CORRESPONDENCE: OUR EXPERIENCE

Course of symptoms for loss of sense of smell and taste over time in one thousand forty-one healthcare workers during the Covid-19 pandemic: Our experience

Matt Lechner1,2 | Jacklyn Liu2 | Nicholas Counsell3 | Ngan Hong Ta4,5 | John Rocke6 | Rajesh Anmolsingh7 | Nicholas Eynon-Lewis1 | Santdeep Paun1 | Claire Hopkins8 | Sadie Khwaja7 | B. Nirmal Kumar6 | Samuel Jayarat1 |
Valerie J. Lund9 | Carl Philpott4,5

1Barts Health NHS Trust, London, UK
2UCL Cancer Institute, University College London, London, UK
3Cancer Research UK & UCL Cancer, Trials Centre, University College London, London, UK
4The Norfolk Smell & Taste Clinic, Norfolk & Waveney ENT Service, Norfolk, UK
5Norwich Medical School, University of East Anglia, Norwich, UK
6Wrightington, Wigan and Leigh Teaching Hospitals NHS Foundation Trust, London, UK
7Manchester University NHS Foundation Trust, London, UK
8Guy’s and St. Thomas’ NHS Foundation Trust, London, UK
9Royal National Throat, Nose and Ear Hospital, UCLH Foundation Trust, London, UK

Correspondence: Carl Philpott, Norwich Medical School, UEA, Norwich NR4 7TJ, UK. Email: c.philpott@uea.ac.uk

Dear Editor,

On 21 April 2020, the Centers for Disease Control and Prevention (CDC) and on 5 May 2020, the World Health Organisation added “new loss of taste or smell” to their list of symptoms related to Covid-19, respectively. Public Health England (PHE) only included loss of smell and taste as official symptoms on 20th May. However, whether individual hospitals were including smell and taste disturbances in their initial work-up for Covid-19 diagnosis is unknown.

Several reports have now demonstrated the prevalence of these symptoms in Covid-19 infected individuals with important implications on diagnosis and management.1 Due to the high incidence of Covid-19 infection which has been reported in the healthcare setting, we sought to understand the symptomatology of a cohort of healthcare personnel in order to assess current management guidelines, including how many healthcare workers were permitted to continue working despite being infected.

1 | MATERIALS AND METHODS

1.1 | Survey design and recruitment

Anonymous questionnaires were distributed to staff at hospitals across six NHS trusts: Barts Health, Guy’s and St. Thomas’, James Paget University Hospital, Norfolk & Norwich University Hospital, Manchester University and Wrightington, Wigan and Leigh. The study was advertised by trust-wide emails to all staff, which included access to an electronic link to the questionnaire. Participants completed the questionnaire online (supplementary material).

Slight alterations to the survey format were utilised, due to logistical and practical reasons across the various trusts. Results from all trusts were pooled at the end of the recruitment period. Questionnaires were distributed and completed between 27 March 2020 and 9 June 2020. A single questionnaire was distributed to three of the six trusts, whilst two questionnaires (baseline and follow-up) were distributed to the remaining three trusts.
Question items were largely identical between the two methodologies; where different, questions were appropriately matched for analysis. This pertains to questions regarding whether participants had experienced the loss of sense of smell/taste within the past 4 weeks and whether or not they had recovered, which was either explicitly asked in the single questionnaire format or implied in the second methodology, on the basis of the baseline and follow-up questionnaires being completed 4 weeks apart. In addition, where relevant, only those who completed the follow-up survey were asked about qualitative smell dysfunction (i.e., distortion of smell, phantom smells and sensations of burning/cooling/tingling in nose and/or mouth). The remainder of the questionnaires included items on age, sex, Covid-19 status and relevant symptoms and specific questions around chemosensory disturbances, such as a smell and taste rating, which were identical between the two methodologies.

Descriptive statistical analysis was conducted on patient characteristics and logistic regression where odds ratios (with 95% confidence intervals and \( P \)-values) are presented. Smell and taste scores were compared between groups using the Mann-Whitney \( U \) test. Sensitivity and specificity of the loss of sense of smell/taste in relation to Covid-19 infection are also presented, in addition to positive and negative predictive values.

