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# Comparative Analysis of Olfactory and Gustatory Function of Patients With COVID-19 Olfactory Dysfunction and Non-COVID-19 Postinfectious Olfactory Dysfunction

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## ABSTRACT

**Background:** Coronavirus disease 2019 (COVID-19) is known to have a high incidence of loss of smell and taste. However, studies in the early stages of the COVID-19 pandemic have evaluated these symptoms using subjective surveys and simple olfactory tests only. Hence, we compared the olfactory and gustatory characteristics of patient groups with COVID-19 olfactory dysfunction (C19OD) and non-COVID-19 postinfectious olfactory dysfunction (PIOD) using an objective olfactory test and evaluated the significance of olfactory training in both patient groups.
**Methods:** We retrospectively analyzed the medical records of 14 patients with a decreased sense of smell after having positive COVID-19 polymerase chain reaction results, and 56 patients with PIOD with no history of confirmed COVID-19. Participants were evaluated using the Korean version of the Sniffin' stick (KVSS) II, and chemical gustometry and olfactory training was assessed during their first visit. Olfactory training was then re-evaluated after an average of 8 (± 6) weeks.
**Results:** The average age of participants in the C19OD group was lower than in those in the non-COVID-19 PIOD group. The proportion of men in the C19OD group was higher than in the non-COVID-19 PIOD group. At baseline assessment, the C19OD group had better olfactory and gustatory functions. After olfactory training, the non-COVID-19 PIOD patient group showed a significant increase in all KVSS II Total, T, D, and I scores, but there was a non-significant increase in all scores in the C19OD group.
**Conclusion:** The C19OD group had better olfactory and gustatory function than the non-COVID-19 PIOD group at the initial assessment. After olfactory training, there was an increase in olfactory function test scores in both groups. Olfactory training may be helpful in C19OD, as in non-COVID-19 PIOD.

**Keywords:** COVID-19; Olfaction; Anosmia; Smell; Ageusia

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**Disclosure**

The authors have no potential conflicts of interest to disclose.

**Author Contributions**

Conceptualization: Kim JK. Data curation: Jung T, Jang M, Kim T. Formal analysis: Jung T, Choi BY. Funding acquisition: Kim JK. Methodology: Jung T, Kim JK. Project administration: Kim JK. Visualization: Seo E. Writing - original draft: Jung T, Kim JK. Writing - review & editing: Jung T, Choi BY, Kim T, Kim JK.

## INTRODUCTION

The severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2)-caused coronavirus disease 2019 (COVID-19) has spread rapidly since it was first diagnosed in December 2019, and continues to be a pandemic worldwide. COVID-19 is transmitted when a virus is simultaneously released through droplets of an infected person and penetrates the respiratory mucous membrane of another person. Main symptoms of COVID-19 infection include sore throat, fever, cough, chills, diarrhea, and olfactory and gustatory dysfunctions. It is known that olfactory and gustatory dysfunction occur at a high rate with objective hyposmia symptoms reported in up to 90% of cases.[1]

There are many hypotheses about the mechanism by which COVID-19 causes olfactory and gustatory dysfunction, but not much has been identified. SARS-CoV-2 has an S protein that attaches to the host's angiotensin-converting enzyme 2 (ACE2) receptor, and promotes transmembrane protease serine subtype 2 (TMPRSS2), which degrades the protein after binding and helps enter the cells.[2] There are hypotheses regarding the relationship between olfactory dysfunction and the olfactory neuroepithelium distribution of ACE2 receptor,[3] but its exact location and function according to its expression have not been clarified.[4]

Before the COVID-19 pandemic, postinfectious olfactory dysfunction (non-COVID-19 PIOD) was one of the most common causes of olfactory dysfunction and refers to persistent olfactory dysfunction even after recovery from an upper respiratory tract infection. This dysfunction may be caused by a conductive olfactory disorder due to mucosal edema in the early stages of upper respiratory tract infection, followed by damage to the olfactory epithelium or damage to the olfactory transmission central nerve.[5]

Various drugs such as zinc, vitamin, α-lipoic acid, and steroid are being studied as pharmacologic management for olfactory dysfunction, and after Hummel et al.[6] suggested olfactory training in 2009; the effect of olfactory training has been confirmed in many studies.[7,8]

The initial pattern of dysfunction in COVID-19 olfactory dysfunction (C19OD) before the occurrence of mutations, such as omicrons, is different from the previous PIOD, wherein many cases were reported without accompanying nasal symptoms, such as nasal congestion and rhinorrhea. Hence, a more comparative study with previous non-COVID-19 PIOD is required.

