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Research Article

Awareness of smell exercise after smell dysfunction related to COVID-19 in Alahsaa, Saudi Arabia

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Abstract

Introduction: Coronavirus disease 2019 (COVID-19) is a severe acute respiratory syndrome. Globally, COVID-19 has infected more than 573 million people, with over 6.3 million deaths on July 27, 2022. The symptoms range from cold-like symptoms, cough, fever, shortness of breath, and sore throat; additionally, studies show that patients frequently have problems with smell and taste disorders (STD).

Aim: We aim to estimate the prevalence of COVID-19-related anosmia, hyposmia, and parosmia in Alahssa, Saudi Arabia and establish the level of awareness of smell exercises.

Patients and methods: This is a cross-sectional study conducted among adults aged 18–60 living in Alahssa, Saudi Arabia. An online questionnaire containing an informed consent form and a survey to collect demographic data, vaccination status, level of loss of smell and taste, and the level of awareness about smell exercises was distributed among all participants who agreed to participate in this study.

Results: Five hundred twenty-four adults agreed to participate in this study. When we assessed their awareness of the smelling exercise, it was found that only 115 patients (21.9%) were aware. About 49 patients (61.3%) practiced the smelling exercise, and 55% reported improvements afterward.

Conclusion: The prevalences of olfactory and gustatory dysfunction were found to be 54.6% and 52.5%, respectively. Awareness of olfactory training was moderately low among those infected with COVID-19, while 28% of the patients who had experienced olfactory disturbances were aware of this training. Active, collaborative research is essential for describing the natural history and effective therapy of chemosensory impairment in COVID-19.

Introduction

Coronavirus-2 (SARS-COV-2) or coronavirus disease 2019 (COVID-19), is a severe acute respiratory syndrome. Globally, COVID-19 has infected more than 573 million people, with over 6.3 million deaths as of July 27, 2022 [1]. This epidemic was first discovered in Wuhan, China in December 2019. It spreads throughout the world and is transmitted via upper respiratory tract droplet inhalation. The World Health Organization labeled it a global pandemic on March 11, 2020. (WHO) [2]. The Kingdom of Saudi Arabia declared its first case of the virus on the 2nd of March 2020 [3]. According to the WHO, the number of confirmed cases in Saudi Arabia has exceeded 808,053, with 9,240 deaths reported [4]. Some studies reveal that patients typically experience issues with smell and taste disorders (STD), in addition to cold-like symptoms like cough, fever, shortness of breath, sore throat, decrease or loss of smell (hyposmia or anosmia), and decrease or loss in taste (hypogeusia or ageusia) [5]. Olfactory disorders have a strong impact on the quality of life; these impairments affect the ability to perceive odors in foods and the environment, leading to consequences such as malnutrition, weight loss, food poisoning, and depression [6]. Olfactory training (OT) is an innovative, non-invasive intervention for the rehabilitation of olfactory disorders. Evidence has shown the effectiveness of this treatment among patients with olfactory disorders for a variety of reasons [7]. To

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the best of our knowledge, no previous study has investigated the prevalence of COVID-19-related anosmia, hyposmia, and parosmia and awareness of smell exercises in the Alahssa region; we aim to do that here.

Methodology

A cross-sectional study design using a "Google Form" was adopted to estimate the prevalence of COVID-19-related anosmia, hyposmia, and parosmia among the patients in Alahssa City, Saudi Arabia during the outbreak of COVID-19 and establish the level of awareness of smell exercises. Data were collected from Jan 10, 2022, to Feb 16, 2022; a self-reported retrospective study was conducted using a standardized questionnaire that included demographic information, vaccination status, level of loss of smell and taste, and the level of awareness about smell training. The sample size was determined to be 535 COVID-19-infected patients. The representative sample size was calculated using the following statistical formula: 95% confidence interval; margin of error was 5%. Patients who were infected with COVID-19 in Alahssa City participated in the selection criteria. All participants younger than 18 years or older than 60 years who were not infected with COVID-19 or who did not fully answer the questionnaires were excluded.