2 | RESULTS

2.1 | Participant characteristics

In total, 1041 healthcare workers from the six NHS trusts responded to our surveys from 27 March 2020 to 9 June 2020. Sample characteristics are described in Table 1; 70.9% female (737 of 1039), 74.6% white (456 of 611), 75.1% work in direct contact with patients (489 of 651), 50.3% (524 of 1041) were aged ≤ 40 years and 5.6% (58 of 1041) aged over 60 years. Overall, 306 (29.4%) participants had experienced the loss of sense of smell/taste within the past 4 weeks and 420 (40.3%) did not suspect that they had been infected, and 315 (30.3%) had not been tested but suspected a confirmed positive test and 98 (9.4% of total, 32.0% of tested) were positive; a further 315 (30.3%) had not been tested but suspected a confirmed positive test and 98 (9.4% of total, 32.0% of tested) were confirmed positive cases. In 519 participants who had recently lost their sense of smell and/or taste, there was strong evidence of an association between losing the sense of smell/taste and Covid-19 (Table 2), participants who lost their sense of smell/taste were more likely to have a positive Covid-19 test (Odds Ratio OR = 8.55, 95% CI: 4.69-15.58, \( P < .001 \)) or suspected Covid-19 infection (OR = 14.55, 95% CI: 10.49-20.18, \( P < .001 \)), that is an 8½-fold increase in risk within the tested subgroup or a 14½-fold increase in risk when including both tested and non-tested participants. The sensitivity and specificity of smell/taste loss being symptoms of Covid-19 positive cases were 89.9% and 49.0%, respectively, whilst the positive predictive and negative predictive values were 78.9% and 69.6%, respectively (Table 3). Similar results were observed when considering the scores, participants gave with regard to their sense of smell/taste at its worst (0 none-10 normal), with markedly lower scores in the Covid-19 positive groups in terms of sense of smell (tested subgroup \( P < .001 \); all participants \( P < .001 \)) and sense of taste (tested subgroup \( P = .05 \); all participants \( P < .001 \)).

In 519 participants who had recently lost their sense of smell and responded to the question: “has it been 4 weeks since you lost your sense of smell/taste?” 88.2% (458 of 519) reported that it had been at least 4 weeks since they had lost their sense of smell/taste—9.9% (45 of 455) had not yet recovered, 38.7% (176 of 455) had recovered partially and 51.4% (234 of 455) had recovered completely (3 time. Of the 272, who responded, 247 participants experienced at least one of the following symptoms: chemesthesis (i.e., sensations of burning, cooling, or tingling) in nose or mouth (34.6%, 94 of 272), parosmia (42.3%, 115 of 272) and phantosmia (33.8%, 92/272).

2.3 | Self-reported experience with smell and taste dysfunction

There was strong evidence of an association between losing the sense of smell/taste and Covid-19 (Table 2), participants who lost their sense of smell/taste were more likely to have a positive Covid-19 test (Odds Ratio OR = 8.55, 95% CI: 4.69-15.58, \( P < .001 \)) or suspected Covid-19 infection (OR = 14.55, 95% CI: 10.49-20.18, \( P < .001 \)), that is an 8½-fold increase in risk within the tested subgroup or a 14½-fold increase in risk when including both tested and non-tested participants. The sensitivity and specificity of smell/taste loss being symptoms of Covid-19 positive cases were 89.9% and 49.0%, respectively, whilst the positive predictive and negative predictive values were 78.9% and 69.6%, respectively (Table 3). Similar results were observed when considering the scores, participants gave with regard to their sense of smell/taste at its worst (0 none-10 normal), with markedly lower scores in the Covid-19 positive groups in terms of sense of smell (tested subgroup \( P < .001 \); all participants \( P < .001 \)) and sense of taste (tested subgroup \( P = .05 \); all participants \( P < .001 \)).

In 519 participants who had recently lost their sense of smell and responded to the question: “has it been 4 weeks since you lost your sense of smell/taste?” 88.2% (458 of 519) reported that it had been at least 4 weeks since they had lost their sense of smell/taste—9.9% (45 of 455) had not yet recovered, 38.7% (176 of 455) had recovered partially and 51.4% (234 of 455) had recovered completely (3
missing). Of those for whom loss of smell/taste occurred within the past 4 weeks (n = 61), 19.5% (8 of 41) had not yet recovered, 58.5% (24 of 41) had recovered partially and 22.0% (9 of 41) had recovered completely (20 missing). Of the total cohort, the median loss was 14 days (range: 1-90), which excludes 116 participants with ongoing symptoms.

