
Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

International Journal of Pediatric Otorhinolaryngology 142 (2021) 110626

Contents lists available at ScienceDirect

International Journal of Pediatric Otorhinolaryngology

journal homepage: www.elsevier.com/locate/ijporl

# Loss of smell and taste in COVID-19 infection in adolescents

Lakshit Kumar [a], Namrata Kahlon [b], Avani Jain [a,*], Jasleen Kaur [a], Mitasha Singh [c], A.K. Pandey [b]

[a] Department of ENT, ESIC Medical College and Hospital, Faridabad, India
[b] Department of Physiology, ESIC Medical College and Hospital, Faridabad, India
[c] Department of Community Medicine, ESIC Medical College and Hospital, Faridabad, India

ARTICLE INFO

*Keywords:*
Anosmia
Hyposmia
COVID-19
Dysgeusia
Children
Adolescents

ABSTRACT

*Objectives:* To study the prevalence, clinical course and outcomes of olfactory and taste dysfunction in COVID-19 positive adolescents.
*Methods:* This prospective study was carried out from May to August 2020. The adolescents, aged 10–19 years, who were detected COVID-19 positive by RT-PCR with mild to moderate disease were included in the study. The following epidemiological and clinical outcomes were studied: age, sex, general symptoms, olfactory and taste dysfunction.
*Results:* Out of 141 patients included in the study, there were 83 males (58.9%) and 58 females (41.1%). The age varied from 10 to 19 years with an average of 15.2 years. Forty patients (28.4%) had olfactory or taste dysfunction. Out of these 40 patients, 28 patients (19.8%) had both olfactory and taste dysfunction. Of the 34 patients (24.1%) who complained of olfactory dysfunction, 16 patients complained of hyposmia and 18 patients complained of anosmia. Dysgeusia was reported by 34 patients (24.1%). The duration of OTD varied from 2 to 15 days with an average of 5.7 days.
*Conclusion:* Loss of smell and taste are common symptoms in COVID-19 positive adolescents. It recovers spontaneously within a few weeks, along with the resolution of other symptoms.

## 1. Introduction

COVID-19, an ongoing global pandemic, results from infection with the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). There are varied clinical presentations of the disease in children. They may be asymptomatic, mildly symptomatic with symptoms similar to common viral respiratory tract infections, or it may manifest as multisystem inflammatory syndrome. However, it has been reported that the infection in most children is mild, and some are completely asymptomatic, and are less likely to be hospitalized as compared to adults [1,2]. The possible causes for less severe disease in children as compared to adults are: decreased expression of angiotensin converting enzyme 2 (the receptor for SARS-CoV-2), less intense immune responsivity and potential viral interference by co-infecting viruses [3,4].

There is increasing evidence that olfactory and taste dysfunction can present in COVID-19 patients. Recognizing this dysfunction can help in identifying asymptomatic individuals who may act as carriers, and thereby prevent further spread of the disease. Although olfactory and taste dysfunction has been reported in COVID-19 adult patients, there is limited data on its occurrence in children and adolescents. The main objective of this study was to determine the prevalence of olfactory and taste dysfunction in adolescents and its outcomes.

## 2. Methodology

We evaluated the olfactory and taste dysfunction in adolescent COVID-19 patients at ESIC Medical College and Hospital, Faridabad from May to August 2020. This was a prospective study and was approved by the Institutional Ethics Committee. The data was collected during ENT consultation or over the phone. The inclusion criteria was adolescents, aged 10–19 years, who were detected COVID-19 positive by RT-PCR during the study period with mild to moderate disease [5]. Those patients who could not be contacted even after 3 attempts were excluded from the study. The exclusion criteria were: patients with severe disease or those on assisted ventilation, psychiatric or neurological disorders, previous surgery or radiation of the nasal or oral cavity, chronic rhinosinusitis, pre existing smell or taste disturbances.

All the adolescents with influenza like illness (ILI) who presented to the study centre during the study period underwent COVID-19 testing by RT-PCR of nasopharyngeal swabs. The patients who were COVID-19

* Corresponding author.
*E-mail address:* avanijain87@hotmail.com (A. Jain).

https://doi.org/10.1016/j.ijporl.2021.110626
Received 11 December 2020; Received in revised form 29 December 2020; Accepted 10 January 2021
Available online 13 January 2021

positive and matching the inclusion criteria were included in the study. After COVID-19 positive report, these patients were further contacted and detailed history was taken.

