Prevalence of anosmia in coronavirus disease 2019-confirmed cases

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Objectives
The current study aims to evaluate the prevalence of anosmia and the factors affecting it in coronavirus disease 2019 (COVID-19)-confirmed cases.

Patients and methods
A cross-sectional, multicenter study was conducted on 400 COVID-19-confirmed patients. The clinical data were collected from patients, either hospitalized in COVID-19 units of different isolation hospitals or home-quarantined, in Egypt. Data were collected through a predesigned survey-based 16 questionnaire, available in two forms, one in a written form and the other was online-designed by Google forms.

Results
The prevalence of anosmia was 68.8% in COVID-19-confirmed cases. About 41.1% of the patients had isolated anosmia. There were no significant differences between those with anosmia and those without as regards smoking and chronic rhinological status, *P* values were 0.118 and 0.132, respectively.

Conclusion
As a prevalent symptom of COVID-19 patients, anosmia will raise the suspicion index of health staff in developing countries with limited access to the COVID-19 test.

Keywords:
COVID-19, Anosmia, Corona virus

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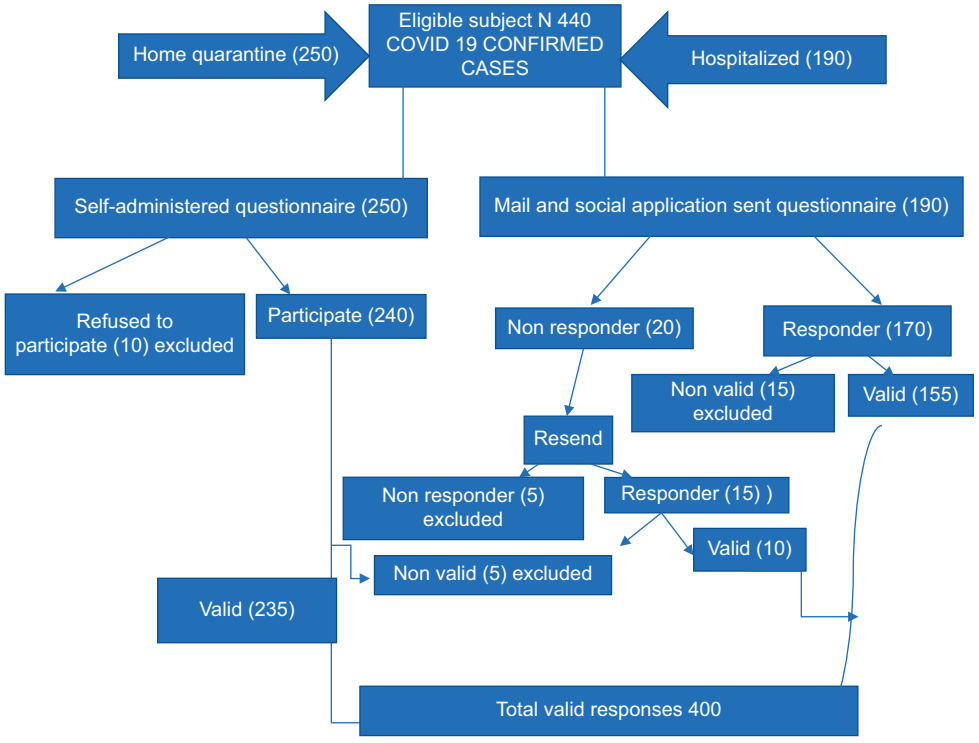
Introduction

Coronavirus disease 2019 (COVID-19) is an ongoing viral pandemic that began in East Asia and then spread worldwide [1]. According to the Asian clinical studies, the most prevalent symptoms were fever, cough, dyspnea, headache, diarrhea, arthralgia, sore throat, and rhinorrhea [2]. The expansion of COVID-19 infection throughout Europe has resulted in the emergency of a novel atypical presentation as smell impairment. Anosmia is not uncommon in viral infections in otolaryngology. Numerous viruses may cause smell impairment through nasal mucosa inflammation. The most common viruses are parainfluenza virus, rhinovirus, Epstein–Barr virus, and some coronaviruses [3]. COVID-19 patients present with a wide variety of clinical symptoms. However, the diagnosis might be difficult in the absence of chest radiologic changes or fever [1]. Thus, other early symptom evaluations are crucially important. The current study aimed to assess the prevalence of anosmia and the factors affecting it in COVID-19-confirmed cases.