3 | DISCUSSION

This study demonstrates the very high prevalence of the loss of sense of smell and/or taste in healthcare personnel, which is significantly related to Covid-19 positivity. In addition, these symptoms may occur with or without the presence of other Covid-19–related symptoms; in 16.6% of the cohort, the loss of sense of smell/taste was the only symptom. This indicates that a number of individuals deemed to be otherwise asymptomatic may in fact be highly contagious and should have been self-isolating.

Importantly, our results demonstrate that nearly half of participants continued to work following the loss of sense of smell and/or taste. Some participants noted that when seeking advice regarding self-isolation from health authorities, they were told to continue working as loss of sense of smell and/or taste had yet to be recognised as official symptoms of Covid-19 (qualitative data are not shown). Thus, it is likely that a large proportion of healthcare workers, who did continue to work, were in fact highly contagious at the time.

Interestingly, whilst objective smell testing was beyond the scope of this study, we do note that symptom self-reporting (ie smell and taste rating) correlated with Covid-19 positivity. This has been similarly demonstrated by a group at King’s College London, where symptom tracking using a mobile app demonstrated that self-reporting of the loss of sense of smell, in addition to fatigue, cough and loss of appetite, may more accurately predict Covid-19 infection.2 Previously, the correlation between subjective and objective assessment of smell function has been shown to be poor.3 However, more detailed questioning can improve the sensitivity of self-reported smell function as demonstrated by the US National Health and Nutrition Examination Survey (NHANES).4 Thus, whilst we cannot conclude whether self-reporting through our questionnaire can predict objective testing outcome, subjective assessment as an initial screen may be beneficial in the detection of Covid-19, especially given the typically sudden onset of the symptom, which is not as characteristic in olfactory dysfunction caused by other viruses. Efforts toward a validated, comprehensive questionnaire, which does correlate better with objective testing, would further this endeavour.

Although both loss of sense of smell and taste improved over time in the majority, there is a need to address the long-term effects of these symptoms, as nearly half of those who lost their sense of

| Characteristic/Question          | Category                        | n (%) |
|----------------------------------|----------------------------------|-------|
| Age                              | 30 or under                      | 251 (24.1) |
|                                  | 31-40                            | 273 (26.2) |
|                                  | 41-50                            | 244 (23.4) |
|                                  | 51-60                            | 215 (20.7) |
|                                  | Over 60                          | 58 (5.6)   |
| Gender (n = 1039)                | Female                           | 737 (70.9) |
|                                  | Male                             | 301 (29.0) |
|                                  | Non-binary                       | 1 (0.1)    |
| Ethnicity (n = 611)              | White                            | 456 (74.6) |
|                                  | Other                            | 155 (25.4) |
| NHS trust                        | Barts Health                     | 273 (26.2) |
|                                  | Guy's and St Thomas'             | 86 (8.3)   |
|                                  | James Paget University Hospitals | 63 (6.1)   |
|                                  | Norfolk & Norwich University Hospital | 91 (8.7) |
|                                  | Manchester University            | 428 (41.1) |
|                                  | Wrightington, Wigan and Leigh    | 100 (9.6)  |
| Does your work involve direct patient contact? (n = 651) | No                               | 162 (24.9) |
|                                  | Yes                              | 489 (75.1) |
| Covid-19 Coronavirus status?     | Negative tested                  | 98 (9.4)   |
|                                  | Negative opinion                 | 420 (40.3) |
|                                  | Positive opinion                 | 315 (30.3) |
|                                  | Positive tested                  | 208 (20.0) |
| TOTAL                            |                                  | 1041 (100.0) |
### Table 2: Survey responses by Covid-19 coronavirus status (N = 1041)

