

A survey of changes in taste and food preferences related to the coronavirus disease (COVID-19) in Hungary

M. Sugár¹, K. Fusz², D. Pusztai¹, N. Rozmann¹, J.M. Macharia³, M. Pintér¹ and B. Raposa^{1*} 

¹ Institute of Nursing Sciences, Basic Health Sciences and Health Visiting, Faculty of Health Sciences, University of Pécs, Vörösmarty út 4, H-7633, Pécs, Hungary

² Institute of Physiology, Faculty of Medicine, University of Pécs, Szigeti út 12, H-7624, Pécs, Hungary

³ Doctoral School of Health Sciences, Faculty of Health Sciences, University of Pécs, Vörösmarty út 4, H-7633, Pécs, Hungary

ORIGINAL RESEARCH PAPER

Received: September 12, 2022 • Accepted: October 25, 2022

Published online: November 18, 2022

© 2022 The Author(s)



ABSTRACT

A plethora of research and empiric observation supported the claim that—among other symptoms—diseases often affect the ability to smell and the sense of taste, possibly affecting the taste- and food preferences as well.

The aim of the present study was to shed light on the impact of COVID-related smell- (dysosmia/ anosmia) and taste function-disorder/loss (dysgeusia/ageusia) on the food and taste preferences COVID-19 patients of different symptomatic and pre-existing conditions and demographic backgrounds.

The research based on a descriptive, cross-sectional survey. In total, 514 participants filled our self-administered online questionnaire. Thirteen participants were excluded according to the exclusion criteria. Descriptive statistics, Chi-square test, *t*-test for correlation coefficient, were performed.

The most common long COVID symptom was fatigue/weakness (53.1%) followed by anosmia (50.9%) and tachycardia (33.5%). Many participants reported dysgeusia/ageusia during the acute phase of the disease, which sometimes prevailed as a long COVID symptom. A high percentage of participants reported that they rejected all kinds of meat of animal origin except cold cuts for their duration of recuperation, which proved to be the most common dietary change during the post-COVID period so far.

* Corresponding author. Tel.: +36 30 277 5693; E-mail: bence.raposa@etk.pte.hu

KEYWORDS

anosmia, dysgeusia, diet, long COVID, taste, food preference

1. INTRODUCTION

The SARS CoV-2 infection based novel coronavirus (COVID-19) disease has a deep impact on almost every aspect of our life since the dawn of 2020. A plethora of research and empiric observation supported the claim that—among other symptoms—the disease often affects the ability to smell and the sense of taste of those who caught the virus. The dysosmia/anosmia (the disorder/loss of the ability to detect one or more smells), dysgeusia/ageusia (the disorder/loss of taste functions of the tongue, especially the inability to detect the basic flavours) are possible symptoms that usually occur before the airway-related symptoms as the very first sign of the disease. During the convalescence, according to previous studies, they cease to exist in almost every patient (Carfi et al., 2020; Gelardi et al., 2020; Moein et al., 2020; Moore and June, 2020).

During the review of the international literature, we found a substantial number of new studies about the impaired ability to perceive tastes and scents in relation to viral infections in general. The papers specifically focused on the impact of the COVID-19 on these attributes from the past year (Dell’Era et al., 2020; Eliezer et al., 2020; Gautier and Ravussin, 2020; Huang et al., 2020; Lechien et al., 2020; Mao et al., 2020).

With that being said, we found limited number of manuscripts that focused on the possible changes in food and taste preferences with characteristics of these changes being related to the COVID-19 disease in the post-COVID period, when the affected person had an impaired ability to taste and/or smell during the disease (Trachootham et al., 2021). The changes led us to the thought that it would be beneficial to carry out a research with relatively large sample size that focuses on the aspects of the changes of taste in the long COVID period (after the acute phase).

Through Delphi methodology, WHO developed a clinical case definition for post-COVID-19 conditions that included 12 domains. Patients, researchers, and others from many different WHO regions worked together to develop this first version. This definition is subject to change as new evidence emerges and our understanding of COVID-19 consequences evolves:

“Post COVID-19 condition occurs in individuals with a history of probable or confirmed SARS- CoV-2 infection, usually 3 months from the onset of COVID-19 with symptoms that last for at least 2 months and cannot be explained by an alternative diagnosis. Common symptoms include fatigue, shortness of breath, cognitive dysfunction but also others which generally have an impact on everyday functioning. Symptoms may be new onset, following initial recovery from an acute COVID-19 episode or persist from the initial illness. Symptoms may also fluctuate or relapse over time.” (WHO, 2021).