Statistical analysis

Descriptive statistics were presented as numbers and percentages. The prevalence of smell dysfunction was grouped depending on the vaccination status. The association between the vaccination status and the prevalence of smell dysfunction has been established using a Chi-square test. Based on the significant results, a multivariate regression model was constructed to determine the significant independent factor associated with the level of awareness of a smell exercise with a corresponding odds ratio and a 95% confidence interval. Two-tailed analyses were used, with $p<0.05$ as a statistical significance cutoff. All data analyses were performed using the statistical package for social sciences, version 26 (SPSS, Armonk, NY: IBM Corp, USA).

Results

We approached 535 COVID-19-infected patients, and out of this, 524 patients gave consent to participate in the study. The baseline characteristics of the participants showed that 40.3% belonged to the age group of 18-60 years, 66% were females, and 46.2% were infected with COVID-19 before taking the vaccine. It was reported that 19.3%, 29.2%, and 16% were reported to be infected with COVID-19 after the first, second, and third doses, respectively. The most commonly reported complaint in infected patients was malaise (63.9%), followed by headache (55.7%), fever (54.2%), chills (35.1%), and cough (25.8%). Nasal congestion and Rhinorrhea were reported in 14.9% and 19.1%, respectively. The source of COVID-19 infection was identifiable in 273 patients, and it was found that 84.5% of the patients had recovered from the infection during the time of this study (Table 1).

About 287 (54.8%) patients reported chemosensory impairment, where olfactory dysfunction was seen in 286 (54.6%) and gustatory dysfunction in 275 (52.5%) patients. Anosmia and parosmia were reported in 156 and 42 patients, respectively, among olfactory changes. In patients who had olfactory disturbances, about 11.9% had it lasted more than 61 days, whereas 45.1% and 23.4% had it for 1-7 days and 8-14 days, respectively. The mean degree of olfactory dysfunction was found to be 4.76 ± 3.16 (95% CI = 4.4-5.1). Gustatory dysfunction was reported in 275 patients (52.4%), where ageusia, dysgeusia, and hypogeusia were seen in 21.2%, 12.6%, and 18.7% of the patients. In patients who had gustatory disturbances, about 5.1% had it lasted more than 61 days, whereas 51.3% and 24% had it for 1-7 days and 8-14 days, respectively. The mean degree of gustatory dysfunction was found to be 5.4 ± 2.8 (95% CI = 5.1-5.7). Only 12 patients (4.2%) were in a hospitalized condition when olfactory and gustatory dysfunctions were observed. About 59.9% of these dysfunctions were observed after diagnosis of COVID-19 infection, and 64.8% reported other symptoms along with these dysfunctions. Among patients who had olfactory and gustatory dysfunctions, 33.1% reported that their health condition worsened, whereas 60.6% said that it was improved. These olfactory and gustatory dysfunctions were reported to be resolved in 88.2% of the patients (Table 2).

When we compared the prevalence of CD with the age of the patients, there was no statistically significant relationship observed for both OD and GD ($p > 0.05$). No statistically significant gender differences were also noted in the prevalence of CD ($p > 0.05$). However, we observed that patients who got infected with COVID-19 before taking the vaccine significantly had more OD (71.5%) and GD (69%) ($p < 0.001$). Similarly,

Table 1: Baseline characteristics of the patients (n = 524).

		Frequency	Percent
Age (Years)	18-25	211	40.3
	26-35	105	20.0
	36-45	122	23.3
	46 and more	86	16.4
Gender	Female	346	66.0
	Male	178	34.0
Infected with COVID-19 before taking vaccine		242	46.2
Infected with COVID-19 after taking first dose		101	19.3
Infected with COVID-19 after taking second dose		153	29.2
Infected with COVID-19 after taking third dose		84	16.0
Complaints reported by the patients	Fever	284	54.2
	Chills	184	35.1
	Malaise	335	63.9
	Cough	135	25.8
	Headache	292	55.7
	Nasal congestion	78	14.9
	Rhinorrhea	100	19.1
	Gastrointestinal distress	56	10.7
	Pneumonia	55	10.5
	Other	12	19.8
	None	59	11.3
COVID-19 infection source identifiable		273	52.1
Current COVID-19 infection status	Active Recovered	81	15.5
		443	84.5
Patients received treatment		199	38

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Table 2: Olfactory and gustatory dysfunctions characteristics.