| Question                                                                 | N = 1041                      | Negative tested | Negative opinion | Positive opinion | Positive tested | Total        |
|--------------------------------------------------------------------------|-------------------------------|-----------------|------------------|------------------|-----------------|--------------|
| Have you suddenly lost your sense of smell/taste in the last 2 mo?       | 0 (0%)                        | 48 (49.0%)      | 286 (68.1%)      | 37 (11.7%)       | 21 (10.1%)      | 392 (37.7%)  |
| (n = 1041)                                                               |                               |                 |                  |                  |                 |              |
| Have you noticed any of the following?                                    | 533 (51.2%)                   | 13 (13.8%)      | 19 (20.2%)       | 32 (34.0%)       | 30 (31.9%)      | 94 (34.6%)   |
| (n = 272)                                                                |                               |                  |                  |                  |                 |              |
| Changes in the sensations of burning, cooling or tingling in your nose or | 236 (22.7%)                   | 15 (13.0%)      | 18 (15.7%)       | 53 (46.1%)       | 29 (25.2%)      | 115 (42.3%)  |
| mouth?                                                                   |                               |                  |                  |                  |                 |              |
| Distortion of smell (things smell differently to what you expect?)       |                               | 10 (10.9%)      | 16 (17.4%)       | 40 (43.5%)       | 26 (28.3%)      | 92 (33.8%)   |
| Feeling like you are smelling something when there is no smell present?  |                               |                  |                  |                  |                 |              |
| None of the above                                                        | 0 (0.0%)                      | 3 (3.1%)        | 7 (7.6%)         | 12 (12.1%)       | 3 (3.1%)        | 21 (8.4%)    |
| How would you rate your sense of smell at its worst?                     | 274 (26.3%)                   | 3.4 (3.79)      | 4.5 (4.11)       | 1.6 (2.82)       | 1.2 (2.65)      | 2.5 (3.56)   |
| (n = 767)                                                                |                               |                  |                  |                  |                 |              |
| How would you rate your sense of taste at its worst?                     | 274 (26.3%)                   | 3.6 (3.44)      | 5.0 (3.95)       | 2.4 (2.91)       | 2.6 (3.05)      | 3.3 (3.50)   |
| (n = 767)                                                                |                               |                  |                  |                  |                 |              |
| If not ongoing, how long did loss of taste/smell last for?               | 114 (11.0%)                   | 12.8 (12.97)    | 14.8 (12.86)     | 16.9 (13.12)     | 15.4 (11.26)    | 15.7 (12.60) |
| (n = 419)                                                                |                               |                  |                  |                  |                 |              |
| Did your sense of smell/taste disappear...?                              | 12 (1.2%)                     | 8 (7.6%)        | 57 (53.8%)       | 23 (21.7%)       | 18 (17.0%)      | 106 (16.6%)  |
| (n = 637)                                                                |                               |                  |                  |                  |                 |              |
| Only symptom                                                             | 392 (37.7%)                   | 9 (9.2%)        | 13 (13.3%)       | 44 (44.9%)       | 32 (32.7%)      | 98 (15.4%)   |
| Before others                                                            |                               |                  |                  |                  |                 |              |
| After others                                                             | 32 (7.4%)                     | 61 (14.1%)      | 208 (48.0%)      | 132 (30.5%)      | 433 (68.0%)     |              |
| If you have suffered symptoms were they...?                              | 321 (30.8%)                   | 1 (2.2%)        | 25 (54.3%)       | 16 (34.8%)       | 4 (8.7%)        | 46 (6.4%)    |
| (n = 720)                                                                |                               |                  |                  |                  |                 |              |
| Mild but continued to work                                               |                               | 1 (2.2%)        | 25 (54.3%)       | 16 (34.8%)       | 4 (8.7%)        | 46 (6.4%)    |
| Mild and self-isolate                                                    |                               | 50 (14.4%)      | 89 (25.6%)       | 123 (35.4%)      | 85 (24.5%)      | 347 (48.2)   |
| Moderate                                                                |                               | 27 (8.6%)       | 39 (12.4%)       | 150 (47.6%)      | 99 (31.4%)      | 315 (43.8)   |
| Severe                                                                  |                               | 1 (8.3%)        | 0 (0.0%)         | 3 (25.0%)        | 8 (66.7%)       | 12 (1.7%)    |