Due to the characteristics of acute infectious diseases and quarantine policies, studies during the early stage of the COVID-19 pandemic were often evaluated through subjective surveys and simple olfactory tests only. Studies comparing C19OD with non-COVID-19 PIOD and reports on the effectiveness of olfactory training in C19OD are few.

Accordingly, the authors compared the olfactory and gustatory characteristics of the C19OD and non-COVID-19 PIOD patient groups using an objective olfactory test, and evaluated the significance by evaluating the effects of olfactory training in both patient groups.

# METHODS

## Participants

Patients with suspected PIOD who visited the otolaryngology outpatient department of our hospital with a decreased sense of smell were included in this study. Patients with a history of chronic sinusitis, nasal surgery, hypothyroidism, liver cirrhosis, malignant tumor, or head trauma were excluded from the study.

In the C19OD patient group, 21 patients who visited the hospital complaining of a decreased sense of smell after COVID-19 and confirmed with a positive SARS-CoV-2 real-time polymerase chain reaction between March 2020 and December 2022 in Korea were selected as study participants. Out of these patients, 7 were lost during follow-up, resulting in a total of 14 patients included in the study. In the non-COVID-19 PIOD patient group, 66 people suspected of having a reduced sense of smell after having symptoms of upper respiratory infection from March 2015 to December 2019 in Korea were selected as study participants. Eleven of them were lost during follow-up, resulting in a total of 55 people included in the study (**Fig. 1**).

## Study design

During the initial visit, a standardized form was used to record each participant's medical history. Systemic examination was done, along with an olfactory cleft endoscopy. The Korean version of the Sniffin' stick II (KVSS II) was used to conduct the olfactory function test. Visual analog scale (VAS) was used to evaluate the subjective nasal function. Gustatory function was evaluated using chemical gustometry. Chemical gustometry uses six diluted solutions of the five tastes (sweet, salty, bitter, sour, and umami); the most diluted and concentrated solution were given 6 points and 1 point, respectively. If the most highly concentrated solution was not recognized, 0 points is given. The detection for taste (detection score) and the capacity to distinguish the kind of taste (recognition score) were also scored. All participants underwent

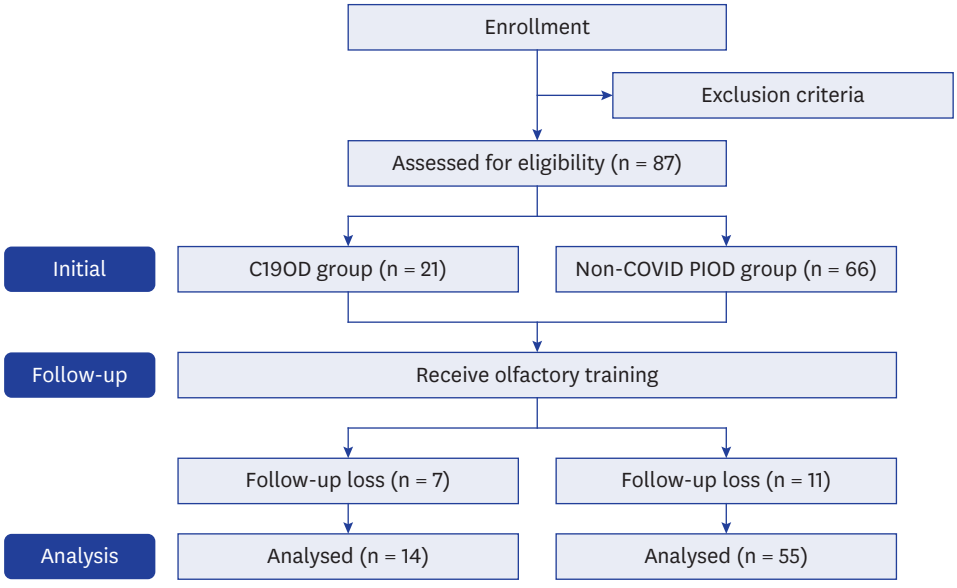


**Fig. 1.** Patient enrollment flow diagram.
COVID-19 = coronavirus disease 2019, C19OD = COVID-19 olfactory dysfunction, PIOD = postinfectious olfactory dysfunction.


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olfactory training after the first visit and were re-evaluated using the KVSS II test after an average of eight weeks.