Patients and methods

On 400 COVID-19 patients, a multicenter cross-sectional study had been conducted in Egypt. The clinical data were collected from patients either hospitalized in COVID-19 units of different isolation hospitals or home-quarantined, in the period from August 25 to October 6, 2020. All cases were confirmed by PCR of a nasal or pharyngeal swab. A pilot study was performed that aimed to assess the usability and clarity of the tool. It also helped to predict the time required for the forms to be filled in. After the pilot study, no changes were done to the tool, so pilot-study participants were included in the study sample. The questionnaire was simple, short, and easy to be answered. There was a good relationship between the staff and the patients encouraging them to participate. Every participant was ensured as regards the confidentiality of the data. We had 440 eligible patients, but the total valid responses were 400. In the self-administered questionnaire, 240 patients decided to participate with 235 valid responses, while 10 patients refused for personal reasons, and five responses were not valid. On the other hand, we had 170 responders among those who received the questionnaire by mail and social application methods. In this group, we had 165 valid responses, so the final valid responses were 400 (Fig. 1).

Figure 1



anosmia flow chart

The present study differs from others in focusing not only on the prevalence of anosmia but also studying the factors affecting it like age, sex, and chronic diseases among Egyptians. Another point of strength is that the study was conducted on a large number of patients, as well as the geographical spread, which included 20 governments in Egypt. Our questionnaire reference was the American Academy of Otolaryngology–Head and Neck Surgery, COVID-19 Anosmia Reporting Tool for Clinicians [4].

Benha University Faculty of Medicine ethical committee has given their approval as regards the methods of selection. Prior to the start of the study, participants gave their informed consent.

Selection and description of participants

Inclusion criteria

Adults aged more than 18 years with a laboratory-confirmed COVID-19 infection and clinically able to fulfill the questionnaire.

Exclusion criteria

Patients having smell disorders before the pandemic, nonlaboratory-confirmed COVID-19-infection cases, and those who were in the ICU at the time of the study.

Data were collected through a predesigned survey-based 16 questionnaire. Two forms were available, one was self-administered, and the other was online, which was sent by mail and social application methods.

The first four questions were about the basic characteristics of the participants (age, sex, residence, and smoking). The next seven questions were about the olfactory dysfunction after COVID-19 infection [presence or absence of anosmia, onset, degree, duration, other related COVID-19 symptoms, the time interval between these symptoms, loss of smell, and improvement of anosmia (partial or gradual)]. The last five questions were about sinonasal disorders and their related surgeries, chronic diseases (asthma, diabetes, and heart disease), any other investigations, and treatment.

Statistical analysis

Data analysis was performed using SPSS, version 25 (IBM, Armonk, New York, USA). Categorical data were summarized as numbers and percentages. The χ^2 test was used for comparing patients' characteristics. All P values were two-sided. P values less than 0.05 were considered significant.

Results

As regards age, 68.3% were below 40 years, and 31.8% were above 40 years. For sex, 44.5% were males, and 55.5% were females. The most frequent residences

were Kafr El Sheikh (27.3%), Qualubia (19.5%), and Giza (16.8%), and the least frequent were Elminya, Damietta, Fayoum, Ismailia, and Sohag (1.0% for each) (Table 1).

The prevalence of anosmia was 68.8%. As regards the degree of anosmia, 84% of patients with anosmia showed absolute (complete) anosmia, and 16% showed partial anosmia. Regarding the onset, 71.6 and 28.4% of patients with anosmia showed sudden onset and gradual onset, respectively. More than one-third (41.1%) of patients with anosmia had no other symptoms, while 58.9% had associated symptoms. Of those with associated symptoms, 48.1% had anosmia after symptoms, 42.0% during symptoms, and 9.9% before symptoms. The duration of anosmia was less than or equal to 2 weeks in 76.7% and more than 2 weeks in 23.3%. More than one-third (43.3%) of patients with anosmia showed complete improvement, 32.4% showed partial improvement, and 24.4% showed no improvement. About 35.3% of patients with anosmia received treatment (Table 2). Among the study population, 39.5% had fever, 32.3% had cough, 14.2% had sore throat, 20.8% had dyspnea, 13.5% had rhinorrhea, 6.8% had nasal obstruction, 12.3% had diarrhea, and 28.2% complained of headache.