(Continues)
| Question                                                                 | N = 1041 | Not answered | Normal Smell/Taste | Not asked<sup>a</sup> | Category                                      | Negative tested | Negative opinion | Positive opinion | Positive tested | Total |
|-------------------------------------------------------------------------|----------|--------------|-------------------|-----------------------|-----------------------------------------------|-----------------|------------------|------------------|----------------|-------|
| Have you...? (n = 793)                                                 |          | 248          | NA                | NA                    | Needed treatment in hospital                  | 0 (0.0%)        | 0 (0.0%)         | 0 (0.0%)         | 3 (100.0%)     | 3 (0.4%)|
|                                                                         |          |              |                   |                       | Self-isolated                                 | 47 (12.1%)      | 53 (13.7%)       | 159 (41.0%)      | 129 (33.2%)    | 388 (48.9%)|
|                                                                         |          |              |                   |                       | Partially self-isolated                        | 3 (17.6%)       | 5 (29.4%)        | 5 (29.4%)        | 4 (23.5%)      | 17 (2.1%)|
|                                                                         |          |              |                   |                       | Continued to work as normal                    | 36 (9.4%)       | 234 (60.8%)      | 88 (22.9%)       | 27 (7.0%)      | 385 (48.5%)|
| What other symptoms have you experienced? (n = 767)                     |          | 274          | NA                | NA                    | Nasal blockage                                | 21 (8.3%)       | 61 (24.2%)       | 102 (40.5%)      | 68 (27.0%)     | 252 (32.9%)|
|                                                                         |          |              |                   |                       | Runny nose                                    | 22 (11.0%)      | 53 (26.5%)       | 147 (48.1%)      | 99 (32.1%)     | 308 (40.2%)|
|                                                                         |          |              |                   |                       | Nasal irritation/burning                       | 10 (8.3%)       | 18 (15.0%)       | 68 (34.0%)       | 57 (28.5%)     | 200 (26.1%)|
|                                                                         |          |              |                   |                       | Distortion of smell                           | 7 (13.7%)       | 8 (15.7%)        | 21 (41.2%)       | 15 (29.4%)     | 51 (6.6%) |
|                                                                         |          |              |                   |                       | Bad smell                                     | 5 (8.6%)        | 14 (24.1%)       | 18 (31.0%)       | 21 (36.2%)     | 58 (7.6%)  |
|                                                                         |          |              |                   |                       | Fever                                         | 27 (8.8%)       | 35 (11.4%)       | 147 (48.1%)      | 99 (32.1%)     | 308 (40.2%)|
|                                                                         |          |              |                   |                       | Cough                                         | 22 (6.7%)       | 43 (13.2%)       | 157 (48.2%)      | 104 (31.9%)    | 326 (42.5%)|
|                                                                         |          |              |                   |                       | Diarrhoea                                     | 17 (11.6%)      | 15 (10.2%)       | 66 (44.9%)       | 49 (33.3%)     | 147 (19.2%)|
|                                                                         |          |              |                   |                       | Shortness of breath                           | 16 (7.0%)       | 29 (12.8%)       | 101 (44.5%)      | 81 (35.7%)     | 227 (29.6%)|
|                                                                         |          |              |                   |                       | Fatigue                                       | 37 (7.4%)       | 89 (17.7%)       | 222 (44.2%)      | 154 (30.7%)    | 502 (65.4%)|
| Has it been ≥ 4 wk since you lost sense of smell/taste? (n = 519)       |          | 3 (0.3%)     | 392 (37.7%)       | 127 (12.2%)            | No                                            | 11 (18.0%)      | 5 (8.2%)         | 12 (19.7%)       | 33 (54.1%)     | 61 (11.8%)|
|                                                                         |          |              |                   |                       | Yes, partially                                | 35 (7.6%)       | 93 (20.3%)       | 214 (46.7%)      | 116 (25.3%)    | 458 (88.2%)|
|                                                                         |          |              |                   |                       | Yes, completely                               | 6 (13.3%)       | 6 (13.3%)        | 16 (35.6%)       | 17 (37.8%)     | 45 (9.9%)  |
|                                                                         |          |              |                   |                       | Yes, partially                                | 9 (5.1%)        | 26 (48.8%)       | 95 (54.0%)       | 46 (26.1%)     | 176 (38.7%)|
|                                                                         |          |              |                   |                       | Yes, completely                               | 19 (8.1%)       | 61 (26.1%)       | 102 (43.6%)      | 52 (22.2%)     | 234 (51.4%)|
|                                                                         |          |              |                   |                       | <4 wk (n = 455)                               | 0 (0.0%)        | 0 (0.0%)         | 2 (25.0%)        | 6 (75.0%)      | 8 (19.5%)  |
|                                                                         |          |              |                   |                       | Yes, partially                                | 5 (20.8%)       | 2 (8.3%)         | 4 (16.7%)        | 13 (54.2%)     | 24 (58.5%)|
|                                                                         |          |              |                   |                       | Yes, completely                               | 3 (33.3%)       | 1 (11.1%)        | 2 (22.2%)        | 3 (33.3%)      | 9 (22.0%)  |

Abbreviation: NA, not applicable.