At the time of presentation, the demographic characteristics of the patients were noted. Clinical history was taken from the parent or the patient. The onset and duration of the symptoms were noted, including loss of smell and taste. The patients were asked to rate their smell sensation at its worst point during the infection, as normal, partial (hyposmia) or complete (anosmia) loss of smell. All the patients were asked if they had any alteration in taste (dysgeusia) or not. The order of appearance of symptoms was noted. The duration of loss of smell and/or taste was noted in a follow up ENT consultation or by telephone contact. The patients were followed up till their OTD recovered or COVID-19 negative report, whichever was later.

Data analysis was done using Epi info version 7 software. Differences between groups were assessed using chi square test for qualitative data and "p" value less than 0.05 was considered as statistically significant.

## 3. Results

A total of 141 patients were included in the study, including 83 males (58.9%) and 58 females (41.1%). The age ranged from 10 to 19 years with a mean of 15.2 years. The symptoms of the patients recorded were: malaise in 20 patients (14.2%), sore throat in 28 patients (19.9%), cough in 29 patients (20.6%), fever in 68 patients (48.2%), diarrhoea in 8 patients (5.7%), nasal discharge in 5 patients (3.5%) and headache in 8 patients (5.7%).

Out of 141 patients, 40 patients (28.4%) reported olfactory or taste dysfunction. Olfactory dysfunction was reported by 34 patients (24.1%), taste dysfunction was reported by 34 patients (24.1%) and, both olfactory and taste dysfunction was reported by 28 patients (19.8%). Of the 34 patients who reported olfactory dysfunction, 16 patients complained of hyposmia and 18 patients complained of anosmia. The OTD reported by the two age groups 10–14 years and 15–19 years was 26% and 29.7%, respectively. This difference between the two age groups was not statistically significant ($p = 0.644$). OTD was reported by 30.1% males and 25.9% females. This difference was not statistically significant ($p = 0.581$).

OTD was first noticed before the appearance of other symptoms in 19 patients (13.5%) and after the appearance of other symptoms in 21 patients (14.9%). The duration of OTD varied from 2 to 15 days with an average of 5.7 days. In only three patients the OTD persisted following recovery from COVID-19 infection, that is, after COVID-19 negative report. Out of these three patients, the duration of OTD was 10 days in two patients and 15 days in one patient. The chemosensory dysfunction of all the patients recovered completely.

The association of OTD with other symptoms is shown in Table 1. It was found that OTD had significant positive association with patients having fever (Odds ratio = 10.60, $p = 0.001$) and diarrhoea (Odds ratio = 4.86, $p = 0.027$).

**Table 1**
Association of OTD and general symptoms.

| | Olfactory or taste dysfunction | |
|---|---|---|
| Malaise | No (n = 101) | Yes (n = 40) |
| No | 89 | 32 |
| Yes | 12 | 8 |
| Odds ratio, p value | 1.55, 0.213 | |
| Sore throat | | |
| No | 85 | 28 |
| Yes | 16 | 12 |
| Odds ratio, p value | 3.61, 0.057 | |
| Cough | | |
| No | 83 | 29 |
| Yes | 18 | 11 |
| Odds ratio, p value | 1.64, 0.200 | |
| Fever | | |
| No | 61 | 12 |
| Yes | 40 | 28 |
| Odds ratio, p value | 10.60, 0.001 | |
| Diarrhoea | | |
| No | 98 | 35 |
| Yes | 3 | 5 |
| Odds ratio, p value | 4.86, 0.027 | |

## 4. Discussion

Early reports from China, Italy and United States of America indicated that children were underrepresented among COVID-19 cases, especially among severe and fatal cases [2,6,7]. However, a study by Bi et al. suggested that children are just as likely as adults to be infected by SARS-CoV-2, but are less likely to be symptomatic or develop severe or critical disease [8]. Children have milder clinical symptoms than adults, which could be responsible for reduced testing for SARS-CoV-2 in children as compared to adults [9]. Children, who are asymptomatic or mildly symptomatic, may play a role in community transmission of the virus [10]. Most of the children infected have been part of a family cluster outbreak. Also, the symptoms of other common viral respiratory tract infections in children, such as influenza and respiratory syncytial virus may overlap and pose additional diagnostic challenges.

