



# Olfactory and Taste Dysfunction in Coronavirus Disease 2019 Pandemic

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**Abstract** This study is done to raise awareness of olfactory and taste dysfunction association in coronavirus disease, urging early detection and isolation of coronavirus positive patients thus breaking the chain of transmission of disease. This is a retrospective observational study done in outpatient department of tertiary care hospital in Mumbai, west India from 1st May 2020 to 1st August 2020 on patients who were confirmed positive for COVID-19 by real-time reverse transcription polymerase chain reaction (rRT-PCR) and having olfactory dysfunction and/or taste disorders. In study population, anosmia and ageusia occurred in 88% and 83.33% respectively. In control population, anosmia and ageusia occurred in 93% and 85.71% respectively. The mean duration of anosmia was around 2 weeks and 3 weeks for study and control group respectively. In study population 94.6% recovered from anosmia, whereas in control population 64.3% recovered from anosmia. Anosmia gradually improved to hyposmia. In the study population 94.3% hyposmia patients showed recovery, while in control population 85.2% showed recovery. Ageusia collaborated with the duration of anosmia. Recovery from taste dysfunction was 88.6% and 63.9% in study and control population respectively.

Olfactory and taste dysfunction are very important clinical features of coronavirus positive patients with anosmia being the most prominent symptom. All patients presenting with smell and or taste dysfunction should be screened for coronavirus disease, helping in early detection in asymptomatic patients.

**Keywords** SARS-CoV-2 · COVID-19 · Olfactory dysfunction · Anosmia · Ageusia

## Abbreviations

SARS-CoV-2	Severe Acute respiratory syndrome coronavirus 2
COVID-19	Coronavirus disease 2019
SARS	Severe acute respiratory syndrome
MERS	Middle East respiratory syndrome
rRT-PCR	Real-time reverse transcription polymerase chain reaction
ENT	Ear Nose Throat
OPD	Out Patient Department
ACE2	Angiotensin Converting Enzyme-2

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## Introduction

Severe Acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the causative agent for Coronavirus disease 2019 (COVID-19) [1]. Corona virus causes respiratory tract infections. The severity can be mild like common cold, or can be even lethal, like SARS (Severe acute respiratory syndrome), MERS (Middle East respiratory syndrome) and COVID-19 (Corona virus disease 2019). COVID-19 disease was first identified in December 2019 in Wuhan, the

capital of China's Hubei province and later caused a worldwide pandemic [2, 3]. The virus mainly spreads by close contact via small droplets produced while coughing, sneezing and talking [4, 5]. Bioaerosol transmission occurs while doing intubation, tracheostomy and cardiopulmonary resuscitation. Fomite transmission is also possible [4]. The virus is most contagious when people are symptomatic; although spread is possible even before symptoms appear [4]. The incubation period is 5 to 6 days but may range from 2 to 14 days. The virus survives for hours to days on surfaces. The patient may be totally asymptomatic or present with flu like symptoms like fever, cough, sneezing, fatigue and shortness of breath. Blood investigations often reveal lymphocytopenia. Ground glass appearance is commonly seen in HRCT of chest. The disease may progress to pneumonia, multi-organ failure, and even death [6–9]. Number of patients who were affected by COVID-19, presented with anosmia and ageusia [14]. Otolaryngologists and health care staff are at high risk of COVID-19 infection, hence appropriate protective and hygiene measures are of utmost importance [10, 11]. The risks seem to be more high in the field of rhinology, neuro-oncology and endoscopic endonasal surgery [12, 13]. In administering the health crisis, early identification of paucisymptomatic patients with anosmia and ageusia is emerging as a crucial factor in order to interrupt the transmission chain of the disease. In few cases these minor and non-specific symptomatology can represent the first and only manifestation of the coronavirus disease.