### Olfactory training

Olfactory training was conducted for an average of eight weeks (± 4 weeks) after the first visit. As reported by Choi et al.[7] and Park et al.,[9] five odors (lemon, rose, cinnamon, peach, and orange) were administered twice a day, during morning and evening. Each plastic container containing five odors was sniffed for 10s at intervals of 10s, and a daily report was written.

### Statistical analysis

R software version 4.2.0 (R Foundation for Statistical Computing, Vienna, Austria) was used for statistical analyses. Comparisons between the two groups were performed using independent *t*-test, $\chi^2$ test, and Fisher's exact test. A paired *t*-test was used to compare the olfactory scores at the first visit and follow-up for each patient group. Statistical significance was set at 0.05.

### Ethics statement

This study was conducted in accordance with the principles of the Declaration of Helsinki. The study was reviewed and approved by the Institutional Review Board of Konkuk University Medical Center (IRB No. KUH 11100063), and written informed consent was obtained from all patients.

## RESULTS

### General characteristics and demographic distribution

This study included 87 participants (mean age, 49.4 ± 15.9 years; range, 10–74 years; 29 males and 58 females) (**Table 1**). The C19OD group consisted of 21 patients (mean age, 30.1 ± 13.6 years; range, 10–62 years; 12 males and nine females) while the non-COVID-19 PIOD group comprised 66 patients (mean age, 55.7 ± 11.0 years; range, 23–74 years; 17 males and 49 females). The average age of the C19OD group was 30.1 years, and that of the non-COVID PIOD group was 55.7 years. The mean age was significantly lower in the C19OD group ($P < 0.001$). The gender composition of each patient group was 57.1% male and 42.9% female in the C19OD group while 25.8% males and 74.2% females in the non-COVID-19 PIOD group (**Fig. 2**). The male proportion of the C19OD group was higher than in the non-COVID-19 PIOD

**Table 1.** General characteristics and demographic distribution of patients group

| Variables | C19OD group (n = 21) | Non-COVID-19 PIOD group (n = 66) | *P* value |
|---|---|---|---|
| Age, yr | 30.14 ± 13.63 | 55.65 ± 11.05 | < 0.001*** |
| Sex | | | 0.005** |
| Male | 12 (57.1) | 17 (25.8) | |
| Female | 9 (42.9) | 49 (74.2) | |
| Median duration, mon (n = 68) | 4.75 ± 3.81 | 5.52 ± 9.45 | 0.774 |
| Degree of dysfunction | | | 0.062 |
| Anosmia | 8 (38.1) | 40 (60.6) | |
| Hyposmia | 11 (52.4) | 25 (37.9) | |
| Normosmia | 2 (9.5) | 1 (1.5) | |

Continuous variables are presented as mean ± standard deviation, and categorical variables are presented as number (%).
COVID-19 = coronavirus disease 2019, C19OD = COVID-19 olfactory dysfunction, PIOD = postinfectious olfactory dysfunction.
**$P < 0.01$, ***$P < 0.001$.


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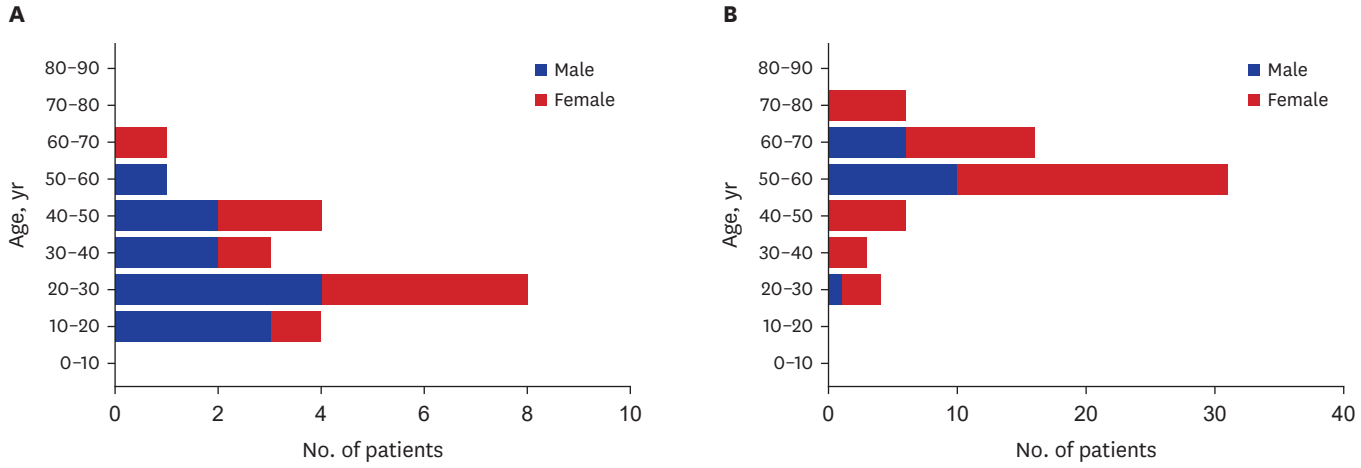