Previous research already made it clear that an interdisciplinary approach is needed to effectively treat both the acute and the chronic phases of a disease such as COVID-19 (Gemelli Against COVID-19 Post-Acute Care Study Group, 2020). The aim of the present study beside the support of previous research data concerning virus-related dysosmia/anosmia, dysgeusia/ageusia (Andrews et al., 2020; Galvan-Tejada et al., 2020; Garrigues et al., 2020; Horvath et al., 2020; Kamal et al., 2020; Tenforde et al., 2020; Zhao et al., 2020; Carvalho-Schneider et al., 2021;



Townsend et al., 2021), was to shed light to the impact of these changes on the food and taste preferences of the individuals who have already passed through the acute phase of the COVID-19 disease with different symptoms, pre-existing conditions, and demographic backgrounds.

1.1. Aims

Our study focused on exploring food preferences and taste changes experienced by individuals suffering from COVID-19.

We also aimed to examine the number of long COVID symptoms of each participant, and whether there was a significant difference for former COVID-19 patients with more or less severe symptoms during the acute phase of the disease.

We also looked into potential connections between the olfactory loss and issues with taste in our research. Before starting the study, it was assumed that most people do not eat certain foods, because they taste and/or smell different, so a question was also added to our study form about the self-reported reason for the changes in food preference after the convalescence of the acute phase of the disease.

Therefore, our working hypothesis was that the COVID-19-related changes in sense of smell and/or taste had a long-term effect on the food and/or taste preferences of the individuals.

2. MATERIAL AND METHODS

The research was started with an online questionnaire as a quantitative and cross-sectional descriptive study in May of 2021 in Hungary. The online questionnaire was shared on the social media platform Facebook with COVID closed groups. Before completing the questionnaire, participants were given a short briefing on how to answer the questions correctly, as well as the meaning of each concept. The anonymity of the participants was fully ensured in accordance with the current EU GDPR rules, as no personally identifiable information was requested. We aimed to measure the changes in taste and smell specifically for each food group and food type, similar to the existing non-neurologically inspired literature, without reference to basic tastes and food preparation methods.

Before the start of the data collection phase, at least 500 participants were planned. The statistical analysis was implemented with the SPSS software, including anyone who was willing to participate and already went through the COVID-19 disease. Applicants with still active COVID-19 disease as well as those who had an impaired ability to taste and/or smell before they fell ill with COVID-19 were excluded. All results are based on self-reported data.

When phrasing our questions during the data collection period, we only focused on the changes in taste and food preferences at the period following the acute phase of the COVID-19. It is an important methodological point, because other factors, such as smoking, head and neck cancer along with the therapy, chronic rhinosinusitis, etc., might also change the ability of taste and/or smell, henceforth the food and taste preferences.

Our dependent variable was the prevalence of smell and taste disorders among the participants. As independent variables sex, age, BMI, pre-existing conditions, allergies, the severity of the COVID-19, place of living, residual symptoms, taste preference, former taste preference, present ability to taste, the length of the impaired ability to taste and the self-reported reason of the altered taste preference were chosen.



During the data collection phase, 514 participants filled our self-administered online questionnaire in total. Thirteen participants were excluded according to the exclusion criteria, so in the end our sample consisted of 501 participants.

We found that 15.8% ($n = 79$) of our sample consisted of male participants and 84.2% ($n = 422$) were females. The average age of the participants was 40.09 ± 11.05 years. The average body mass index (BMI) was $26.29 \pm 6.10 \text{ kg m}^{-2}$ (Table 1). By residence, 19.4% of our participants were from the capital, 22% from a county seat, 19.2% from other bigger towns, 16.8% from small towns, and 22.8% from villages (Table 2).

During our statistical analysis, we performed descriptive statistics, Chi-square test, t -test for correlation coefficient.

2.1. Ethics

Ethical approval for our research was sought and received from the Medical Research Council of Hungary (administration number: IV/3878- 3 /2021/EKU). At the first page of our online questionnaire, we informed all our participants that they would remain anonymous and their data would not be used individually, only as a part of the whole sample. Therefore, they gave their consent by starting the questionnaire. The questionnaire informed the participants that there were no right or wrong answers for the questions.