Table 1 Demographic characteristics in study population

	n (%)
Age	
Below 40	273 (68.3)
More than 40	127 (31.8)
Sex	
Males	178 (44.5)
Females	222 (55.5)
Residence	
Beheira	6 (1.5)
Alexandria	4 (1.0)
Elminya	1 (0.3)
Assiut	2 (0.5)
Beni Suef	2 (0.5)
Cairo	23 (5.8)
Damietta	1 (0.3)
Dakahlia	3 (0.8)
Fayoum	1 (0.3)
Gharbia	10 (2.5)
Giza	67 (16.8)
Ismailia	1 (0.3)
Kafr El Sheikh	109 (27.3)
Luxor	8 (2.0)
Matrouh	3 (0.8)
Menoufia	64 (16.0)
Port Said	2 (0.5)
Qualiobia	78 (19.5)
Sharkia	14 (3.6)
Sohag	1 (0.3)

As regards the occurrence of anosmia according to different patients' characteristics, young age (below 40 years) was significantly higher in those with anosmia (74.2%) compared with those without anosmia (55.2%) with a *P* value less than 0.001. The female sex was significantly higher in those with anosmia (59.3%) compared with those without anosmia (47.2%) with a *P* value of 0.024. The presence of chronic diseases was significantly lower in those with anosmia (10.2%) compared with those without anosmia (23.2%) with a *P* value of 0.001. There were no significant differences between those with anosmia and those without as regards smoking or chronic rhinological status. *P* values were 0.118 and 0.132, respectively (Table 3).

Old age (above 40 years) was significantly higher in those with isolated anosmia (32.7%) compared with those with no pure anosmia (21.0%). *P* value was 0.028. Smoking was significantly higher in those with pure anosmia (23.0%) compared with those with no pure anosmia (8.6%). *P* value was 0.001. There were no significant differences between those with pure anosmia and those with no pure anosmia as regards sex, presence of chronic disease, or chronic rhinological status; *P* values were 0.799, 0.542, and 0.172, respectively.

Old age (above 40 years) was significantly higher in those with a duration less than or equal to 2 weeks (29.9%) compared with those with a duration of more than 2 weeks (12.5%), *P* value was 0.005. Male sex was significantly higher in those with duration less than or equal to 2 weeks (45.5%) compared with those with duration of more than 2 weeks (25.0%), *P* value was 0.003. Receiving treatment was significantly higher in those with a duration of more than 2 weeks (54.7%) compared with those with a duration less than or equal to 2 weeks (29.4%), *P* value was less than 0.001. There were no significant differences between both groups as regards smoking, presence of chronic disease, and chronic rhinological status. *P* values were 0.596, 0.235, and 0.444, respectively (Table 4).

There were no significant differences between those with gradual-onset and those with sudden-onset anosmia as regards age (*P*=0.966), sex (*P*=0.451), smoking (*P*=0.530), presence of chronic disease (*P*=0.979), and chronic rhinological status (*P*=0.798).

As regards improvement of anosmia according to different patients' characteristics, chronic rhinological status showed an overall significant difference between grades of improvement with a *P* value of 0.029. Pairwise analysis revealed that it was significantly higher in those not improved (25.4%) compared with those with

complete improvement (11.8%). Receiving treatment also showed an overall significant difference between grades of improvement, *P* value was 0.015. Pairwise analysis revealed that it was significantly higher in those not improved (47.8%) compared with those with complete improvement (26.9%). There were no significant differences between grades of improvement as regards age (*P*=0.114), sex (*P*=0.093), smoking (*P*=0.619), and chronic diseases (*P*=0.244) (Table 5).