**Fig. 2.** Age distribution by sex. (**A**) C19OD group, (**B**) non-COVID-19 PIOD group.
COVID-19 = coronavirus disease 2019, C19OD = COVID-19 olfactory dysfunction, PIOD = postinfectious olfactory dysfunction.

group ($P$ = 0.005). The average duration of olfactory dysfunction was 4.75 months and 5.52 months for the C19OD and non-COVID-19 PIOD groups, respectively, which is not statistically significant ($P$ = 0.643). The degree of loss of smell was classified as anosmia (0–20 points), hyposmia (21–27 points), and normosmia (28–48 points) according to the total KVSS II score, During the initial visit, hyposmia accounted for 52.4% in the C19OD patient group. In the non-COVID PIOD patient group, anosmia was as high as 60%, although the difference in the composition rate between the two groups was not statistically significant ($P$ = 0.062).

## Chemical gustometry scores of C19OD and non-COVID-19 PIOD groups

After the chemical gustometry test performed at the first visit, the gustatory detection score showed a significantly higher scores in sweet ($P$ = 0.049), salty ($P$ = 0.013), sour ($P$ = 0.012), and umami tastes ($P$ = 0.005) in the C19OD patient group. The bitter taste score was significantly higher in the non-COVID-19 PIOD group ($P$ = 0.014) (**Table 2**).

The Recognition score, which is the capacity to distinguish the correct taste, was significantly higher in the C19OD patient group for sweet ($P$ = 0.002) and salty tastes ($P$ < 0.001). Sour taste ($P$ = 0.344) and umami taste ($P$ = 0.589) were also higher in the C19OD patient group

**Table 2.** Chemical gustometry score of C19OD and non-COVID PIOD group

| Variables | C19OD group (n = 14) | Non-COVID-19 PIOD group (n = 55) | *P* value |
|---|---|---|---|
| Chemical gustometry detection score (initial) (n = 66) | | | |
| Sweet | 5.08 ± 1.80 | 4.17 ± 1.37 | 0.049* |
| Bitter | 2.69 ± 1.89 | 3.92 ± 1.49 | 0.014* |
| Salty | 5.38 ± 1.71 | 4.32 ± 1.24 | 0.013* |
| Sour | 5.31 ± 1.80 | 4.00 ± 1.58 | 0.012* |
| Umami | 5.54 ± 1.66 | 4.08 ± 1.63 | 0.005** |
| Chemical gustometry recognition score (initial) (n = 66) | | | |
| Sweet | 4.69 ± 2.21 | 3.17 ± 1.35 | 0.002** |
| Bitter | 0.46 ± 1.13 | 2.92 ± 1.58 | < 0.001*** |
| Salty | 5.00 ± 1.91 | 2.19 ± 1.72 | < 0.001*** |
| Sour | 3.54 ± 2.82 | 2.94 ± 1.78 | 0.344 |
| Umami | 3.31 ± 2.81 | 2.96 ± 1.84 | 0.589 |

Continuous variables are presented as mean ± standard deviation.
COVID-19 = coronavirus disease 2019, C19OD = COVID-19 olfactory dysfunction, PIOD = postinfectious olfactory dysfunction.
*$P$ < 0.05, **$P$ < 0.01, ***$P$ < 0.001.


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although the difference was not significant. The bitter taste score was significantly higher in the non-COVID-19 PIOD group ($P < 0.001$).