3. RESULTS AND DISCUSSION

Regarding the incidence of chronic diseases, 36.5% of the participants had one or more known chronic diseases, the most frequent being hypertonia (13.6%). Regarding allergies, 46.9% of the participants had one or more known allergies (Table 2).

Most of the participants had moderate acute phase symptoms (56.7%), 39.9% had mild symptoms and 17 people (3.4%) had severe acute phase of COVID-19. A total of 403 individuals reported loss of taste (80.9%). We also assessed the time that had passed since the first positive PCR test of the participants in months. The number of symptoms for participants ranged from 1 to 13 with a mean of 3.68 ± 1.984 (Table 3).

Table 1. Age and BMI of the participants ($n = 501$)

Demography	Minimum	Maximum	Mean	Std. deviation
Age	13	71	40.09	11.05
BMI	16.17	60.21	26.29	6.10

Table 2. Acute phase of COVID-19 and time since positive PCR ($n = 501$)

Acute phase of COVID-19	Minimum	Maximum	Mean	Std. deviation
Severity	1	3	1.63	0.548
Time since positive PCR (months)	1	13	3.68	1.984

Severity: 1-mild; 2-moderate; 3-severe



Table 3. Demography and medical history ($n = 501$)

Demography and medical history		Frequency	%
Gender	male	79	15.8
	female	422	84.2
Residence	capital	97	19.4
	county seat (county administrative centre)	110	22.0
	big town (over 20,000 prs.)	96	19.2
	small town (under 20,000 prs.)	84	16.8
	village (under 5,000 prs.)	114	22.8
Chronic disease	one or more	183	36.5
Allergy	one or more	235	46.9

It has been established that a substantial portion of the participants (88.8%) had long COVID symptoms, which means, they still had remaining symptoms even after the cessation of the acute phase of the disease, with a negative PCR-test. Among all long COVID symptoms, the most common symptom was fatigue/weakness (59.8%), followed by anosmia (57.3%), and tachycardia (37.8%). A surprisingly high percentage of our participants reported PTSD (post-traumatic stress disorder) as well (33.9%), dysgeusia (28.1%) and dyspnoe (25.6%) were also very common. We provided our participants with a list of options in our questionnaire that included the most common long COVID symptoms, and we also allowed the participants to add other symptoms they have experienced (Alimohamadi et al., 2020). The frequency and percentage of the long COVID symptoms can be found in more details in Table 4.

Beside the number of long COVID symptoms, factors influencing the severity of the acute phase were examined as well. Older individuals, women, those with higher BMIs, participants with allergy and chronic diseases also experienced more severe symptoms and more long COVID complaints (Tables 5 and 6).

Positive correlations were found between the number of long COVID symptoms and the following factors: severity of acute phase ($r = 0.29$, $P < 0.001$), time since positive PCR ($r = 0.19$, $P < 0.001$), and time of dysgeusia ($r = 0.43$, $P < 0.001$) (Table 6).

Associations between olfactory loss and taste perception problems were found (Table 7).

In Table 8, a list of foods is provided, which the participants did not reject before the COVID-19 disease, but they have since then.

As it is apparent from the results that the type of food people who went through the COVID-19 disease most commonly reject is all kinds of meat of animal origin (poultry, pork, beef, fish) (hereinafter: meat) after the convalescence from the disease. Considering the taste of cold cuts and the differences in level and extent of processing, this food group is classified into a separate category (according to the literature). Of the participants, 22.4% reported this particular change in their dietary habits, 59.3% of the respondents who rejected at least one of the listed foods, and 61.7% of the respondents reported that they have an altered taste of food since the convalescence. Among those who rejected any type of food since the COVID-19-related dysgeusia, the most common self-reported cause of that was a different smell perception regarding the food, which altered their eating habits. This reasoning was reported by 57.9% of the respondents. The second most common justification was the different taste and the food being simply undesirable,



Table 4. Long COVID symptoms with a mean of 3.68 months after the positive PCR test (Alimohamadi et al., 2020)