## Methods

Amidst the COVID-19 pandemic in Mumbai this is a retrospective observational study of patients, who were confirmed positive for COVID-19 by real-time reverse transcription polymerase chain reaction (rRT-PCR) and having olfactory dysfunction and/or taste disorders. The patients attended outpatient department of tertiary care hospital in Mumbai, west India from 1st May 2020 to 1st August 2020.

**Study group**—42 Patients who were positive for COVID-19 and having olfactory and/or taste disorders and were treated with conventional medical management protocol for COVID-19 treatment with additional oral medical line of treatment along with smell or taste training for faster and effective recovery.

**Control group**—42 Patients who were positive for COVID-19 and having olfactory and/or taste disorders and were treated only with conventional medical management protocol for COVID-19 without any specific treatment or smell or taste training.

**Exclusion criteria**—Subjects having additional comorbidities, patients with a history of any nasal pathology or nasal surgery, neurological pathology or had complications due to COVID-19 disease.

**Inclusion criteria**—Subjects who were under regular follow up in ENT department and also under the observation of a physician to keep a check to any progressive complications due to Coronavirus disease.

Proper history, OPD examinations and meticulous follow up was done in all the patients and tabulation done from all the accumulated data.

The olfactory function for each patient was tested by using vial containing easily available, non-irritating substance like vanilla, lemon, freshly ground coffee and scented soap, which stimulate the olfactory receptors. Irritating odour such as camphor or menthol which stimulate the trigeminal sensory receptors in addition to the olfactory receptors were not used to avoid any false positive result. All patients were informed about the test. The patients were asked to place an index finger over one nostril to block it (for example, right index finger over right nostril). They were then asked to sniff repeatedly and inform when an odour is detected and recognized with both eyes closed. The test odour was brought up-to within 30 cm or less of the nose. No auditory clue was given. The same process was repeated with the other nostril. Smell sensation was intact when patient detected the odour. The degree of smell sensation gave an idea if the patient had anosmia or hyposmia. All the study group who were under home quarantine were explained the procedure and they were advised to repeat this test every 4 days and the recovery was assessed.

The ageusia for each patient was tested by sugar, salt and vinegar using different concentrations. The patient was asked to rinse the mouth with plain water and wipe the tongue dry with a clean tissue paper. A clean cotton swab was dipped in 10 percent sugar solution and was gently applied on the surface of the tongue. Patient was then asked whether he or she can taste the sweetness. This test was repeated with 1%, 0.1% and 0.01% sugar solutions, rinsing the mouth and wiping the tongue before testing each solution. This gave an approximate taste threshold for sugar. The same was repeated with salt and vinegar with 10, 1, 0.1 and 0.01% concentrations. The taste dysfunction and threshold was assessed accordingly. The study group who were under home quarantine were explained the procedure and they were advised to repeat this test every 4 days and the recovery was assessed.

All the patients were advised isolation, with study group advised to do smell and taste training to improve and fasten smell and taste recovery along with the treatment protocol for COVID-19. In addition, study group patients were treated with intranasal corticosteroid sprays, oral vitamin B

complex with omega-3 fatty acid, oral vitamin A and intranasal sodium citrate. Systemic corticosteroids were not prescribed as it may lower the immunity. Both the study group and control group were given conventional medical management for COVID-19 treatment with Doxycycline, Ivermectin and Vitamin C as advised by the physician.

## Results

This study consist of 42 study population and 42 control population. Out of 42 study population, 26 (62%) were males and 16 (38%) were females. Out of 42 control population, 31 (73.8%) were males and 11 (26.2%) were females (Table 1).

The males belonged to the age group of 24 to 68 years (mean age 42.65 years) in the study population and belonged to the age group of 26 to 58 years (mean age 40.25 years) in the control population. The females belonged to the age group of 21 to 60 years (mean age 38.56 years) in the study population and belonged to the age group of 22 to 61 years (mean age 35.25 years) in the control population (Table 2). 24 out of 42 study population (57.14%) and 23 out of 42 control population (54.76%) had confirmed contact with COVID-19 positive individuals. The incubation period of these patients was 0 to 8 days (mean 3.79 days).