### Comparison of olfactory function before and after olfactory training

The olfactory VAS score was 2.83 points for the C19OD group and 2.52 points for the non-COVID-19 PIOD group, with no significant difference. The average total KVSS II score before olfactory training was 21.77 points in the C19OD group, which was significantly higher than the 17.4 points in the non-COVID-19 PIOD group ($P = 0.018$) (**Table 3**). The average discrimination score was 10.07 points in the C19OD group, which was significantly higher than the 7.04 points in the non-COVID-19 PIOD group ($P < 0.001$). There was no significant difference between the threshold ($P = 0.414$) and identification scores ($P = 0.072$). The average total KVSS II score after olfactory training was 22.64 points in the C19OD group and 21.25 points in the non-COVID-19 PIOD group, with no significant difference ($P = 0.459$). The average threshold score was 2.50 points in the C19OD group, which was significantly lower than the 4.09 points in the non-COVID-19 PIOD group ($P = 0.034$). The average discrimination score was 10.21 points in the C19OD group, which was significantly higher than the 8.07 points in the non-COVID-19 PIOD group ($P = 0.007$). There was no significant difference in the identification scores ($P = 0.327$).

### Difference in KVSS II score in each group after olfactory training

In the C19OD group, the total KVSS II score increased from 21.77 ± 5.48 points before olfactory training to 22.64 ± 5.22 points after olfactory training, although not statistically significant ($P = 0.419$). The threshold score ($P = 0.195$), discrimination score ($P = 0.793$), and identification score ($P = 0.626$) also increased but were not statistically significant. In the non-COVID-19 PIOD group, the KVSS II total score significantly increased from 17.40 ± 6.16 points before olfactory training to 21.25 ± 6.45 points after olfactory training ($P < 0.001$), and the threshold score ($P < 0.001$), discrimination score ($P < 0.001$), and identification scores ($P < 0.001$) all increased significantly (**Fig. 3**, **Table 4**).

The average difference in the KVSS II total score after olfactory training was 0.88 in the C19OD group and 3.85 in the non-COVID-19 PIOD group. The increase in the score was higher in the non-COVID-19 PIOD group, however the difference was not statistically significant ($P = 0.051$). There were no significant differences in the threshold score ($P = 0.151$), discrimination score ($P = 0.266$), or identification score ($P = 0.229$) (**Table 5**).

**Table 3.** Comparison of olfactory function before and after olfactory training

| Variables | C19OD group (n = 14) | Non-COVID-19 PIOD group (n = 55) | *P* value |
|---|---|---|---|
| VAS score (initial) (n = 67) | 2.83 ± 1.75 | 2.52 ± 2.23 | 0.648 |
| KVSS II initial total score | 21.77 ± 5.48 | 17.40 ± 6.16 | 0.018* |
| Threshold score (initial) | 2.12 ± 1.21 | 2.64 ± 2.24 | 0.414 |
| Discrimination score (initial) | 10.07 ± 2.13 | 7.04 ± 2.32 | < 0.001*** |
| Identification score (initial) | 9.57 ± 3.30 | 7.73 ± 3.38 | 0.072 |
| KVSS II follow-up total score (8 ± 4 wks) | 22.64 ± 5.22 | 21.25 ± 6.45 | 0.459 |
| Threshold score (8 ± 4 wks) | 2.50 ± 1.57 | 4.09 ± 2.63 | 0.034* |
| Discrimination score (8 ± 4 wks) | 10.21 ± 2.01 | 8.07 ± 2.70 | 0.007** |
| Identification score (8 ± 4 wks) | 9.93 ± 3.00 | 9.05 ± 2.95 | 0.327 |

Continuous variables are presented as mean ± standard deviation.
COVID-19 = coronavirus disease 2019, C19OD = COVID-19 olfactory dysfunction, PIOD = postinfectious olfactory dysfunction, VAS = visual analog scale, KVSS = Korean version of the Sniffin' stick.
*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.