Discussion

Giacomelli *et al.* [5], in a small sample with a nonvalidated questionnaire, investigated smell disorders and reported olfactory dysfunction in 33.9% of 59 COVID-19 patients in Italy. The current cross-sectional, multicenter study had been conducted on 400 COVID-19-confirmed patients and our questionnaire reference was American Academy of Otolaryngology–Head and Neck Surgery, COVID-19 Anosmia Reporting Tool for Clinicians [4]. Anosmia prevalence in the present study was 68.8% of 400 COVID-19-confirmed cases.

Table 2 Prevalence of anosmia and its characteristic

	n (%)
Anosmia	
Yes	275 (68.8)
Degree of anosmia	
Complete	231 (84.0)
Partial	44 (16.0)
Onset of loss of smell	
Gradual	78 (28.4)
Sudden	197 (71.6)
Associated symptoms with anosmia	
Pure anosmia	113 (41.1)
Anosmia with associated symptoms	162 (58.9)
Timing of anosmia*	
After symptoms	78 (48.1)
Before the symptoms	16 (9.9)
During the symptoms	68 (42.0)
Duration of anosmia	
≤2 weeks	211 (76.7)
>2 weeks	64 (23.3)
Improvement status	
Complete	119 (43.3)
No improvement	67 (24.4)
Partial	89 (32.4)
Treatment of anosmia	
Yes	97 (35.3)

According to larger-scale European research, 85.6% of 417 mild-to-moderate COVID-19 patients had smell dysfunction [6]. Alterations in smell were noted in 64.4% of 202 mildly symptomatic COVID-19 patients in another Italian study [7]. According to a study done in the United States of America, 68% of 59 individuals showed olfactory dysfunction [8]. In France, 47% of 114 COVID-19 patients complained of anosmia [9]. These percentages were significantly higher in COVID-19 patients than in influenza patients [10]. The University of Pennsylvania smell-identification test (UPSIT) demonstrated olfactory impairment in 98% of 60 patients from Iran [11]. Anosmia and hyposmia were found in 66.2 and 13.5% of patients who did not complain of nasal stuffiness or rhinorrhea, respectively [7]. In China, contrary to the previous research, only 5.1% of 214 patients had hyposmia [12]. According to the publications, in Europe and the United States, the rate of olfactory dysfunction is different from China or Asia.

As regards the occurrence of anosmia according to different patients' characteristics, in the current study, we found that young age (below 40) was significantly higher in those with anosmia (74.2%) compared with those without anosmia (55.2%), *P* value was less than 0.001. Up till now, no sufficient data with or against our results.

The onset of olfactory dysfunction, which showed variation among several studies, is also another issue. Olfactory-dysfunction onset in the COVID-19

Table 3 Occurrence of anosmia according to patients' characteristics

	Anosmia (*n*=275) [*n* (%)]	No anosmia (*n*=125) [*n* (%)]	*P*
Age (years)			
Below 40	204 (74.2)	69 (55.2)	<0.001
More than 40	71 (25.8)	56 (44.8)	
Sex			
Males	112 (40.7)	66 (52.8)	0.024
Females	163 (59.3)	59 (47.2)	
Smoking			
Yes	40 (14.5)	26 (20.8)	0.118
Chronic disease			
Yes	28 (10.2)	29 (23.2)	0.001
Chronic rhinological status			
Yes	52 (18.9)	16 (12.8)	0.132

Table 4 Duration of anosmia according to patients' characteristics

	Less than or equal to 2 weeks (*n*=211) [*n* (%)]	More than 2 weeks (*n*=64) [*n* (%)]	*P*
Age (years)			
Below 40	148 (70.1)	56 (87.5)	0.005
More than 40	63 (29.9)	8 (12.5)	
Sex			
Males	96 (45.5)	16 (25.0)	0.003
Females	115 (54.5)	48 (75.0)	
Smoking			
Yes	32 (15.2)	8 (12.5)	0.596
Chronic disease			
Yes	24 (11.4)	4 (6.3)	0.235
Chronic rhinological status			
Yes	42 (19.9)	10 (15.6)	0.444
Treatment of anosmia			
Yes	62 (29.4)	35 (54.7)	<0.001