Anosmia occurred in 37 patients out of 42 (88%) study population and 39 patients out of 42 (93%) control population (Table 3). Ageusia occurred in 35 out of 42 patients (83.33%) study population and 36 patients out of 42 (85.71%) control population (Table 4). 30 out of 42 study population (71.43%) presented with both anosmia and ageusia. 31 out of 42 control population (73.80%) presented with both anosmia and ageusia. Seven patients (16.67%) presented with only anosmia and 5 patients (11.90%) presented with only ageusia in study population, while 8 patients (19.00%) presented with only anosmia and 3 patients (7.20%) presented with only ageusia in control population (Table 5). In both the cases of anosmia and ageusia, the mean onset of symptoms occurred at around 4th day, but most patients appreciated the distinct anosmia and taste dysfunction after 7 to 10 days after clinical onset

of symptoms. In our study population 5 patients (11.9%) had reduced olfaction and taste sensation together from the 1st day. Two patients had reduced sense of taste alone on the 1st day before the patients felt any other symptoms.

The mean duration of anosmia was around 2 weeks (7—21 days) for study population and 3 weeks (12—30) for control population (Table 3). In study population, out of 37 patients who had anosmia, 35 patients (94.6%) recovered from anosmia and two patients (5.4%) did not show appreciable recovery, whereas in control population, out of 39 patients who had anosmia, 27 patients (64.3%) recovered from anosmia and 15 patients (35.7%) did not show appreciable recovery (Table 3). Anosmia gradually improved to hyposmia where the patients were able to appreciate only strong smell. The mean duration of hyposmia was around 5 weeks (21—50 days) in study population and 8 weeks (30—75 days) in control population (Table 3). In study population, out of 35 patients having hyposmia, 33 patients (94.3%) had near total recovery and 2 patients (5.7%) did not show any significant recovery, while in control population, out of 27 patients having hyposmia, 23 patients (85.2%) had near total recovery and 4 patients (14.8%) did not show any significant recovery (Table 3).

Ageusia collaborated with the duration of anosmia and improved gradually. Initially patients were able to differentiate bitter taste, later taste sensation improved with time. The mean duration of altered taste sensation was around six weeks (21—68 days) for study population and eight weeks (30—77 days) for control population (Table 4). In study population, out of 35 patients having taste dysfunction, 31 patients (88.6%) recovered and four patients (11.4%) did not show any significant recovery, whereas in control population, out of 36 patients having taste dysfunction, 23 patients (63.9%) recovered and 13 patients (36.1%) did not show any significant recovery (Table 4). Incidentally, it was noted that patients who did not recover from anosmia also showed poor recovery in ageusia.

In both the study and control population, the most common associated symptom was cough, followed by headache and myalgia, sore throat, rhinitis, fever and diarrhea.

**Table 1** Sex distribution of COVID- 19 positive patient came with olfactory and/ taste problem

Tabulation of sex of COVID-19 positive patient came with olfactory and/taste problem

Total number of study group		Total number of control group	
42		42	
Male	Female	Male	Female
26 (62%)	16 (32%)	31 (73.8%)	11 (26.2%)

**Table 2** Age distribution of COVID-19 positive patient came with olfactory and/ taste problem

Tabulation of age of COVID-19 positive patient came with olfactory and/taste problem

Study group age		Control group age	
Male	Female	Male	Female
Range 24–68	Range 21–60	Range 26–58	Range 22–61
Mean 42.65	Mean 38.56	Mean 40.25	Mean 35.25