Long COVID symptoms	Frequency	% (<i>n</i> = 501)	% (of those, who had at least one long COVID symptom) (<i>n</i> = 445)
Fatigue, weakness	266	53.1	59.8
Anosmia	255	50.9	57.3
Tachycardia	168	33.5	37.8
Posttraumatic stress syndrome	151	30.1	33.9
Dysgeusia	125	25.0	28.1
Dyspnoe	114	22.8	25.6
Brain fog	113	22.6	25.4
Joint and muscle pain/numbness	33	6.6	7.4
Parosmia	17	3.4	3.8
Headache	11	2.2	2.5
Dizziness	11	2.2	2.5
Hair loss	10	2.0	2.2
Hypertension	10	2.0	2.2
Cough	9	1.8	2.0
Chest pain	8	1.6	1.8
Gastrointestinal problems	7	1.4	1.6
Menstrual disorder	4	0.8	0.9
Other (1–3 people per example)	tinnitus, oedema, bruising, nose bleeding, rash, itching, acne, phantom odour (phantosmia), sweating, thyroiditis, sinusitis, fever, blurred vision		
The number of participants who have at least one of the above symptoms	445	88.8	100

Table 5. Factors correlating with severity of acute phase (*n* = 501)

Factor		Significance
Age	$r = 0.22$	$P < 0.001^{**}$
Female gender	$Z = -3.04$	$P = 0.002^*$
BMI	$r = 0.10$	$P = 0.021^*$
Chronic disease	$Z = -3.11$	$P = 0.001^{**}$
Allergy	$Z = -3.54$	$P = 0.001^{**}$

Asterisks indicate the strength of the significant relations; *: $P < 0.05$ – significant; **: $P \leq 0.001$ – highly significant.

r: *r*-score (correlation coefficient – strength, direction); *Z*: *Z*-score (the distance of the mean from the data point).

with 40.1% for both of these explanations. The third most common reason was that the food causes complaints with 8.7%.

The correlation between avoiding meat eating after COVID-19, which was the most common dietary change during the long COVID period, and other factors was also examined, to get a clearer picture of the phenomenon, to find the factors that might contribute the most to the development of this change.



Table 6. Factors correlating with the number of long COVID symptoms ($n = 445$)

Factor		Significance
Age	$r = 0.14$	$P = 0.002^*$
Female gender	$t = -7.64$	$P < 0.001^{**}$
BMI	$r = 0.10$	$P = 0.031^*$
Chronic disease	$t = -4.57$	$P < 0.001^{**}$
Allergy	$t = -2.52$	$P = 0.012^*$
Severity of acute phase	$r = 0.29$	$P < 0.001^{**}$
Time since positive PCR	$r = 0.19$	$P < 0.001^{**}$
Time of dysgeusia	$r = 0.43$	$P < 0.001^{**}$
There are foods that have not been liked since COVID	$t = 4.93$	$P < 0.001^{**}$

Asterisks indicate the strength of the significant relations; *: $P < 0.05$ – significant; **: $P \leq 0.001$ – highly significant.

$t = t$ -score (the difference between the observed and expected means divided by the standard error);

r : r -score (correlation coefficient – strength, direction).

Table 7. Associations between olfactory loss and taste perception problems ($n = 255$)

Factor		Sig.
Taste perception problem under COVID-19	$df = 1$	$P < 0.001^{**}$
Taste perception has not yet returned	$df = 2$	$P < 0.001^{**}$
There are foods they have not like since COVID-19 infection	$df = 2$	$P < 0.001^{**}$

Asterisks indicate the strength of the significant relations; *: $P < 0.05$ – significant, **: $P \leq 0.001$ – highly significant; df: degree of freedom.

There was a correlation between the age of the participant and the prevalence of avoiding meat eating ($t = 2.25$; $P = 0.025$), and also between the severity of the COVID symptoms and the prevalence of avoiding meat eating ($t = 2.18$; $P = 0.030$). The same was true about the number of long COVID symptoms ($t = -4.43$; $P < 0.001$), time since the first positive PCR test ($t = -2.16$; $P = 0.031$), and the time of dysgeusia ($t = -5.26$; $P < 0.001$) (Table 9).

According to the currently accessible scientific evidence, it is already known that the COVID-19 disease might have long lasting effects on the affected individuals (Lopez-Leon et al., 2021). This phenomenon occurs in the long COVID period, and it might come with a collection of prevailing symptoms. It often includes a long-lasting dysgeusia/ageusia, suspectedly changing the individuals' taste of food. A study in 2020 examined the prevalence of post-COVID fatigue and found it to be of 52.3% on the studied population, using the CFQ-11 questionnaire (Townsend et al., 2020). A study on the persistent symptoms within the long COVID period found 87% prevalence of the fatigue 3 months after the infection, and the prevalence of anosmia (13%) and ageusia (11%) were also determined (Goërtz et al., 2020). As comparison, in our survey, 53.1% of the participants reported fatigue, 50.9% anosmia, and 25% dysgeusia as long COVID symptoms.