		N	%
Chemosensory dysfunction (CD) reported		287	54.8
Olfactory dysfunction (n = 286)	Anosmia	156	29.8
	Hyposmia	88	16.8
	Parosmia	42	8
	No change	238	45.4
Duration of olfactory dysfunction (n = 286)	1 – 7 days	129	45.1
	8 – 14 days	67	23.4
	15 -21 days	17	5.9
	22 -29 days	16	5.6
	30-37 days	10	3.5
	38-45 days	7	2.4
	46-52 days	2	0.7
	53-60 days	4	1.4
	61 days and more	34	11.9
The degree of olfactory dysfunction	Mean: 4.76 ± 3.16 (95% CI =4.4-5.1)		
Gustatory changes	Ageusia	111	21.2
	Dysgeusia	66	12.6
	Hypogeusia	98	18.7
	No change	249	47.5
Duration of olfactory dysfunction (n = 286)	1 – 7 days	141	51.3
	8 – 14 days	66	24
	15 -21 days	16	5.8
	22 -29 days	16	5.8
	30-37 days	7	2.5
	38-45 days	6	2.2
	46-52 days	4	1.5
	53-60 days	5	1.8
	61 days and more	14	5.1
The degree of olfactory dysfunction	Mean: 5.4 ± 2.8 (95% CI =5.1-5.7)		
Condition of the patient at the time of Olfactory and gustatory changes	Inpatient / hospitalized	12	4.2
	Outpatient	275	95.8
Time of Olfactory and gustatory changes observed	After diagnosis	172	59.9
	Before diagnosis	115	40.1
Other symptoms reported during Olfactory and gustatory dysfunction		186	64.8
Reported symptoms (n = 186)	Fever	119	64
	Chills	62	33.3
	Malaise	83	39
	Cough	101	54.3
	Headache	131	70.4
	Nasal congestion	82	44.1
	Rhinorrhea	75	40.3
	Gastrointestinal distress	49	26.3
	Pneumonia	20	10.8
	Other	7	3.8
Condition of the patients after the Olfactory and gustatory changes was observed	No change	18	6.3
	Worsened	95	33.1
	Improved	174	60.6
Status of olfactory and gustatory dysfunction	Not resolved	34	11.8
	Resolve	253	88.2

the prevalence of OD and GD was markedly higher in patients who got infected with COVID-19 after taking the first dose ($p < 0.001$). It was found the prevalence of OD and GD was comparatively less when got infected with COVID-19 after taking the third dose ($p < 0.05$) (Table 3).

When we assessed the awareness of the smelling exercise, it was found that only 115 patients (21.9%) were aware of this exercise, and among these, 59% correctly identified the definition of smell exercise. It was agreed by 47.9% of the participants that smell exercise aims to help recovery based on neuroplasticity. About 49 patients (61.3%) practiced smell exercise, and 55% reported improvement after this exercise. It was reported by 69.4% that they practiced this exercise for 1-7 days, whereas 4.1% did it for 53-60 days. About 46.9% reported that it took 1-7 days to get recovery after smell exercise, whereas 8.2% recovered after 53-60 days only (Table 4).