**Table 3** Olfactory dysfunction in COVID- 19 positive patients

Tabulation of olfactory dysfunction of COVID- 19 positive patients

	Study group		Control group	
Problem in olfaction	37 patients	88%	39 Patients	93%
Onset of anosmia (days)	Range 0–12	Mean 3.43	Range 0–14	Mean 3.5
Duration of anosmia (days)	Range 7–21	Mean 14.05	Range 12–30	Mean 21.25
Anosmia recovered or not	35 patients recovered and 2 not recorded	Out of 37 patients, 94.6% recovered and 5.4% not recovered	27 Patients recovered and 15 not recorded	Out of 27 patients, 64.3% recovered and 35.7% not recovered
Duration of hyposmia (days)	Range 21–50	Mean 32.17	Range 30–75	Mean 55.33
Hyposmia recovered or not	33 patients recovered and 2 not recovered	Out of 35 patients, 94.3% recovered and 5.7% not recovered	23 patients recovered and 4 not recovered	Out of 27 patients, 85.2% recovered and 14.8% not recovered

**Table 4** Taste dysfunction in COVID- 19 positive patients

Tabulation of taste dysfunction of COVID-19 positive patients

	Study group		Control group	
Problem in taste	35 patients	83.33%	36 patients	85.71%
Onset of reduced taste sensation (days)	Range 0–12	Mean 3.2	Range 0–14	Mean 3.7
Duration of reduced taste sensation (days)	Range 21–68	Mean 43.6	Range 30–77	Mean 58.5
Taste sensation recovered or not	31 patients recovered and 4 not recovered	88.6% recovered and 11.4% not recovered	23 patients recovered and 13 not recovered	63.9% recovered and 36.1% not recovered

**Table 5** Olfactory or taste dysfunction in COVID- 19 positive patients

Tabulation of only olfactory or taste dysfunction of COVID-19 positive patients

	Study group		Control group	
Patient having only olfactory dysfunction	7 patients	16.67%	8 patients	19.00%
Patient having only taste dysfunction	5 patients	11.90%	3 patients	7.20%
Patient having both olfactory and taste dysfunction	30 patients	71.43%	31 patients	73.80%

## Discussion

### Association of COVID-19 and Olfactory Dysfunction

Olfactory dysfunction is currently the most common early clinical feature of COVID-19 [15]. Anosmia of sudden onset is the a classical early sign of COVID-19 disease [16].

We studied 42 study population and 42 control population who were coronavirus positive and having olfactory and or taste dysfunction. In study population, anosmia occurred in 88% and ageusia in 83.33% patients respectively, with 71.43% presenting with both olfactory and taste dysfunction. In control population, anosmia occurred in 93% and ageusia in 85.71% patients respectively, with 73.8% presenting with both olfactory and taste dysfunction. The mean duration of total anosmia in study population was 2 weeks in which 94.6% recovered from anosmia to hyposmia, whereas in control population was 3 weeks in which 64.3% recovered from anosmia to hyposmia. The mean duration of hyposmia in study population was around 5 weeks with 94.3% recovering to normal smell function, whereas in control population was around 8 weeks with 85.2% recovery too normalcy. Ageusia collaborated with the duration of anosmia with the mean duration of reduced taste sensation in study population was 6 weeks with 88.6% recovering to normal taste sensation and in control population was 8 weeks with 63.9% recovering to normal taste. Our results collaborated with the study done by Klopfenstein et al., where anosmia developed 4.4 days after the outset of the SARS-CoV-2 infection. He also reported 98% recovery of anosmia within 28 days and was frequently associated with dysgeusia [17, 18]. Incidence of Olfactory dysfunction in COVID-19 patients was ranging from 33.9 to 68% [19–23].

Although females have been significantly more affected by olfactory and gustatory dysfunctions than males during the COVID-19 epidemic [15], in our study 62% and 73.8% were males in study and control population respectively. Moreover, the olfactory and or taste dysfunction appeared after he or she experienced fever and sore throat. However, it is important to note that in some patients, the anosmia and or taste symptoms may appear before the general or respiratory symptoms appear [15].