Positive correlations were found between the number of long COVID symptoms and the following factors: severity of acute phase, time since positive PCR, and time of dysgeusia. Elder individuals, women, those with higher BMIs, participants with allergy and chronic diseases also experienced more severe symptoms and longer COVID complaints.



Table 8. Foods that the participant rejected since their convalescence from COVID-19

Foods that are not liked after COVID-19 infection	Frequency	% (<i>n</i> = 501)	% (of those, who reject at least one of the listed foods) (<i>n</i> = 189)
All kinds of meat of animal origin except cold cuts (poultry, pork, beef, fish)	112	22.4	59.3
Coffee	29	5.8	15.3
Citrus fruits	27	5.4	14.3
Onions: onion, garlic	26	5.2	13.8
Chocolate	25	5.0	13.2
Alcoholic drinks	25	5.0	13.2
Dairy products	22	4.4	11.6
Other fruits (e.g.: apples, pears, plums)	19	3.8	10.1
Egg	14	2.8	7.4
Vegetables (e.g.: peppers, tomatoes, cucumbers)	11	2.2	5.8
Meat products (only cold cuts)	6	1.2	3.2
Spicy food	6	1.2	3.2
Cola	3	0.6	1.6
Other (1–2 people per example)	cooked food, ketchup, oil, olives, legumes, porridge, vanilla, mayonnaise fish salad, baked goods, horseradish, melon		
The number of participants who reject at least one of the above foods	189	37.7	100.0

Table 9. Factors correlating with avoiding meat (all kinds of animal origin except cold cuts) eating (*n* = 501)

Factor	Significance
Age	$t = 2.25$ $P = 0.025^*$
Severity of COVID-19	$t = 2.18$ $P = 0.030^*$
Number of long COVID symptoms	$t = -4.43$ $P < 0.001^{**}$
Time since positive PCR	$t = -2.16$ $P = 0.031^*$
Time of dysgeusia	$t = -5.26$ $P < 0.001^{**}$
The smell of food is different	$df = 1$ $P = 0.001^{**}$
The food tastes different	$df = 1$ $P < 0.001^{**}$

Asterisks indicate the strength of the significant relations; *: $P < 0.05$ – significant, **: $P \leq 0.001$ – highly significant.

t: *t*-score (the difference between the observed and expected means divided by the standard error);

df: degree of freedom.

Our working hypothesis was that the COVID-19-related changes in smell and/or taste perception might have a long-term effect on the food and/or taste preference of the individuals. The results of the statistical analysis of our survey supported this claim. We found several examples of food that people, who went through the COVID-19 disease with a deficient ability to



smell and/or taste, started to find disagreeable after the convalescence. The most frequently reported ones were: meat, coffee, citrus fruits, onions, and chocolate in this order. Among these examples, there was an extremely wide gap between the first and the second most commonly rejected type of food, the rejection of meat was reported almost 4 times more frequently than the second most common, which was coffee. In light of these findings, it is safe to conclude that the COVID-19 disease can lead to developing a distaste for certain foods. In total, 37.7% of the respondents mentioned at least one type of food they dislikes since the convalescence after the disease.

A positive correlation was found between the age of the participants and the prevalence of avoiding meat eating, which means that according to the statistical analysis of our sample, elder participants were more susceptible for this particular long COVID symptom.

It was also found that if the COVID symptoms during the acute phase of the disease were more severe, the participants avoided meat eating during the long COVID period more frequently.

Negative correlation was found between the prevalence of avoiding meat eating and the number of long COVID symptoms, time since the first positive PCR test, and the time of dysgeusia.

4. CONCLUSIONS

The most important finding of our study was that the most common type of food that people would reject after the COVID-19 disease was meat. The rejection of meat was significantly higher compared to other types of food in our survey. As a result of our research, the affected person may easily adjust their diet to include less or no eating this type of food once the virus has passed its acute phase.

According to the currently available scientific articles we can safely claim that the present study is the first to address taste and food preference changes in the population affected by long COVID in Hungary. Most likely, these changes are only temporary and they will cease after the complete return of the ability to smell and taste.