Table 5 Grade of improvement of anosmia according to patients' characteristics

	Complete (*n*=119) [*n* (%)]	Partial (*n*=89) [*n* (%)]	Not improved (*n*=67) [*n* (%)]	*P*
Age (years)				
Below 40	89 (74.8)	60 (67.4)	55 (82.1)	0.114
More than 40	30 (25.2)	29 (32.6)	12 (17.9)	
Sex				
Males	57 (47.9)	33 (37.1)	22 (32.8)	0.093
Females	62 (52.1)	56 (62.9)	45 (67.2)	
Smoking				
Yes	17 (14.3)	11 (12.4)	12 (17.9)	0.619
Chronic disease				
Yes	16 (13.4)	8 (9.0)	4 (6.0)	0.244
Chronic rhinological status				
Yes	14 (11.8) a	21 (23.6) a, b	17 (25.4) b	0.029
Treatment of anosmia				
Yes	32 (26.9) a	33 (37.1) a, b	32 (47.8) b	0.015

clinical course might be important. In our study, 48.1% had anosmia after symptoms, 42.0% during symptoms, and 9.9% before symptoms.

According to Lechien *et al.* [6], 11.8% of COVID-19 patients having smell dysfunction presented before other general symptoms, 65.4% after general symptoms, and 22.8% at the same time. Anosmia was noted in 20.3% of COVID-19 patients in Italy prior to other general symptoms and 13.5 percent during hospitalization [5]. According to the other study conducted in Italy, 11.9% of COVID-19 patients had smell or taste alternations before other symptoms, and 26.7% following other symptoms. Among 23 COVID-19 patients with anosmia in Iran, 83% complained of anosmia as their primary symptom [13], while among 31 COVID-19 patients in Spain, 67.7% showed acute onset of smell dysfunction and 35.5% complained early [14]. However, another study from Iran found that all 21 COVID-19 patients had olfactory impairment simultaneously with or immediately following the other general symptoms [11]. Complete anosmia was often reported 3 weeks after the onset of the first symptom in cases of SARS-CoV infection [15]. The other point of concern is the olfactory impairment and otolaryngologic symptom correlation. The olfactory dysfunction is not closely correlated with nasal stuffiness and rhinorrhea [6]. In our study, 13.5% had rhinorrhea, and 6.8% had nasal obstruction. Only 4% of patients with olfactory impairment in China complained of rhinorrhea[16] and 5% of patients with nasal stuffiness [1]. In the current study, because confirmed COVID-19 patients complained of sudden-onset anosmia without any other symptoms, 41.1% of patients with anosmia were described as isolated anosmia. On April 6, 2020, the Korean Center for Disease Control announced that the percentage of asymptomatic COVID-19 cases was 33.3% based on the presence or absence of symptoms at the time of confirmation [17]. In the United Kingdom, on 2428 patients with new-onset anosmia, a survey study was done and revealed that 17% of patients having anosmia reported no other additional otolaryngologic symptoms, except for anosmia [18]. According to another Italian study, 3% of patients with COVID-19 (*n*=130) had a single

symptom of smell or taste alteration [7]. However, one publication reports that anosmia may accompany otorhinolaryngeal symptoms [9]. According to one study, the majority of gustatory dysfunction manifests as an early prehospitalization symptom [5]. Additionally, there may be a strong association between olfactory and gustatory impairment as an early or occasionally solitary sign of COVID-19. As regards the occurrence of anosmia as the only presenting symptom according to different patients' characteristics, old age (above 40 years) was significantly higher in those with pure anosmia (32.7%) compared with those with no pure anosmia (21.0%), *P* value was 0.028. Smoking was significantly higher in those with pure anosmia (23.0%) compared with those with no pure anosmia (8.6%), *P* value was 0.001. In the current study, the female sex was significantly higher in those with anosmia (59.3%) compared with those without anosmia (47.2%), and *P* value was 0.024. Numerous studies have revealed that women experience olfactory impairment at a higher rate than men [5,9,13], although the explanation is difficult to define at the moment. Activation of Toll-like receptors with the production of cytokines and protein phosphorylation is linked with X chromosomes, according to a recent study. This could explain distinct inflammatory states and clinical outcomes following infection in men and women [19]. However, men and women had a similar olfactory function, according to another study [11]. Additional research on sex differences is required. In sensorineural olfactory impairment, recovery of olfactory function is relatively slower than in conductive olfactory dysfunction [20]. In the present study, the duration of anosmia was less than or equal to 2 weeks in 76.7% and more than 2 weeks in 23.3%. Among patients with anosmia, 43.3% showed complete improvement, 32.4% showed partial improvement, and 24.4% showed no improvement.