Moein et al. executed olfactory function test of 60 COVID-19 positive patients and 60 subjects as control group having similar age and gender of the patient's group and concluded that COVID-19 patients presented with marked olfactory dysfunction [24]. Another investigation done using self-reported questionnaire which surveyed the prevalence of taste and/or smell disorders in COVID-19 and influenza patients.25 The study showed that incidence

rate in COVID-19 cases (39.2%) was significantly higher than in influenza cases (12.5%) [25].

Mayo Clinic analyzed the symptoms and signs of COVID-19 infection by using artificial intelligence which revealed that the prevalence of anosmia or dysgeusia in COVID-19 positive patients was 28.6 fold more than that of COVID-19 negative patients. The study also disclosed that anosmia or dysgeusia was one of the earliest presentation of COVID-19 infection [26]. COVID-19 infection has some association to host genotype with heritability for anosmia 47% [27]. Olfactory dysfunction has a high incidence rate in COVID-19 cases in some American and European countries, but it had very low reported cases in Chinese patients [27, 28]. This low incidence of olfactory dysfunction in COVID-19 positive Chinese patients can be probably due to genotype mutation.

Forster et al. found changes in amino acids in three central variants. The A and C genotype of SARS-Cov-2 presents remarkably in Americans and Europeans, with B type being most common genotype in East Asians. Type A and C genotype seem high pathogenicity for human nasal cavity, thus favoring increased prevalence of olfactory dysfunction in American and European countries [29].

### Nasal Cavity and COVID-19 Infection

In humans it has been found that there are 7 types of coronaviruses namely SARS-CoV-2, Severe acute respiratory syndrome coronavirus (SARS-CoV), Middle East respiratory syndrome coronavirus (MERS-CoV), HCoV-NL63, HCoV-OC43, HCoV-229E and HCoV-HKU1 [30]. SARS-CoV-2 genome is a 29,903 by single-stranded RNA coronavirus [31]. SARS-CoV-2 virus bears a spiny protein named S1 which adheres to the ACE2 receptor present on host cell membrane [31]. ACE2 receptors are distributed in the central nervous system [5]. The olfactory system has olfactory bulb. Virus can invade this olfactory system via cribriform plate to involve the central nervous system [32–34]. SARS-CoV-2 mainly reside in ciliated cells and goblet cells in the nasal mucosa, thus transmission occurs primarily through droplets [35]. SARS-CoV-2 virus can pass from nasal cavity via nasolacrimal duct to eye, hence it can be detected in tears [36]. Olfactory dysfunction following COVID-19 infection is believed to be caused by either damage to the olfactory epithelium or central olfactory system pathways [37].

The exact catastrophic mechanism of SARS-CoV-2 virus on the olfactory system is still unresolved. It is ambiguous whether olfactory dysfunction is due to local inflammation of the nasal cavity or viral-induced olfactory nerve damage or both. Rhesus monkey can be used to study the physiological and pathological effect of the olfactory system by SARS-CoV-2 virus. Olfactory epithelium of

COVID-19 positive patients can be biopsied for better delineation of the pathology of olfactory dysfunction [38].

### Association of COVID-19 and Taste Dysfunction

It is unclear how the gustatory problems in COVID-19 patients target the sense of taste. The fact that three of our patients experienced gustatory dysfunction alone with no anosmia or any other associated symptoms, indicates that more than one pathophysiological pathway might exist. The gustatory system is transmitted via the Chorda tympani nerve supplying anterior two thirds of the tongue, Glossopharyngeal nerve supplying posterior one third of tongue and vagus nerve supplying vallecula. These recognize the basic tastes like sweet, sour, salty, bitter and umami. The key receptor for the entry of SARS-CoV-2 inside the host cells is Angiotensin Converting Enzyme-2 (ACE2). ACE-2 receptor is expressed in multiple organs like lungs, heart, kidney, intestines, buccal cavity, brain etc.