In adults, the most frequently reported clinical features of COVID-19 are fever, cough, shortness of breath, myalgia, fatigue and headache [10]. Studies have found similar symptoms in children. A review by Hoang et al. [11] reported that the most common clinical manifestations in children were fever (59.1%), cough (55.9%), rhinorrhoea (20.0%) and myalgia/fatigue (18.7%). Children rarely progressed to severe or critical disease, unlike adults [12]. The prevalence of gastrointestinal symptoms varies in various studies.

Sudden loss of smell and taste have also been reported as symptoms of COVID-19 infection. The exact pathophysiology of OTD in COVID-19 patients is still unknown. The possible hypotheses are direct extension via angiotensin-converting enzyme 2 (ACE2) receptor on the nasal epithelium and/or direct invasion of the olfactory bulb and central nervous system [13]. ACE2 is highly expressed on the oral mucosa and tongue, which may be a possible mechanism for gustatory dysfunction. In adults, anosmia and dysgeusia in COVID-19 patients has been widely reported in literature with a varying prevalence. There is a difference in the prevalence of olfactory and taste dysfunction between the Asian [14–16] and European population [17–22]. This may be due to increased expression of ACE2 in the European population as compared to the Asian population [23]. In a review and meta analysis by von Bartheld et al. [24], the prevalence of olfactory and/or gustatory dysfunction in the East Asian and European populations was found to be 23.4% and 54.7%, respectively.

Although there are multiple reports on the prevalence of OTD in adult patients with COVID-19, there is limited data regarding its occurrence in the paediatric population. This may be due to the fact that the diagnosis of olfactory disorders in young children is challenging. PQ Mak et al. [25] reported three children aged- 14 years, 15 years and 17 years, with COVID-19 infection who presented with anosmia and/or ageusia. In a multicentric study by Qiu et al. [16], out of 27 COVID-19 positive children, ten children (37%) reported olfactory or gustatory dysfunction. The age of these ten children ranged from 15 to 17 years, and six were male. Gaborieau et al. [26] reported anosmia/dysgeusia in seven out of 157 children (4.5%) who were positive for SARS-CoV-2 by RT-PCR test. In a study by Somekh et al. [27], in the age group 11–17 years, eight out of twenty children (40%) had altered smell or taste, and in the age group 5–11 years, no children had altered smell or taste. One of the possible mechanisms for OTD in COVID-19 patients is the ability of SARS CoV-2 to bind to ACE2 in the nasal and oral mucosa. Somekh et al. [27] correlated the difference in the impairment of sensation in different age groups with ACE2 expression in the corresponding age groups. They reported that the sensory impairment was significantly lower in children as compared to adult COVID-19 positive patients. This

significant difference supports the data that showed age dependent expression of ACE2 in the nasal epithelium. This could possibly explain that the differences in the sensory impairment may be due to distribution and expression of ACE2 in the oral cavity and nasal epithelium. However, in our study there was no significant difference in the OTD in different age groups.

In our study, the OTD lasted for 2–15 days, with an average of 5.7 days. Three patients reported persisting OTD following recovery from COVID-19 infection, that is, after COVID-19 negative report. Out of these three patients, the OTD was reported for a total duration of 10 days in two patients and 15 days in one patient. However, all the patients reported complete recovery of their smell and taste sensations. This rapid and spontaneous recovery of OTD has also been reported in adult COVID-19 patients. Some studies report that chemosensory loss in COVID-19 adult patients recovers in about 1–2 weeks of onset, in conjunction with improvement of infection [14,17]. This short duration and spontaneous recovery supports the findings that SARS-CoV-2 targets the non neural olfactory epithelial cells. This knowledge of spontaneous recovery of chemosensory dysfunction helps in reassuring patients. Meini et al. [21], reported a complete and near complete recovery in 83% of the studied patients in a month from the hospital discharge (mean recovery time for females was 26 days and for males 14 days). Lechien et al. [17] reported that the olfactory dysfunction persisted after the resolution of other symptoms in 63.0% of cases. The short-term olfaction recovery rate, which was assessed in 59 clinically cured patients, was 44.0%.