There are currently just a few research examining the recovery of olfactory function in patients with COVID-19. The mean duration of anosmia in Spain was within 2 weeks, and 40% of 30 patients showed complete recovery within a week (7.4±2.3 days) [14]. A total of 357 patients out of 417 COVID-19 (85.6%) patients showed olfactory impairment, according to a European study. However, only 44% of 59 clinically cured patients demonstrated recovery of olfactory function within 14 days. The majority showed recovery within 8 days (72.6% of those with recovered olfactory dysfunction), and recovery more than 15 days following COVID-19 resolution was detected in only a few patients (3.4%) [6]. The time period for determining recovery of olfactory function has been estimated to be 2 weeks, as viral load significantly decreases in around 14 days [6,21], but further research is required to determine the time period for recovery and to follow patients long term. Recovery of olfactory function, whether partial or complete, may take several months in comparison with other viral infections [22]. Patients were stated to suffer from anosmia for almost 2 years in the case of anosmia following SARS [15]. As regards the duration of anosmia according to different patients' characteristics, old age (above 40 years) was significantly higher in those with duration less than or equal 2 weeks (29.9%) compared with those with a duration of more than 2 weeks (12.5%), *P* value was 0.005. Male sex was significantly higher in those with duration less than or equal to 2 weeks (45.5%) compared with those with duration of more than 2 weeks (25.0%). *P* value was 0.003.

In our study, 64.7% did not receive any treatment, and only 35.3% received it. It may be an interesting finding that receiving treatment was significantly higher (54.7%) in those with a longer duration of anosmia (>2 weeks) compared with those with a duration less than or equal to 2 weeks (29.4%) (*P*<0.001).

Receiving treatment also showed an overall significant difference between grades of improvement (*P*=0.015). Pairwise analysis revealed that it was significantly higher in those not improved (47.8%) compared with those with complete improvement (26.9%).

This could be explained in two points: first, spontaneous recovery rates were higher in postviral patients than in posttraumatic ones. In postviral patients with olfactory or gustatory dysfunction, including COVID-19, no definitive treatment guidelines are found. The second is the patient's annoyance after a prolonged period of anosmia, thus starting to seek medical treatment to find a solution.

Limitations

The present study has some limitations in terms of disease dissemination in the present pandemic context. To prevent transmission risk among healthcare providers, an objective smell assessment, such as the University of Pennsylvania Smell Identification Test, was not used to confirm smell dysfunction.

Conclusion

As a common sign of COVID-19 infection, anosmia will increase the health worker's suspicion index in underdeveloped countries with limited access to the COVID-19 test.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, *et al*. Clinical characteristics of coronavirus disease 2019 in China. New Engl J Med 2020; 382:1708–1720.

2 Young BE, Ong SW, Kalimuddin S, Low JG, Tan SY, Loh J, *et al*. Epidemiologic features and clinical course of patients infected with SARS-CoV-2 in Singapore. JAMA 2020; 323:1488–1494.

3 Suzuki M, Saito K, Min WP, Vladau C, Toida K, Itoh H, Murakami S. Identification of viruses in patients with postviral olfactory dysfunction. Laryngoscope 2007; 117:272–277.

4 Kaye R, Chang CD, Kazahaya K, Brereton J, Denneny III JC. COVID-19 anosmia reporting tool: initial findings. Otolaryngol Head Neck Surg 2020; 163:132–134.