Hao Xu et al. in his study showed that the ACE2 receptors are present and highly enriched in the epithelial cells of the oral cavity. Moreover, ACE2 was seen higher in tongue than in buccal and gingival tissues. These findings indicate that the oral cavity mucosa is a potentially high risk route of COVID-19 infection [39].

### Treatment of COVID-19 with Olfactory and or Taste Dysfunction

When olfactory and or taste dysfunction related to COVID-19 improves spontaneously with the routine COVID-19 treatment, then specific treatment may not be required. But when impairment persists beyond 2 weeks, treatment should be considered. The efficacy of available treatments for patients with COVID-19 related olfactory and or taste dysfunction is unknown, however treatments may potentially be helpful in such conditions. Olfactory training involves repeat and deliberate sniffing of a set of odorants (commonly lemon, rose, cloves and eucalyptus) for 20 s each at least twice a day for at least 3 months. Studies have demonstrated improved olfaction in patients with post-infectious olfactory dysfunction after olfactory training [40]. Olfactory training can be considered for patients with persistent COVID-19 related olfactory dysfunction because this therapy has low cost and negligible adverse effects. Oral and intranasal corticosteroids used to reduce any inflammatory component in patients with postinfectious olfactory dysfunction. However, because of safety concerns, the administration of systemic corticosteroids for the routine management of acute COVID-19 is not recommended [40]. Patients who were using intranasal steroids before developing COVID-19 (example, for allergic rhinitis), can continue their medications. Other medications

that have shown promising result in post-infectious olfactory dysfunction include intranasal sodium citrate, which is thought to modulate olfactory receptor transduction cascades, intranasal vitamin A, which may act to promote olfactory neurogenesis and systemic omega-3, which may act a neuro-regenerative or anti-inflammatory [40, 41]. Intranasal vitamin A and systemic omega-3 serve as adjuvant therapies in olfactory training.

In our study the study populations were advised self isolation with smell and taste training. In addition, these study group were treated with intranasal corticosteroid, Oral Vitamin B complex with omega-3 fatty acid, Oral Vitamin A and intranasal sodium citrate.

### Key Messages

This study found that olfactory and or taste dysfunction among patients infected with COVID-19 disease is very common, with both anosmia and ageusia occurs in majority of cases. Hence, it is very important to consider olfactory and taste dysfunction as part of the screening process for COVID-19 that can in turn help to improve case detection and further curtail the spread of the virus. All patients with olfactory and taste dysfunction should be trained to do smell and taste training because that helps in faster self-recovery over time. It is very important to obtain olfactory and gustatory testing data on patients with confirmed COVID-19 testing, to provide a quantitative data on the incidence and severity of these sensory functions. Finally, more studies are required to understand the mechanism of olfactory and taste dysfunction with respect to coronavirus infections and also the status of the nasal mucosa in post-covid patients.

**Author Contributions** MJ collected patients details and followed up, BS analyzed and interpreted the patient data regarding the olfactory and taste dysfunction in COVID-19 patients. Both the authors contributed in writing the manuscript. All authors read and approved the final manuscript.

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**Data Availability** This is a retrospective observational study of COVID-19 positive patients who had olfactory and or taste dysfunction, attended Otorhinolaryngology outpatient department of tertiary care hospital in Mumbai, West India from 1st May 2020 to 1st August 2020. Proper history, OPD examinations and meticulous follow up were done in all the patients and tabulation done from all the accumulated data.

### Declarations

**Conflict of interest** All authors hereby declare that there is no financial or personal relationship that could cause a conflict of interest regarding this article. There are no financial or personal relationships with people or organizations that could inappropriately bias employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications / registrations, and grants or other funding.

**Ethical Approval** Ethical committee approval was taken from Bombay Hospital Ethics Committee with registration number ECR/296/Inst/MH/2013, 15/01/2021.

**Consent to Participate** This is a retrospective observational study, so consent to participate is waived.

**Consent for Publication** Consent for publication is taken.

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