophonia may experience emotional reactions like disgust, anger, and irritability towards auditory and visual stimuli, and they may exhibit behaviors such as avoidance, escape, and confrontation (17). Studies on

OCD have specifically highlighted the relationships between dirtiness/contamination obsessions and the experience of disgust (45). While anxiety is the most prominent emotion associated with acquiring cleaning and washing rituals, recent research has revealed the potential significance of disgust in this process as well (46). Abnormalities in specific neural circuits of the limbic system may contribute to disgust sensitivity in both OCD and misophonia (24). The reasons for the higher rates of dirtiness obsessions in patients with misophonia in our study are currently unknown and require further investigation.

Furthermore, our findings indicated that patients with OCD and misophonia had a significantly higher rate of other compulsion subtypes compared to those without misophonia. These subtypes include mental rituals beyond checking and counting, excessive list-making, the need to say, ask, or confess, and touching, hitting, or rubbing. Among these items, our patient group specifically reported a need for touching/hitting. These conditions, also known as sensory phenomena, were initially described in patients with Tourette's syndrome (TS), a neurodevelopmental disorder characterized by atypical sensory responses, sudden-onset vocal and motor tics. They were later observed in patients with OCD (47). Studies have reported that sensory phenomena may serve as a valuable dimensional measure in subtyping OCD (48). It has also been noted to be more common in early-onset and tic-related OCD (47). Interestingly, increased activation in the insular region, which plays a critical role in interceptive signal perception and emotional processes, has been implicated in the etiology of sensory phenomena and misophonia (24,49). Both sensory phenomena and misophonia are highly correlated with perfectionism, which is a phenotypic component of OCD (22,50). Additionally, a report published by the International College of Obsessive-Compulsive Disorders (ICOCS) suggested a transition between OCD, TS, and misophonia (51,52). Although the rates of comorbidity with tic disorders were lower in our study compared to the literature, patients diagnosed with tic disorders were found in the misophonia group (53). Some authors have documented concurrent misophonia in pediatric OCD and tic disorders and proposed that misophonia may be associated with neurodevelopmental conditions, particularly in the context of sensory sensitivity syndrome (52). In our study, the earlier onset of OCD and the higher frequency of sensory phenomena in the misophonia patient group may suggest a relationship between the presence of misophonia and a neurodevelopmental condition. However, there is insufficient data in the literature on this subject.

Studies have shown that OCD is often comorbid with other mental disorders (54). It has been reported that OCD is commonly accompanied by depressive and anxiety disorders (55). In our study, the most frequent comorbidity was anxiety disorders, as moderate and severe major depressive disorder cases were excluded. Patients with OCD and misophonia in our study were found to have a higher prevalence of anxiety disorders compared to those without misophonia. Among anxiety disorders, the comorbidity rates of agoraphobia were particularly high. Although there is still a limited number of studies on comorbidities in misophonia, a study with a small sample reported that 11% of patients with misophonia had comorbid agoraphobia (56). On the other hand, Erfanian et al. (2019) (19) illustrated that misophonia and agoraphobia shared environmental triggers, exhibited avoidance behavior towards these triggers, and were clinically similar due to the accompanying antecedent anxiety, a suggesting a likelihood of co-occurrence diagnostically. Consistent with this, the incidence of agoraphobia was high in patients with misophonia in our study. One study emphasized the mediating role of anxiety in the relationship between misophonia and various psychiatric disorders (57).

In general, the autonomic nervous system responses in misophonia, such as arousal symptoms (tightness in the chest and head, tachycardia, sweating, hyperthermia) and negative emotional reactivity (disgust, distress, anxiety, anger, and irritability), coincide with findings observed in anxiety disorders. In fact, one study linked misophonia to anxiety sensitivity (20). Anxiety sensitivity refers to an intense fear that anxiety-related sensations and symptoms can have negative physical and/or social consequences, and it is considered a precursor to anxiety disorders.

Individuals with high anxiety sensitivity tend to enter an alarm state when experiencing anxiety due to their fears, which can exacerbate their anxiety (58). The same study found that misophonia symptoms were more prevalent in individuals with high anxiety sensitivity and were associated with obsessions rather than compulsions (20). Similarly, in our study, participants with misophonia had significantly higher Y-BOCS obsession scores compared to those without misophonia. On the other hand, the avoidance behavior associated with anxiety towards specific situations/animals in phobias and the avoidance

behavior observed in response to auditory stimuli in misophonia are similar. This suggests a potentially strong correlation between various phobic avoidance behaviors driven by anxiety within the patient group with misophonia.

In our study, there was a significantly higher frequency of comorbidity with binge eating disorder in the group with misophonia compared to those without misophonia. Another study examining 15 patients diagnosed with an eating disorder found misophonia in three individuals (two with anorexia nervosa and one with bulimia nervosa). It was demonstrated that there was a temporal relationship between the occurrence of misophonia and eating disorders in these patients (59). In a study investigating the comorbidities of 52 patients with misophonia, it was reported that 17.3% had an eating disorder, and the severity of misophonia and anorectic symptoms were associated with these patients (19). One of the most distressing sounds for patients with misophonia is the sound of eating, leading them to often avoid eating with their family or friends (60). This behavior may cause patients to deviate from regular eating patterns, lose their sense of control, and consume large amounts of food alone within a certain period. However, further studies are needed to gain a better understanding of the issue.