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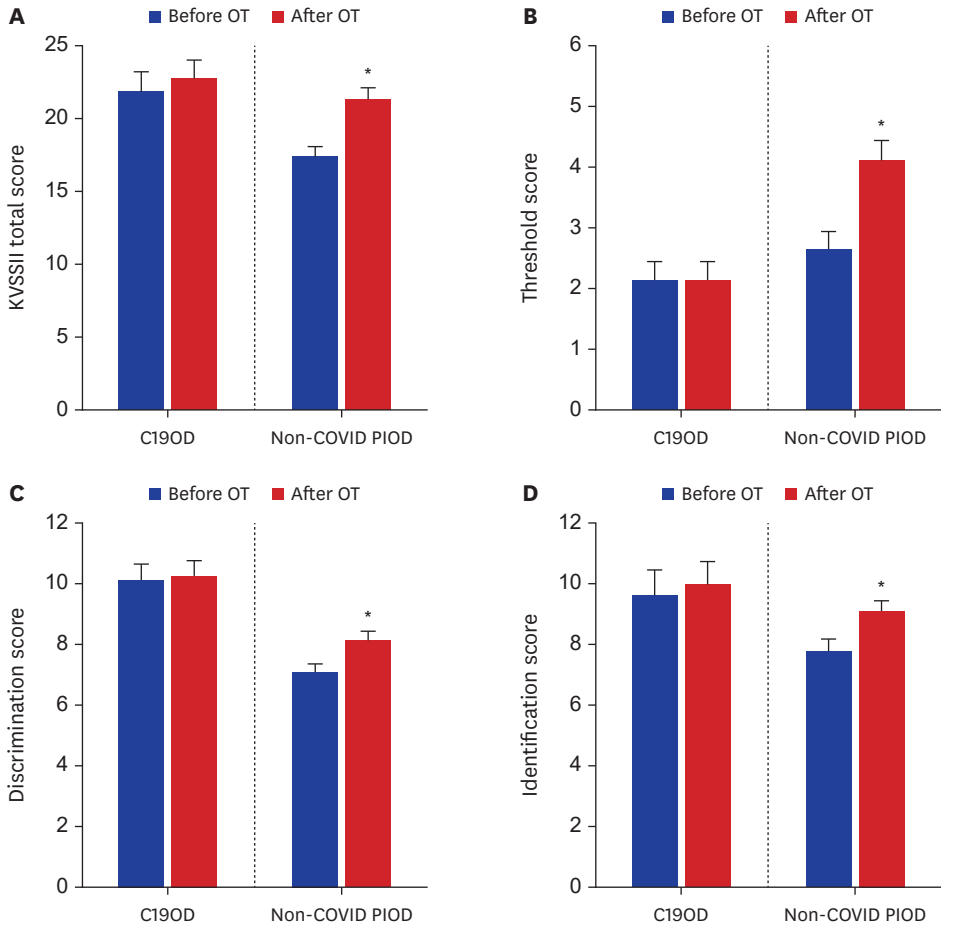


**Fig. 3.** Comparison of the KVSS II score. Total threshold, discrimination, and identification (TDI) scores (**A**), threshold score (**B**), discrimination score (**C**), identification score (**D**), and difference between the initial and final assessments in the C19OD and non-COVID-19 PIOD groups.
COVID-19 = coronavirus disease 2019, C19OD = COVID-19 olfactory dysfunction, PIOD = postinfectious olfactory dysfunction, OT = olfactory training.

**Table 4.** Difference in KVSS II score in each group after olfactory training

| Variables | Initial KVSS II test | Follow-up KVSS II test | *P* value |
|---|---|---|---|
| C19OD group (n = 14) | | | |
| KVSS II test score | 21.77 ± 5.48 | 22.64 ± 5.22 | 0.419 |
| Threshold score | 2.12 ± 1.21 | 2.50 ± 1.57 | 0.195 |
| Discrimination score | 10.07 ± 2.13 | 10.21 ± 2.01 | 0.793 |
| Identification score | 9.57 ± 3.30 | 9.93 ± 3.00 | 0.626 |
| Non-COVID-19 PIOD group (n = 55) | | | |
| KVSS II test score | 17.40 ± 6.16 | 21.25 ± 6.45 | < 0.001*** |
| Threshold score | 2.64 ± 2.24 | 4.09 ± 2.63 | < 0.001*** |
| Discrimination score | 7.04 ± 2.32 | 8.07 ± 2.70 | 0.008** |
| Identification score | 7.73 ± 3.38 | 9.05 ± 2.95 | < 0.001*** |

Continuous variables are presented as mean ± standard deviation.
KVSS = Korean version of the Sniffin' stick, COVID-19 = coronavirus disease 2019, C19OD = COVID-19 olfactory dysfunction, PIOD = postinfectious olfactory dysfunction.
**$P$ < 0.01, ***$P$ < 0.001.