This prospective study reports olfactory and taste dysfunction in adolescent COVID-19 patients. Out of the 141 patients included in the study, 28.4% (40 patients) reported OTD. Although the prevalence of OTD in COVID-19 adult patients has been reported in literature, limited research has been published on OTD in children. This study has several limitations. Firstly, in our patients, there was no objective evaluation of olfactory and taste dysfunction, such as psychophysical tests or electrophysiological methods, because of the risk of exposure to health care workers. All the symptoms were self reported by the patients. Secondly, this study included only patients with mild to moderate disease. Patients with severe disease were not included in the study. Additionally, smell and taste disorders are confounded if not separately measured [28].

## 5. Conclusion

Loss of smell and taste are common symptoms in COVID-19 patients and may be the only symptoms in some patients. These symptoms may help in early diagnosis of COVID-19 patients and in reducing the spread of infection. There is limited data on the prevalence of OTD in children and adolescents. In our study, the prevalence of OTD in COVID-19 adolescent patients was 28.4%. OTD resolves spontaneously in around 1–2 weeks of onset.

## Conflicts of interest and source of funding (for all the authors)

None declared.

## References

[1] E. Wang, K. Brar, COVID-19 in children: an epidemiology study from China, J Allergy Clin Immunol Pract 8 (2020) 2118–2120.
[2] N. Parri, M. Lenge, D. Buonsenso, Coronavirus Infection in pediatric emergency departments (CONFIDENCE) research group. Children with Covid-19 in pediatric emergency departments in Italy, N. Engl. J. Med. 383 (2020) 187–190.
[3] S. Bunyavanich, A. Do, A. Vicencio, Nasal gene expression angiotensin-converting enzyme 2 in children and adults, J. Am. Med. Assoc. 323 (2020) 2427–2429.
[4] P. Brodin, Why is COVID-19 so mild in children? Acta Paediatr. 109 (2020) 1082–1083.
[5] Covid-19 Treatment Guidelines Panel, Coronavirus disease 2019 (COVID-19) treatment guidelines. National institutes of health, Available at: https://www.covid19treatmentguidelines.nih.gov/. (Accessed November 2020).
[6] Y. Dong, X. Mo, Y. Hu, X. Qi, F. Jiang, Z. Jiang, et al., Epidemiology of COVID-19 among children in China, Pediatrics 145 (2020), e20200702.
[7] Cdc Covid-19 Response Team, Coronavirus disease 2019 in children—United States, february 12–april 2, 2020, Morb. Mortal. Wkly. Rep. 69 (2020) 422–426.
[8] Q. Bi, Y. Wu, S. Mei, et al., Epidemiology and transmission of COVID-19 in 391 cases and 1,286 of their close contacts in in Shenzhen China: a retrospective cohort study, Lancet Infect. Dis. 20 (2020) 911–919.
[9] P. Zimmermann, N. Curtis, Coronavirus infections in children including COVID-19: an overview of the epidemiology, clinical features, diagnosis, treatment and prevention options in children, Pediatr. Infect. Dis. J. 39 (2020) 355–368.
[10] W.J. Guan, Z.Y. Ni, Y. Hu, W.H. Liang, C.Q. Ou, J.X. He, et al., Clinical characteristics of coronavirus disease 2019 in China, N. Engl. J. Med. 382 (2020) 1708–1720.
[11] A. Hoang, K. Chorath, A. Moreira, M. Evans, F. Burmeister-Morton, F. Burmeister, et al., COVID-19 in 7780 pediatric patients: a systematic review, EClinicalMedicine 24 (2020) 100433.
[12] C. Huang, Y. Wang, X. Li, L. Ren, J. Zhao, Y. Hu, et al., Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China, Lancet 395 (2020) 497–506.
[13] R. Pellegrino, K.W. Cooper, A. Di Pizio, P.V. Joseph, S. Bhutani, V. Parma, Coronaviruses and the chemical senses: past, present, and future, Chem. Senses 45 (2020) 415–422.