Contrary to our belief, the groups with and without misophonia performed similarly in terms of attention, cognitive flexibility, problem-solving, response inhibition, verbal fluency, and abstraction. Patients with OCD and misophonia had significantly lower scores in TMT-A, ToL administration time, and ToL time violations compared to those without misophonia. However, in the analysis where the variables of age and educational status were fixed, this significant difference in psychomotor speed did not persist.

There is no previous study in the literature comparing executive functions in OCD and misophonia. Meta-analysis studies have reported medium to large effect size impairments in executive function areas, such as cognitive flexibility, problem-solving, decision-making, and inhibition, in OCD (7,8). On the other hand, there are only a few studies on misophonia with small sample sizes. One study found that patients with misophonia had poorer selective attention than patients with tinnitus when exposed to triggering sounds (26). Another study found that individuals with misophonia had difficulty maintaining alertness during attention tasks compared to a control group but did not find a significant difference in executive function (17). However, one study reported that the ST results in patients with misophonia were similar to those of healthy controls (25). In other words, no impairments related to motor inhibition, focused attention, and selective attention were found in the misophonia group.

The aforementioned clinical studies indicate that misophonia may have impairments, particularly in the attention systems rather than executive functions, but there are conflicting results in this regard. In our study, we evaluated simple attention with the digit span test, focused and selective attention with the ST, sustained attention with the verbal fluency test, and complex attention with the verbal fluency and WCST tests. According to our findings, the attention processes of patients with OCD with and without misophonia showed similar performance.

It is known that patients with misophonia experience attention difficulties only in the presence of specific disturbing auditory stimuli. There is no evidence to suggest that patients with misophonia have impaired cognitive functions such as attention without these stimuli. In our study, patients with misophonia were able to maintain their attention similar to those without misophonia because no disturbing stimuli were presented to our sample during the neuropsychological tests. Another explanation for the lack of difference between the groups is that, unlike OCD, misophonia may not affect executive functions. In terms of underlying mechanisms, abnormalities in the fronto-striato-thalamo-cortical circuit are specific to OCD, while abnormalities in the limbic areas are mostly associated with misophonia.

Although attention has been a focal point in studies on misophonia in the literature, theoretical assumptions have been made regarding potential impairments in emotion, learning, and memory within the neuropsychological systems underlying the formation of the misophonic response (23). Neuroimaging studies have shown abnormalities in micro and macro structures in the white matter of patients with misophonia, suggesting potential effects on attention, social-emotional processes, and facial emotion recognition (61). In our study, we were limited in the cognitive areas that could be examined. To investigate the presence of cognitive impairment in misophonia, future studies can explore different domains (e.g., memory, learning, decision-making, social cognition) using more comprehensive cognitive tests.

Our study aimed to investigate the impact of misophonia on clinical features and neuropsychological functions in patients with a primary diagnosis of OCD. To date, there have been no previous studies examining the presence of misophonia in patients with OCD. Misophonia is a complex condition that can coexist with various psychiatric disorders, but there is no consensus on whether it should be classified as a separate psychiatric disease. Some studies have linked misophonia to a range of psychiatric disorders such as TS, tic disorders, autism, neurodevelopmental disorders such as Attention-Deficit/Hyperactivity Disorder (ADHD), OCD spectrum, anxiety disorders, and PTSD (62). However, none of these disorders fully match the clinical presentation of misophonia. Interestingly, contrary to expectations, some studies have found that the majority of individuals diagnosed with misophonia do not have significant psychiatric comorbidities, leading to suggestions that misophonia should be considered a distinct psychiatric condition (19,63).

A study that explored the neural basis of misophonia proposed that it could be classified as a separate disorder (24). However, it is worth noting that most of the studies on misophonia have primarily focused on audiology patients (e.g., tinnitus, hyperacusis), university students, and individuals seeking family medicine services (11,12,20,63–65). There are very few studies that have specifically investigated psychiatric populations (19). Therefore, due to potentially lower psychiatric comorbidity rates and different clinical features in non-psychiatric sample groups, it is challenging for these findings to provide a comprehensive understanding of misophonia's psychopathology and generalizability. Additionally, research in this area is limited because patients with misophonic symptoms are less likely to seek treatment specifically for these symptoms in psychiatric outpatient clinics (13).

From these perspectives, we believe that our study contributes to the literature as it evaluates a clinical sample. More studies are needed to understand the nature, epidemiology, etiology, underlying neuropsychological factors, and treatment of misophonia in order to determine its classification. It is generally considered that misophonia falls within the realm of psychiatric disorders, and having a diagnostic framework may be beneficial when considering clinical implications (44). Based on the phenomenological similarities between OCD and misophonia, Schröder et al. (10) suggested that misophonia should be classified as a separate psychiatric disorder under the category of OCD. Remarkably, some studies have explored the relationship between misophonia and OCD, as well as obsessive-compulsive symptoms. This raises the question of whether misophonia adequately meets the criteria to be included within the spectrum of OCRDs.