Discussion

Chemosensory dysfunction (CD) such as olfactory dysfunction (OD) and gustatory dysfunction (GD) are commonly reported symptoms in COVID-19 patients [8]. Unpublished statistical data and anecdotal findings claim that these CD symptoms resolve within 2-3 weeks. However, due to a lack of long-term follow-up, the percentage of patients who suffer chronic post-infectious CD is uncertain. In patients with recent-onset acute olfactory and/or gustatory dysfunction, with or without accompanying symptoms of COVID-19, self-isolation and SARS-CoV-2 testing should be done as soon as possible. Chemosensory assessment of smell and taste should be considered in patients who require urgent hospitalization (e.g., breathing difficulties) only when clinical conditions permit and adequate PPE is available [9]. Olfactory training (OT), commonly known as smell exercise, entails the deliberate and repeated sniffing of various natural odorants such as eucalyptus, lemon, cloves, or rose for 20-30 seconds minimum twice daily for at least 90 days. Evidence shows OT effectively improved post-infectious OD in COVID-19 patients [10]. Patients with chronic COVID-19-related OD may benefit from olfactory training, which is simple, economical, and has few side effects. The current study findings showed that more than half of the patients (54.8%) had experienced olfactory and/or gustatory dysfunction. A meta-analysis estimated alteration of the sense of smell or taste prevalence to be 47% [11]. In Saudi Arabia, smell loss was reported in 62% of the patients with a mean persistence of 15.9 days, whereas 55% of the patients showed loss of taste [12]. Another study done in India by Gupta et al. reported OD and GD prevalence to be 43.15% and 39.53%, respectively [13]. In our study, anosmia was the commonly reported OD, and ageusia was the commonly reported GD. An accumulating amount of anecdotal evidence suggests that anosmia, hyposmia, ageusia, and dysgeusia may all be potential signs of SARS- CoV-2 infection, either independently or in conjunction with conventional symptoms. According to research by Moein et al., the incidence of anosmia in patients who were positive for COVID-19 was as high as 98 %, and 63 percent of patients were unaware of their anosmia [14]. In our study, 11.8% of the

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Table 3: Relationship of Chemosensory dysfunction with baseline characteristics.

		Olfactory dysfunction			Gustatory dysfunction		
		Present	Absent	p value*	Present	Absent	p value*
Age	18-25	104	107	0.093	98	113	0.087
		49.3%	50.7%		46.4%	53.6%	
	26-35	65	40		61	44	
		61.9%	38.1%		58.1%	41.9%	
	36-45	73	49		72	50	
		59.8%	40.2%		59.0%	41.0%	
	46 and more	44	42		44	42	
		51.2%	48.8%		51.2%	48.8%	
Gender	Female	199	147	0.06	185	161	0.528
		57.5%	42.5%		53.5%	46.5%	
	Male	87	91		90	88	
		48.9%	51.1%		50.6%	49.4%	
Infected with COVID-19 before taking vaccine.	No	113	169	<0.001	108	174	<0.001
		40.1%	59.9%		38.3%	61.7%	
	Yes	173	69		167	75	
		71.5%	28.5%		69.0%	31.0%	
Infected with COVID-19 after taking first dose	No	212	211	<0.001	204	219	<0.001
		50.1%	49.9%		48.2%	51.8%	
	Yes	74	27		71	30	
		73.3%	26.7%		70.3%	29.7%	
Infected with COVID-19 after taking second dose	No	203	168	0.922	198	173	0.526
		54.7%	45.3%		53.4%	46.6%	
	Yes	83	70		77	76	
		54.2%	45.8%		50.3%	49.7%	
Infected with COVID-19 after taking third dose	No	251	189	0.009	241	199	0.016
		57.0%	43.0%		54.8%	45.2%	
	Yes	35	49		34	50	
		41.7%	58.3%		40.5%	59.5%	

** a p value <0.05 is considered statistically significant*

Table 4: Knowledge and practices related to smell exercise.

		N	%
Awareness of smell exercise (n = 524)	No	409	78.1
	Yes	115	21.9
Definition of smell exercise (n = 115)	No	47	41
	Yes	68	59
Smell exercise aims to help recovery based on neuroplasticity (n = 115)	No	60	52.1
	Yes	55	47.9
Awareness of smell exercise in patients who experiences smell changes (n = 286)	No	206	72
	Yes	80	28
Practiced smell exercise (n = 80)	No	31	38.8
	Yes	49	61.3
Olfactory dysfunction improved after smell exercise (n = 80)	No	36	45.0
	Yes	44	55.0
Duration of practicing smell exercise (n = 80)	1-7 days	34	69.4
	8-14 days	8	16.3
	15-21 days	2	4.1
	22-29 days	1	2.00
	30-37 days	2	4.1
	46-52 days	2	4.1
Time taken to reach recovery after performing smell exercise (n = 80)	1-7 days	23	46.9
	8-14 days	10	20.4
	15-21 days	3	6.1
	22-29 days	2	4.1
	30-37 days	4	8.2
	46-52 days	3	6.1
	53-60 days	4	8.2