5 Giacomelli A, Pezzati L, Conti F, Bernacchia D, Siano M, Oreni L, *et al*. Self-reported olfactory and taste disorders in patients with severe acute respiratory coronavirus 2 infection: a cross-sectional study. Clin Infect Dis 2020; 71:889–890.

6 Lechien JR, Chiesa-Estomba CM, De Siati DR, Horoi M, Le Bon SD, Rodriguez A, *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 Otorhinolaryngol 2020; 277:2251–2261.

7 Spinato G, Fabbris C, Polesel J, Cazzador D, Borsetto D, Hopkins C, Boscolo-Rizzo P. Alterations in smell or taste in mildly symptomatic outpatients with SARS-CoV-2 infection. JAMA 2020; 323:2089–2090.

8 Yan CH, Faraji F, Prajapati DP, Boone CE, DeConde AS. Association of chemosensory dysfunction and COVID-19 in patients presenting with influenza-like symptoms. Int Forum Allergy Rhinol 2020; 10:806–813.

9 Klopfenstein T, Royer PY, Toko L, Gendrin V, Zayet S. COVID-19: comparative clinical features and outcome in 114 patients with or without pneumonia (Nord Franche-Comte Hospital, France). Microbes Infect 2020; 22:622–625.

10 Monreal E, de la Maza SS, Fernández-Velasco JI, Natera-Villalba E, Rita CG, Rodríguez-Jorge F, *et al*. The impact of immunosuppression and autoimmune disease on severe outcomes in patients hospitalized with COVID-19. J Clin Immunol 2021; 41:315–323.

11 Moein ST, Hashemian SM, Mansourafshar B, Khorram-Tousi A, Tabarsi P, Doty RL. Smell dysfunction: a biomarker for COVID-19. Int Forum Allergy Rhinol 2020; 10:944–950.

12 Kang YJ, Cho JH, Lee MH, Kim YJ, Park CS. The diagnostic value of detecting sudden smell loss among asymptomatic COVID-19 patients in early stage: the possible early sign of COVID-19. Auris Nasus Larynx2020; 47:565–573.

13 Heidari F, Karimi E, Firouzifar M, Khamushian P, Ansari R, Ardehali MM, Heidari F. Anosmia as a prominent symptom of COVID-19 infection. Rhinology 2020; 58:302–303.

14 Beltrán-Corbellini Á, Chico-García JL, Martínez-Poles J, Rodríguez-Jorge F, Natera-Villalba E, Gómez-Corral J, *et al*. Acute-onset smell and taste disorders in the context of COVID-19: a pilot multicentre polymerase chain reaction based case–control study. Eur J Neurol 2020; 27:1738–1741.

15 Hwang C Olfactory neuropathy in severe acute respiratory syndrome: report of a case. Acta Neurol Taiwan 2006; 15:26.

16 Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, *et al*. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet 2020; 395:507–513.

17 Park HC, Do Hyoung Kim KD, Kim YG, Lee SH, Yoon HE, Kim DK, *et al*. Korean clinical practice guidelines for preventing transmission of coronavirus disease 2019 (COVID-19) in hemodialysis facilities. Kidney Res Clin Pract 2020; 39:145.

18 Hopkins C, Surda P, Whitehead E, Kumar BN. Early recovery following new onset anosmia during the COVID-19 pandemic–an observational cohort study. J Otolaryngol Head Neck Surg 2020; 49:1–6.

19 Lefèvre N, Corazza F, Valsamis J, Delbaere A, De Maertelaer V, Duchateau J, Casimir G. The number of X chromosomes influences inflammatory cytokine production following toll-like receptor stimulation. Front Immunol 2019; 10:1052.

20 Gane SB, Kelly C, Hopkins C. Isolated sudden onset anosmia in COVID-19 infection. A novel syndrome. Rhinology 2020; 58:299–301.

21 Zou L, Ruan F, Huang M, Liang L, Huang H, Hong Z, *et al*. SARS-CoV-2 viral load in upper respiratory specimens of infected patients. New Engl J Med 2020; 382:1177–1179.

22 Hummel T, Whitcroft KL, Andrews P, Altundag A, Cinghi C, Costanzo RM, *et al*. Position paper on olfactory dysfunction. Rhinology 2016; 56:1–30.