[14] A. Jain, L. Kumar, J. Kaur, T. Baisla, P. Goyal, A.K. Pandey, A. Das, L. Parashar, Olfactory and taste dysfunction in coronavirus disease 2019 patients: its prevalence and outcomes, J. Laryngol. Otol. (2020 Nov 16) 1–5.
[15] L. Mao, H. Jin, M. Wang, Y. Hu, S. Chen, Q. He, et al., Neurologic manifestations of hospitalized patients with coronavirus disease 2019 in Wuhan, China, JAMA Neurol 77 (2020) 683–690.
[16] C. Qiu, C. Cui, C. Hautefort, A. Haehner, J. Zhao, Q. Yao, et al., Olfactory and gustatory dysfunction as an early identifier of COVID-19 in adults and children: an international multicenter study, Otolaryngol. Head Neck Surg. (2020 Jun 16), 194599820934376.
[17] J.R. Lechien, C.M. Chiesta-Estomba, D.R. De Siati, M. Horoi, S.D. Le Bon, A. Rodriguez, et al., Olfactory and gustatory dysfunctions as a clinical presentation of mild-to-moderate forms of the coronavirus disease (COVID-19): a multicenter European study, Eur. Arch. Oto-Rhino-Laryngol. 277 (2020) 2251–2261.
[18] M.M. Speth, T. Singer-Cornelius, M. Oberle, I. Gengler, S.J. Brockmeier, A. R. Sedaghat, Olfactory dysfunction and sinonasal symptomatology in COVID-19: prevalence, severity, timing, and associated characteristics, Otolaryngol. Head Neck Surg. 163 (2020) 114–120.
[19] A. Patel, E. Charani, D. Ariyanayagam, A. Abdulaal, S.J. Denny, N. Mughal, et al., New-onset anosmia and ageusia in adult patients diagnosed with SARS-CoV-2 infection, Clin. Microbiol. Infect. 26 (2020) 1236–1241.
[20] V. Gorzkowski, S. Bevilacqua, A. Charmillon, R. Jankowski, P. Gallet, C. Rumeau, D.T. Nguyen, Evolution of olfactory disorders in COVID-19 patients, Laryngoscope (2020 Jul 2), https://doi.org/10.1002/lary.28957.
[21] S. Meini, L.R. Suardi, M. Busoni, A.T. Roberts, A. Fortini, Olfactory and gustatory dysfunctions in 100 patients hospitalized for COVID-19: sex differences and recovery time in real-life, Eur. Arch. Oto-Rhino-Laryngol. 4 (2020) 1–5.
[22] A. Haehner, J. Draf, S. Dräger, K. de With, T. Hummel, Predictive value of sudden olfactory loss in the diagnosis of COVID-19, ORL J Otorhinolaryngol Relat Spec 82 (2020) 175–180.
[23] Y. Cao, L. Li, Z. Feng, S. Wan, P. Huang, X. Sun, et al., Comparative genetic analysis of the novel coronavirus (2019-nCoV/SARS-CoV-2) receptor ACE2 in different populations, Cell Discov 6 (2020) 11.
[24] C.S. von Bartheld, M.M. Hagen, R. Butowt, Prevalence of chemosensory dysfunction in COVID-19 patients: a systematic review and meta-analysis reveals significant ethnic differences, Preprint. *medRxiv* (2020) 2020, https://doi.org/10.1101/2020.06.15.20132134, 06.15.20132134. Published 2020 Jun 17.
[25] P.Q. Mak, K.S. Chung, J.S. Wong, C.C. Shek, M.Y. Kwan, Anosmia and ageusia: not an uncommon presentation of COVID-19 infection in children and adolescents, Pediatr. Infect. Dis. J. 39 (2020) e199–e200.
[26] L. Gaborieau, C. Delestrain, P. Bensaid, A. Vizeneux, P. Blanc, A. Garraffo, et al., Epidemiology and clinical presentation of children hospitalized with SARS-CoV-2 infection in suburbs of paris, J. Clin. Med. 9 (2020) 2227.
[27] I. Somekh, H. Yakub Hanna, E. Heller, H. Bibi, E. Somekh, Age-dependent sensory impairment in COVID-19 infection and its correlation with ACE2 expression, Pediatr. Infect. Dis. J. 39 (2020) e270–e272.
[28] D.A. Deems, R.L. Doty, R.G. Settle, V. Moore-Gillon, P. Shaman, A.F. Mester, et al., Smell and taste disorders, a study of 750 patients from the university of Pennsylvania smell and taste center, Arch. Otolaryngol. Head Neck Surg. 117 (1991) 519–528.