patients had reported they had not resolved from CD. Even before COVID-19, viral infections were the most common cause of persistent anosmia [15], but the pandemic amplified these issues dramatically as evidence shows that up to 67% of the symptomatic COVID-19 patients experience CD [16-18]. In addition, the CD has been found to be a common symptom in reinfections [19] and in cases of COVID-19 infection in people who have been vaccinated [20]. A longitudinal study done by Herman et al. reported that the prevalence of OD after two weeks and four weeks of immunization was 9.95% and 5.43%, respectively, and the prevalence increased to 69% when people got infected after 14 days of taking the vaccine [21]. Evidence shows that post-infectious OD might be related to immune-mediated processes, whereas anti-nuclear antibodies were considerably higher in individuals with olfactory impairment than in controls following viral infection [22] The awareness regarding olfactory training (OT) was observed in only 21.9% of the patients, and among this, 59% knew how to do it. Only 28% of the patients who had OD were aware of this training, and among this, 61.3% reported that they performed this exercise. OT has been used to effectively treat smell impairments caused by upper respiratory tract illness, dramatically improving odor discrimination and recognition abilities [23]. It has also been reported that OT helps in reducing depression symptoms in people with OD [24]. OT is an effective and low-cost non-pharmacological therapy for post-viral OD when there is a lack of specific pharmacologic therapies [18]. Our study findings showed that 55% benefited from OT in improving olfactory functions, and 67.3% recovered from OD within two weeks (< 14 days).

Research suggests that the majority of patients will be able to return to their normal sense of smell within 14 days of completing their OT. Our study findings are consistent with the one reported by Lechien et al., which showed that 67.8% of the anosmia patients recovered olfactory function and 25.5% recovered from both OD and GD within less than two weeks after the resolution of conventional symptoms. Nevertheless, there are several notable limitations to our study. Firstly, a self-administered questionnaire to collect the data, and this retrospective method of data collection could have resulted in recall bias and, to some extent, social desirability bias. Also, self-reported health measures could give false negative and false positive reports leading to underestimation and overestimation, respectively. Thus, this type of reporting should be interpreted with caution.

Conclusion

The prevalence of olfactory dysfunction and gustatory dysfunction was found to be 54.6% and 52.5%, respectively. The incidence of olfactory and gustatory dysfunctions was significantly higher when the patients got infected before taking the vaccine and after taking the first dose when compared to the incidence after taking the second and third doses, respectively. The awareness of olfactory training was moderately low among the COVID-19 infected, where 28% of the patients who had experienced olfactory disturbances were of this training. Active, collaborative research is

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essential to describe the natural history and effective therapy of chemosensory impairment in COVID-19. Anosmia and ageusia are complaints that warrant additional investigation during a patient encounter, given the rising evidence of their relationship with COVID-19. Comprehensive screening and prophylaxis must be performed to prevent nosocomial and community infection.

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Statement of ethics

This study protocol was reviewed and approved by King Faisal University, approval number [KFU-REC-2021- DEC - EA000286]. Informed consent was obtained from all participants.

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Author contributions

KAA, AAA, AKD, AFA, SMA, and FKA conceptualized the study, contributed to data interpretation, and revised and finalized the manuscript. AFA and SMA contributed to statistical analysis and drafted the manuscript; AKD, AA, KA, and FKA contributed to drafting and revising the article. All authors have read and approved the published version of the manuscript.