This hypothesis could be the basis of a new study that examines the duration of dietary changes due to the changed food preference, in relation to the COVID-19 disease. Nevertheless, if the impairment of the ability to smell and taste becomes a chronic problem, the related dietary changes might become a chronic problem, too. The rejection of different food groups affects the individual's body weight and health state as well. The investigation of these claims requires further research.

4.1. Limitations

Due to the great variability of the possible symptoms during the long COVID period, we did not use any specific questionnaire or score system to assess the prevalence of these, so [Table 3](#) consists only of self-reported post-COVID symptoms.

These results are based on an online survey answered by layman and this manuscript is a description of this survey (without medical supervision).

The COVID-19 only became a pandemic relatively recently, so with this study, we were only able to assess the existence of the long COVID symptoms within a relatively short time span.



Naturally it includes the effects of the anosmia and dysgeusia, which are the two most important factors in relation to the change of taste of food and the consequential change in diet after the disease.

Our study only represents the sample group, not the whole Hungarian population of people, who already went through the COVID-19 disease.

ACKNOWLEDGEMENTS

Hereby, we would like to express our gratitude and appreciation to all our participants, who supported our study with their answers.

REFERENCES

- Alimohamadi, Y., Sepandi, M., Taghdir, M., and Hosamirudsari, H. (2020). Determine the most common clinical symptoms in COVID-19 patients: a systematic review and meta-analysis. *Journal of Preventive Medicine and Hygiene*, 61(3): E304–E312. <https://doi.org/10.15167/2421-4248/jpmh2020.61.3.1530>.
- Andrews, P.J., Pendolino, A.L., Ottaviano, G., Scarpa, B., Grant, J., Gaudioso, P., Bordin, A., Rosario Marchese-Ragon, R., Leoni, D., Cattelan, A., Kaura, A., Gane, S., Hamilton, N.J., Choi, D., and Andrews, J.A. (2020). Olfactory and taste dysfunction among mild-to-moderate symptomatic COVID-19 positive health care workers: an international survey. *Laryngoscope Investigating Otolaryngology*, 5: 1019–1028. <https://doi.org/10.1002/lio2.507>.
- Carfi, A., Bernabei, R., and Landi, F. (2020). Persistent symptoms in patients after acute COVID-19. *JAMA*, 324(6): 603–605. <https://doi.org/10.1001/jama.2020.12603>.
- Carvalho-Schneider, C., Laurent, E., Lemaigren, A., Beaufils, E., Bourbao-Tournois, C., Laribi, S., Flament, T., Ferreira-Maldent, N., Bruyère, F., Stefic, K., Gaudy-Graffin, C., Grammatico-Guillon, L., and Bernard, L. (2021). Follow-up of adults with noncritical COVID-19 two months after symptom onset. *Clinical Microbiology and Infection*, 27(2): 258–263. <https://doi.org/10.1016/j.cmi.2020.09.052>.
- Dell’Era, V., Farri, F., Garzaro, G., Gatto, M., Aluffi Valletti, P., and Garzaro, M. (2020). Smell and taste disorders during COVID -19 outbreak: cross-sectional study on 355 patients. *Head & Neck*, 42(7): 1591–1596. <https://doi.org/10.1002/hed.26288>.
- Eliezer, M., Hautefort, C., Hamel, A.L., Verillaud, B., Herman, P., Houdart, E., and Eloit, C. (2020). Sudden and complete olfactory loss of function as a possible symptom of COVID-19. *JAMA Otolaryngology – Head & Neck Surgery*, 146(7): 674–675. <https://doi.org/10.1001/jamaoto.2020.0832>.
- Galván-Tejada, C.E., Cintya Fabiola Herrera-García, C.F., Godina-González, S., Villagrana-Bañuelos, K.E., De Luna Amaro, J.D., Herrera-García, K., Reyes-Escobedo, F., Celaya-Padilla, J.M., Galván-Tejada, J.I., Gamboa-Rosales, H., Martínez-Acuña, M., Cervantes-Villagrana, A., Rivas-Santiago, B., and Gonzalez-Curiel, I.E. (2020). Persistence of COVID-9 symptoms after recovery in Mexican population. *International Journal of Environtal Research and Public Health*, 17(24): 9367. <https://doi.org/10.3390/ijerph17249367>.
- Garrigues, E., Janvier, P., Kherabi, Y., le Bot, A., Hamon, A., Gouze, H., Doucet, L., Berkani, S., Oliosi, E., Mallart, E., Corre, F., Zarrouk, V., Moyer, J.D., Galy, A., Honsel, V., Fantin, B., and Nguyen, Y. (2020). Post-discharge persistent symptoms and health-related quality of life after hospitalization for COVID-19. *Journal of Infection*, 81(6): E4–E6. <https://doi.org/10.1016/j.jinf.2020.08.029>.