Diseases within the OCD spectrum exhibit similar behavioral patterns, share common neuropsychological processes, have high rates of comorbidity with OCD in individuals or their families, and respond to similar treatment approaches (66). Impairments in response inhibition in neurocognitive areas, a decrease in cognitive flexibility, and an increase in perseverative errors are considered prototypical features, especially in disorders within the OCD category (67,68). In our study, patients with misophonia performed similarly to those without misophonia in terms of response inhibition, cognitive flexibility, and perseverative error rates. The presence of misophonia diagnosis can be interpreted as not causing impairment in cognitive flexibility areas but rather affecting response inhibition. In other words, based on our study, it can be suggested that misophonia may not fit within the OCRDs category in terms of neuropsychological profile. However, further comprehensive studies are needed to determine whether misophonia should be included under the spectrum of OCRDs.

Additionally, there is a diagnostic similarity between misophonia and phobic disorders in terms of environmental triggers, antecedent anxiety symptoms, and phobic avoidance behaviors in response to triggering factors. Interestingly, in our study, we found a high frequency of comorbidity with agoraphobia in patients with misophonia, which can also be considered as phobic behavior towards triggering sounds. However, it is important to note that the dominant emotions in anxiety disorders are anxiety and fear, whereas in misophonia, they are anger, restlessness, and disgust.

Unfortunately, in our study, it may be premature to comment on the relationship between anxiety disorders and misophonia due to the lack of information on the trigger factors and the emotional and behavioral responses to these triggers in the misophonia group. Another point that contributes to the controversy surrounding the diagnosis of misophonia is the difficulty in establishing clear diagnostic boundaries between conditions such as PTSD, phobic disorder, OCD, sensory sensitivity syndrome, and misophonia, which increases the risk of misdiagnosis (63).

Our study has several limitations. Firstly, the heterogeneity of the patient group, including variations in medication use, new diagnoses, and comorbidities, may have influenced the results. Due to the high comorbidity rates of depressive and anxiety disorders in

OCD, the presence of these comorbid conditions, as well as factors such as drug therapy, may have influenced the results of the neuropsychological test. Secondly, the exclusion of individuals with HDRS scores >17 and those with alcohol and substance use disorders, aimed at minimizing the impact on neuropsychological tests, may have affected the comorbidity rates. Therefore, conducting a study that includes all comorbidities and compares the rates in both groups would provide more accurate results. Thirdly, patients with misophonia were not evaluated audiologically, and possible differential diagnoses such as hyperacusis and tinnitus were not excluded. A multidisciplinary approach may be more accurate when diagnosing patients with misophonia. Additionally, the diagnoses of misophonia were solely based on the referenced diagnostic criteria, without the use of a scale to measure the clinical characteristics, triggers, emotional and behavioral responses to triggers, and the severity of misophonia. This constitutes the greatest deficiency and limitation of our study. Furthermore, the small sample size makes it difficult to generalize our results, highlighting the need for studies with larger patient populations. Finally, evaluating cognitive functions solely through tests, without simultaneous neuroimaging, may have limited the reliability of the results in our study.

CONCLUSION

Our study revealed that patients with OCD and misophonia had higher obsession scores, increased dirtiness obsessions, and exhibited other compulsions such as touching/hitting more frequently compared to those without misophonia. The presence of misophonia may intersect with subsets of sensory phenomena and disgust sensitivity within the OCD spectrum. Furthermore, the high prevalence of agoraphobia in the OCD group with misophonia suggests that these patients may have heightened anxiety sensitivity and frequently engage in avoidance behaviors. Contrary to expectations, there was no significant deterioration in the attention and executive functions of patients with OCD in the presence of misophonia. The preservation of executive functions in misophonia implies a divergence from the OCD category, but further comprehensive studies are necessary to investigate this matter. Detecting the presence of misophonia may hold significance as patients with OCD exhibit a heterogeneous clinical presentation, comorbidity patterns, and cognitive functions. Therefore, larger-scale studies are needed to generalize and validate our findings.

Contribution Categories		Author Initials
Category 1	Concept/Design	A.G.B., E.P.A., H.D., O.A.O.
	Literature review	A.G.B., E.P.A., H.D.
	Data analysis/Interpretation	E.P.A.
Category 2	Drafting manuscript	A.G.B., E.P.A., H.D.
	Critical revision of manuscript	O.A.O.
Category 3	Final approval and accountability	E.P.A., A.G.B., H.D.
Other	Supervision	O.A.O.

Ethical Approval: The Health Sciences University, Sisli Hamidiye Etfal Training and Research Hospital Clinical Research Ethics Committee granted approval for this study (date: 31.12.2019, number: 2612).

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