References

1. COVID-19 Map - Hopkins J. Coronavirus Resource Center. Johns Hopkins Coronavirus Resource Center. 2022. https://coronavirus.jhu.edu/map.html

2. Wong DKC, Gendeh HS, Thong HK, Lum SG, Gendeh BS, Saim A, Salina H. A review of smell and taste dysfunction in COVID-19 patients. Med J Malaysia. 2020 Sep;75(5):574-581. PMID: 32918429.

3. Saudi Arabia: WHO Coronavirus Disease (COVID-19) Dashboard With Vaccination Data Covid19.who.int. 2022. https://covid19.who.int/region/emro/country/sa

4. Al-Hanawi MK, Angawi K, Alshareef N, Qattan AMN, Helmy HZ, Abudawood Y, Alqurashi M, Kattan WM, Kadasah NA, Chirwa GC, Alsharqi O. Knowledge, Attitude and Practice Toward COVID-19 Among the Public in the Kingdom of Saudi Arabia: A Cross-Sectional Study. Front Public Health. 2020 May 27;8:217. doi: 10.3389/fpubh.2020.00217. PMID: 32574300; PMCID: PMC7266869.

5. Mastrangelo A, Bonato M, Cinque P. Smell and taste disorders in COVID-19: From pathogenesis to clinical features and outcomes. Neurosci Lett. 2021 Mar 23;748:135694. doi: 10.1016/j.neulet.2021.135694. Epub 2021 Feb 15. PMID: 33600902; PMCID: PMC7883672.

6. Zhang Y, Mei T, Chen Y, Wang L, Jiang L, Liu K, Zhao L, Luo Z, Chi W, Zhu X. Smell disorders in COVID-19 patients: role of olfactory training: A protocol for systematic review and meta-analysis. Medicine (Baltimore). 2021 Feb 26;100(8):e24862. doi: 10.1097/MD.0000000000024862. PMID: 33663108; PMCID: PMC7909207.

7. Oleszkiewicz A, Bottesi L, Pieniak M, Fujita S, Krasteva N, Nelles G, Hummel T. Olfactory training with Aromastics: olfactory and cognitive effects. Eur Arch Otorhinolaryngol. 2022 Jan;279(1):225-232. doi: 10.1007/s00405-021-06810-9. Epub 2021 Apr 16. PMID: 33864109; PMCID: PMC8051546.

8. Whitcroft KL, Hummel T. Olfactory Dysfunction in COVID-19: Diagnosis and Management. JAMA. 2020 Jun 23;323(24):2512-2514. doi: 10.1001/jama.2020.8391. PMID: 32432682.

9. 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 Aug;10(8):944-950. doi: 10.1002/alr.22587. Epub 2020 Jun 18. PMID: 32301284; PMCID: PMC7262123.

10. Whitcroft KL, Hummel T. Clinical Diagnosis and Current Management Strategies for Olfactory Dysfunction: A Review. JAMA Otolaryngol Head Neck Surg. 2019 Sep 1;145(9):846-853. doi: 10.1001/jamaoto.2019.1728. PMID: 31318413.

11. Borsetto D, Hopkins C, Philips V, Obholzer R, Tirelli G, Polesel J, Boscolo-Rizzo P. Self-reported alteration of sense of smell or taste in patients with COVID-19: a systematic review and meta-analysis on 3563 patients. Rhinology. 2020 Oct 1;58(5):430-436. doi: 10.4193/Rhin20.185. PMID: 32626853.

12. Khodeir MM, Shabana HA, Rasheed Z, Alkhamiss AS, Khodeir M, Alkhowailed MS, Alharbi S, Alsoghair M, Alsagaby SA, Al Abdulmonem W. COVID-19: Post-recovery long-term symptoms among patients in Saudi Arabia. PLoS One. 2021 Dec 8;16(12):e0260259. doi: 10.1371/journal.pone.0260259. PMID: 34879074; PMCID: PMC8654233.