- Gautier, J. and Ravussin, Y. (2020). A New symptom of COVID-19: loss of taste and smell. *Obesity*, 28(5): 848. <https://doi.org/10.1002/oby.22809>.
- Gelardi M., Trecca E., Cassano M., Ciprandi G. (2020). Smell and taste dysfunction during the COVID-19 outbreak: a preliminary report. *Acta Biomedica*, 91(2): 230–231. <https://doi.org/10.23750/abm.v91i2.9524>.
- Gemelli Against COVID-19 Post-Acute Care Study Group (2020). Post-COVID-19 global health strategies: the need for an interdisciplinary approach. *Aging Clinical and Experimental Research*, 32: 1613–1620. <https://doi.org/10.1007/s40520-020-01616-x>.
- Goërtz, Y.M., van Herck, M., Delbressine, J.M., Vaes, A.W., Meys, R., Machado, F.V., Houben-Wilke, S., Burtin, C., Posthuma, R., Franssen, F.M., van Loon, N., Hajian, B., Spies, Y., Vijlbrief, H., van 't Hul, A.J., Janssen, D.J., and Spruit, M.A. (2020). Persistent symptoms 3 months after a SARS-CoV-2 infection: the post-COVID-19 syndrome? *ERJ Open Research*, 6(4): 00542–02020. <https://doi.org/10.1183/23120541.00542-2020>.
- Horvath, L., Lim, J.W.J., Taylor, J.W., Saief, T., Stuart, R., Rimmer, J., and Michael, P. (2020). Smell and taste loss in COVID-19 patients: assessment outcomes in a Victorian population. *Acta Oto-Laryngologica*, 141(3): 299–302. <https://doi.org/10.1080/00016489.2020.1855366>.
- Huang, C., Wang, Y., Li, X., Ren, L., Zhao, J., Hu, Y., Zhang, L., Fan, G., Xu, J., Gu, X., Cheng, Z., Yu, T., Xia, J., Wei, Y., Wu, W., Xie, X., Yin, W., Li, H., Liu, M., Xiao, Y., Gao, H., Guo, L., Xie, J., Wang, G., Jiang, R., Gao, Z., Jin, Q., Wang, J., and Cao, B. (2020). Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet*, 395(10223): 497–506. [https://doi.org/10.1016/S0140-6736\(20\)30183-5](https://doi.org/10.1016/S0140-6736(20)30183-5).
- Kamal, M., Abo Omirah, M., Hussein, A., and Saeed, H. (2020). Assessment and characterisation of post-COVID-19 manifestations. *International Journal of Clinical Practice*, 75(3): e13746 <https://doi.org/10.1111/ijcp.13746>.
- Lechien, J.R., Chiesa-Estomba, C.M., de Siati, D.R., Horoi, M., le Bon, S.D., Rodriguez, A., Dequanter, D., Bleicic, S., el Afia, F., Distinguin, L., Chekkoury-Idrissi, Y., Hans, S., Delgado, I.L., Calvo-Henriquez, C., Lavigne, P., Falanga, C., Barillari, M.R., Cammaroto, G., Khalife, M., Edjlali, M., Carlier, R., Ris, L., Lovato, A., De Filippis, C., Coppee, F., Fakhry, N., Ayad, T., and Saussez, S. (2020). Olfactory and gustatory dysfunctions as a clinical presentation of mild-to-moderate forms of the coronavirus disease (COVID-19): a multicenter European study. *European Archives of Oto-Rhino-Laryngology*, 277(8): 2251–2261. <https://doi.org/10.1007/s00405-020-05965-1>.
- Lopez-Leon, S., Wegman-Ostrosky, T., Perelman, C., Sepulveda, R., Rebolledo, P.A., Cuapio, A., and Villapo, S. (2021). More than 50 long-term effects of COVID-19: a systematic review and meta-analysis. *Scientific Reports*, 11: 16144. <https://doi.org/10.1038/s41598-021-95565-8>.
- Mao, L., Jin, H., Wang, M., Hu, Y., Chen, S., He, Q., Chang, J., Hong, C., Zhou, Y., Wang, D., Miao, X., Li, Y., and Hu, B. (2020). Neurologic manifestations of hospitalized patients with coronavirus disease 2019 in Wuhan, China. *JAMA Neurology*, 77(6): 683–690. <https://doi.org/10.1001/jamaneurol.2020.1127>.
- Moein, S.T., Hashemian, S.M., Tabarsi, P., and Doty, R.L. (2020). Prevalence and reversibility of smell dysfunction measured psychophysically in a cohort of COVID-19 patients. *International Forum of Allergy & Rhinology*, 10(10): 1127–1135. <https://doi.org/10.1002/alar.22680>.
- Moore, J.B. and June, C.H. (2020). Cytokine release syndrome in severe COVID-19. *Science*, 368(6490): 473–474. <https://doi.org/10.1126/science.abb8925>.
- Tenforde, M.W., Kim, S.S., Lindsell, C.J., Billig Rose, E., Shapiro, N.I., Files, D.C., Gibbs, K.W., Erickson, H.L., Steingrub, J.S., Smithline, H.A., Gong, M.N., Aboodi, M.S., Exline, M.C., Henning, D.J., Wilson,