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**Table 5.** Difference in KVSS II score in each group before and after olfactory training

| Variables | C19OD group (n = 14) | Non-COVID-19 PIOD group (n = 55) | *P* value |
|---|---|---|---|
| Difference in total score (follow-up to initial) | 0.88 ± 3.92 | 3.85 ± 5.23 | 0.051 |
| Threshold score | 0.38 ± 1.03 | 1.45 ± 2.73 | 0.152 |
| Discrimination score | 0.14 ± 1.99 | 1.04 ± 2.80 | 0.266 |
| Identification score | 0.36 ± 2.68 | 1.33 ± 2.67 | 0.229 |

Continuous variables are presented as mean ± standard deviation.
KVSS = Korean version of the Sniffin' stick, COVID-19 = coronavirus disease 2019, C19OD = COVID-19 olfactory dysfunction, PIOD = postinfectious olfactory dysfunction.

## DISCUSSION

Several hypotheses have been proposed for being the mechanism by which COVID-19 causes olfactory and gustatory disorders, but none has been clearly identified. C19OD differs from PIOD in that it has a sudden onset and lasts for a relatively short period, with a high rate of spontaneous improvement. Olfactory function recovered within one month in most studies. Recent research has revealed that the dysfunction in the olfactory sensory neurons (OSN) must be more than 90% for olfactory dysfunction to occur due to a decrease in OSN function.[10] However, such extensive neuronal loss has not been reported in patients with COVID-19, and OSN damage is known to recover within 10 days to 1 month. In contrast, the supporting cells recover faster, typically within 4 to 8 days. The rapid onset and recovery period of C19OD may be attributed to these factors. Furthermore, RNAscope analysis has revealed that SARS-CoV-2 is found in the supporting cells of the olfactory epithelium, specifically the sustentacular cells, rather than the olfactory bulb neurons.[11] This finding suggests that the olfactory supporting cells, rather than OSN, are associated with the onset of the condition. It is presumed that the high prevalence of hyposmia is due to the targeting of supporting cells rather than the olfactory neurons. Tan et al.[1] reported that in a meta-analysis of studies in patients with C19OD worldwide, the recovery rate of smell was 74.1% within 30 days and 95.7% within 180 days, and the recovery rate of taste was 78.8% within 30 days and 98.0% within 180 days. Oral steroid administration, topical steroids, and olfactory training were provided as treatment for C19OD,[8,12,13] but reports on long-term follow-up observations and results are lacking. In previous studies of non-COVID-19 PIOD, olfactory training was known as a treatment method that can restore olfactory function without major side effects, but there is a lack of studies evaluating the progress by conducting olfactory training in C19OD using objective tests.

Comparing each patient group initially recruited in this study, the C19OD group had a lower average age, a higher proportion of males, and a higher rate of hyposmia. Previous non-COVID-19 PIOD is known to be common in women over the age of 50,[14,15] and our study confirmed similar results wherein the average age was 55.7 years with a female proportion of 74.2%. In our study, the C19OD patient group had an average age of 31.7 years and a female sex proportion of 42.7%. It has been previously reported that COVID-19 patients with olfactory dysfunction have a lower average age than COVID-19 patients without olfactory dysfunction.[16,17] Contrary to the findings of our study, a recent report indicated that the C19OD patient group included a high percentage of women.[18,19,20] Heo et al. reported that patients who recovered were mostly women ($P$=0.001) who were significantly younger ($P$=0.048).[20] Considering that the average duration of symptoms in the C19OD patient group who visited our hospital was more than four months, selection bias may have occurred because of the high proportion of men who did not recover from the symptoms. Similarly, in the C19OD patient group, the duration of olfactory loss was found to be longer than what is


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commonly observed. This may be attributed to the potential selection bias as the institution where the study was conducted is a tertiary healthcare facility. Thus, rather than representing the overall prevalence in the general population, the likelihood of receiving a larger number of patients who were referred after treatment at primary or secondary healthcare facilities with no improvement in their post-infection olfactory dysfunction was higher.

It was expected that the gustatory function would be worse in the C19OD group, but in this study, the gustatory function was better in the C19OD group, except for bitter taste. In C19OD, the ratio of chemosensory dysfunction, including olfactory and gustatory function, was high. According to Tan et al.,[1] a global meta-analysis reported that the sense of taste was restored, with a recovery rate of 78.8% within 30 days and 98.0% after 180 days. The ACE2 receptor is known as a functional receptor for SARS-CoV-2, which is abundantly distributed in epithelial cells of the tongue, basal cells of the nasal cavity, and acinar cells of the salivary gland.[3] Some reports suggest a high possibility of chemosensory dysfunction. However, the specific cell types that highly express ACE2 remain unclear.[4] As for gustatory dysfunction in C19OD patients, there are reports that the function of sweetness and bitterness is significantly reduced.[21] Some reports indicate a decreased sensation mainly in the salty taste,[22] while others report a decrease in threshold of the salty taste in patients with C19OD.[23] There are few reports evaluating gustatory function; therefore, further research is needed. In this study, gustatory function was better in the C19OD group. Considering that the olfactory score was high in the C19OD group, it can be assumed that olfactory function is most important to gustatory function in C19OD, as in the previous PIOD.