13. Gupta V, Banavara Rajanna L, Upadhyay K, Bhatia R, Madhav Reddy N, Malik D, Srivastava A. Olfactory and Gustatory Dysfunction in COVID-19 Patients from Northern India: A Cross-Sectional Observational Study. Indian J Otolaryngol Head Neck Surg. 2021 Jun;73(2):218-225. doi: 10.1007/s12070-021-02391-5. Epub 2021 Feb 10. PMID: 33589874; PMCID: PMC7875162.

14. 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 Aug;10(8):944-950. doi: 10.1002/alr.22587. Epub 2020 Jun 18. PMID: 32301284; PMCID: PMC7262123.

15. Doty RL. Epidemiology of smell and taste dysfunction. Handb Clin Neurol. 2019;164:3-13. doi: 10.1016/B978-0-444-63855-7.00001-0. PMID: 31604555.

16. Otte MS, Bork ML, Zimmermann PH, Klussmann JP, Luers JC. Persisting olfactory dysfunction improves in patients 6 months after COVID-19 disease. Acta Otolaryngol. 2021 Jun;141(6):626-629. doi: 10.1080/00016489.2021.1905178. Epub 2021 Apr 6. PMID: 33823752.

17. Bussière N, Mei J, Lévesque-Boissonneault C, Blais M, Carazo S, Gros-Louis F, De Serres G, Dupré N, Frasnelli J. Chemosensory Dysfunctions Induced by COVID-19 Can Persist up to 7 Months: A Study of Over 700 Healthcare Workers. Chem Senses. 2021 Jan 1;46:bjab038. doi: 10.1093/chemse/bjab038. PMID: 34423831; PMCID: PMC8499810.

18. Vaira LA, Salzano G, Le Bon SD, Maglio A, Petrocelli M, Steffens Y, Ligas E, Maglitto F, Lechien JR, Saussez S, Vatrella A, Salzano FA, Boscolo-Rizzo P, Hopkins C, De Riu G. Prevalence of Persistent Olfactory Disorders in Patients With COVID-19: A Psychophysical Case-Control Study With 1-Year Follow-up. Otolaryngol Head Neck Surg. 2022 Jul;167(1):183-186. doi: 10.1177/01945998211061511. Epub 2021 Nov 23. PMID: 34813382.

19. Lechien JR, Chiesa-Estomba CM, Vaira LA, Saussez S, Hans S. COVID-19 Reinfection and Second Episodes of Olfactory and Gustatory Dysfunctions: Report of First Cases. Ear Nose Throat J. 2020; 145561320970105.

20. Vaira LA, De Vito A, Lechien JR, Chiesa-Estomba CM, Mayo-Yàñez M, Calvo-Henrìquez C, Saussez S, Madeddu G, Babudieri S, Boscolo-Rizzo P, Hopkins C, De Riu G. New Onset of Smell and Taste Loss Are Common Findings Also in Patients With Symptomatic COVID-19 After Complete Vaccination. Laryngoscope. 2022 Feb;132(2):419-421. doi: 10.1002/lary.29964. Epub 2021 Nov 26. PMID: 34812498; PMCID: PMC9011575.

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21. Herman B, Viwattanakulvanid P, Dzulhadj A, Oo AC, Patricia K, Pongpanich S. Effect of full vaccination and post-covid olfactory dysfunction in recovered covid-19 patient. a retrospective longitudinal study with propensity matching. medRxiv. 2022 Jan 1.

22. Wallitzec-Dworschak U, Zimmermann AM, Poletti S, Hummel T. Antinuclear antibodies in post infectious smell loss - a pilot study. Rhinol Online. 2019; 2:1-5.

23. Qiao XF, Wang GP, Li X, Bai YH, Zheng W. Analysis of the clinical effect of olfactory training on olfactory dysfunction after upper respiratory tract infection. Acta Otolaryngol. 2019 Jul;139(7):643-646. doi: 10.1080/00016489.2019.1614224. Epub 2019 May 24. PMID: 31124736.

24. Birte-Antina W, Ilona C, Antje H, Thomas H. Olfactory training with older people. Int J Geriatr Psychiatry. 2018 Jan;33(1):212-220. doi: 10.1002/gps.4725. Epub 2017 Apr 21. PMID: 28429377.

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