- J.G., Khan, A., Qadir, N., Brown, S.M., Peltan, I.D., Rice, T.W., Hager, D.N., Ginde, A.A., Stubblefield, W.B., Patel, M.M., Self, W.H., and Feldstein, L.R. (2020). Symptom duration and risk factors for delayed return to usual health among outpatients with COVID-19 in a multistate health care systems network — United States, March–June 2020. *MMWR. Morbidity and Mortality Weekly Report*, 69(30): 993–998. <https://doi.org/10.15585/mmwr.mm6930e1>.
- Townsend, L., Dyer, A.H., Jones, K., Dunne, J., Mooney, A., Gaffney, F., O'Connor, L., Leavy, D., O'Brien, K., Dowds, J., Sugrue, J.A., Hopkins, D., Martin-Loeches, I., Ni Cheallaigh, C., Nadarajan, P., McLaughlin, A.M., Bourke, N.M., Bergin, C., O'Farrelly, C., Berger, C., O'Farrelly, C., Banlan, C., and Conlon, N. (2020). Persistent fatigue following SARS-CoV-2 infection is common and independent of severity of initial infection. *PLoS One*, 15(11): e0240784. <https://doi.org/10.1371/journal.pone.0240784>.
- Townsend, L., Dowds, J., O'Brien, K., Sheill, G., Dyer, A.H., O'Kelly, B., Hynes, J.P., Mooney, A., Dunne, J., Ni Cheallaigh, C., O'Farrelly, C., Bourke, N.M., Conlon, N., Martin-Loeches, I., Bergin, C., Nadarajan, P., and Bannan, C. (2021). Persistent poor health after COVID-19 is not associated with respiratory complications or initial disease severity. *Annals of the American Thoracic Society*, 18(6): 997–1003. <https://doi.org/10.1513/annalsats.202009-1175oc>.
- Trachootham, D., Thongyen, S., Lam-Ubol, A., Chotechuang, N., Pongpirul, W., and Prasithsirikul, W. (2021). Simultaneously complete but not partial taste and smell losses were associated with SARS-CoV-2 infection. *International Journal of Infectious Diseases*, 106: 329–337. <https://doi.org/10.1016/j.ijid.2021.03.083>.
- WHO. (2021). *A clinical case definition of post COVID-19 condition by a Delphi consensus*. World Health Organization. [online] Available at: https://www.who.int/publications/i/item/WHO-2019-nCoV-Post_COVID-19_condition-Clinical_case_definition-2021.1.
- Zhao, Y.M., Shang, Y.M., Song, W.B., Li, Q.Q., Xie, H., Xu, Q.F., Jia, J.L., Li, L.M., Mao, H.L., Zhou, X.M., Luo, H., Gao, Y.F., and Xu, A.G. (2020). Follow-up study of the pulmonary function and related physiological characteristics of COVID-19 survivors three months after recovery. *EClinicalMedicine*, 25: 100463. <https://doi.org/10.1016/j.eclinm.2020.100463>.