The KVSS II score increased after olfactory training in both groups but only significantly increased in the non-COVID-19 PIOD group. Hummel et al. reported that a higher residual olfactory function was negatively associated with a relevant improvement in olfactory function.[24] This is consistent with the finding that olfactory training was less effective in the C19OD group, which had a higher residual olfactory function. Lechien et al.[25] reported an objective improvement in olfactory scores for up to 12 months in the olfactory training group. In our study, the C19OD group was followed up after an average of 6.8 weeks and the non-COVID-19 PIOD group after an average of 10.9 weeks. The possibility that a significant difference occurred due to the difference in these periods cannot be ruled out. The exact effect of the total score or each subscore of T, D, and I after olfactory training in patients with PIOD is still unclear. Hummel et al.[6] reported a significant effect only on the T-score after olfactory training, and Sorokowska et al.[8] reported significant effects on the D, I, and TDI total scores, excluding the T-score. Vandersteen et al.[19] reported a significant increase in the T score and decrease in the D score after olfactory training in patients with C19OD, suggesting the need for a study on the etiology of the central abnormality of C19OD. Although there are differences among papers on the exact effect of olfactory training, olfactory training was introduced as a good treatment method without side effects even in C19OD.[26,27] Although it was not statistically significant in our study, we confirmed the score improvement ($P = 0.051$), olfactory training can be a treatment method for C19OD.

The C19OD group had higher olfactory scores at the first visit, and the scores were similar between the two groups at follow-up. The increase in score after olfactory training was higher in the non-COVID-19 PIOD group. The C19OD group visited the hospital after an average of 4.75 months, whereas the non-C19OD group visited the hospital after 5.52 months. There was no significant difference between the two groups in terms of the time taken for testing after symptom manifestation ($P = 0.643$). Considering the low average age of the C19OD


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group, it may be that younger people who usually had good olfactory function were more sensitive to the loss of smell and more likely to visit the hospital. The drop out rate was high in the C19OD group. According to previous reports analyzing subjective symptoms, the average symptom duration of C19OD is approximately 10 days, and the recovery rate is known to be–32–89%.[1,28,29] As reported in several studies, it is possible that the patients in the C19OD group did not follow-up because of a high rate of spontaneous recovery. Prem et al.[30] reported hyposmia in 72.5% and anosmia in 4.0% of patients with C19OD after an average of 216 days. Our study revealed that the rate of hyposmia in patients with C19OD was at 52.4% after an average of 16 weeks, indicating a high hyposmia rate in these patients; however, more research is needed in this regard.

This study has certain limitations. First, most of the patients visited the hospital after experiencing symptoms for more than five weeks; therefore, the evaluation of the initial symptoms was insufficient. Second, only a small number of patients were included in the study. Moreover, limitations in the treatment and examination of patients with COVID-19 make it difficult to study a large number of patients. In addition, it was challenging to conduct the research by adjusting for demographic features between the two groups due to the limited number of patients. Further research must be conducted to address this issue. Third, there was no long-term follow-up since follow up was only for an average of 12 weeks. However, results on the long-term effects of olfactory training are lacking. Lastly, this study was limited by its retrospective nature, which may have introduced biases due to limitations in data collection or confounding variables. An analysis method utilizing covariates should be considered to address the bias caused by confounding variables. However, similar to other studies on patients with COVID-19, we were unable to perform such an analysis due to the small number of patients in the C19OD group, as performing such an analysis could further reduce the sample size.

In conclusion, comparing the C19OD group and the non-COVID-19 PIOD group, the average age of the subjects in the C19OD group was lower than of the non-COVID-19 PIOD group. The proportion of men in the C19OD group was higher than in the non-COVID-19 PIOD group. At baseline assessment, the C19OD group had better olfactory and gustatory functions. After olfactory training, the non-COVID-19 PIOD patient group showed a significant increase in all KVSS II total, T, D, and I scores. There was also an increase in all the scores in the C19OD group, but this was not statistically significant. Olfactory training may be helpful in C19OD; however, further research is required.

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