<sup>a</sup>Did not complete follow-up questionnaire.

<sup>b</sup>Excludes 116 participants who reported ongoing symptoms.
smell/taste at least 4 weeks prior to the survey had yet to recover at the time of the survey. The reported persistence of smell/taste disturbances requires improved management guidelines, and points to the need for more treatments to be evaluated through clinical trials. At present, guidelines published by ENT UK/British Rhinological Society recommend those with recent loss of smell and Covid-19 infection are managed by their GP with treatments suggested, which may include oral steroids after the initial 2 weeks. Further guidance can be found on supportive resources such as those available through Fifth Sense (www.fifthsense.org.uk).

A limitation to self-reported questionnaires in general is the potential for response/selection and recall biases. Furthermore, since a repeat questionnaire was used at three sites, as opposed to the singular questionnaire was used at the remaining sites, it was not possible to perfectly match the questions and subsequent results. In addition, the design of the study allowed participants to opt out of certain questions. As such, there is necessarily missing data, which may impact the results.

In addition, a further limitation of this study is that only 20% of respondents had proven Covid-19. An additional 30% of respondents reported a suspicion of Covid-19 infection. Whilst Covid-19 infection in the latter group could not be confirmed, it is highly likely these individuals suffered from infection as the chance of sudden loss of smell and/or taste not due to Covid-19 infection is extremely rare. Indeed, a recent study demonstrated a positive rate of 87.5% of those with recent loss of smell and Covid-19 infection were managed by their GP with treatments suggested, which may include oral steroids after the initial 2 weeks. Further guidance can be found on supportive resources such as those available through Fifth Sense (www.fifthsense.org.uk).

|               | Tested positive | Tested negative |
|---------------|-----------------|-----------------|
| Reported loss of smell/taste | 187             | 50              |
| Did not report loss of smell/taste | 21              | 48              |
| Sensitivity   | 89.9%           |                 |
| Specificity   | 49.0%           |                 |
| Positive predictive value | 78.9%       |                 |
| Negative predictive value | 69.6%       |                 |

Bold highlights the importance of smell loss as a symptom in Covid-19.

Table 3: The loss of sense of smell and/or taste in predicting a positive Covid-19 test

self-reporting such as the Global Consortium for Chemosensory Research questionnaire. In contrast, a study in South Korea, which assessed only individuals who had a positive Covid-19 test, found that roughly 30% of patients with early stage or mild disease experienced anosmia/ageusia. Nevertheless, whilst the true proportion of those who experience the loss of sense of smell/taste may be lower than observed in our study, our results indicate the importance of these symptoms and demonstrate their utility as part of targeted mass screening.

It has been evident that healthcare workers frequently report loss of sense of smell, particularly in the absence of other symptoms and looking at other studies, it can now be regarded likely that most healthcare workers, who have suffered from a loss of sense of smell at the time of the first wave of the pandemic, are likely to have had Covid-19 infection as the chance of sudden loss of olfactory function is so rare otherwise, especially with limited social contact in a national lockdown. Therefore, in order to prevent hospital transmission, it is imperative that the 20% rate of testing seen in the first wave must be improved upon, particularly as Europe faces a second wave of infection, which may be greater than the first. Increased awareness of Covid-19 symptomatology, in particular the loss of sense of smell, and implementation of due measures will certainly help to mitigate the increasing severity of the ongoing crisis.

CONFLICT OF INTEREST
None to declare.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID
Ngan Hong Ta https://orcid.org/0000-0002-8747-5329
John Rocke https://orcid.org/0000-0002-2224-0246
Carl Philpott https://orcid.org/0000-0002-1125-3236

REFERENCES
1. Lechner M, Chandrasekharan D, Jumani K, et al. Anosmia as a presenting symptom of SARS-CoV-2 infection in healthcare workers - a systematic review of the literature, case series, and recommendations for clinical assessment and management. Rhinology. 2020;58(4):394-399. https://doi.org/10.4193/Rhin20.189
2. Menni C, Valdes AM, Freidin MB, et al. Real-time tracking of self-reported symptoms to predict potential COVID-19. *Nat Med*. 2020; https://doi.org/10.1038/s41591-020-0916-2

3. Philpott CM, Wolstenholm CR, Goodenough PC, Clark A, Murty GE. Comparison of subjective perception with objective measurement of olfaction. *Otolaryngol Head Neck Surg*. 2006;134:488-490.

4. Rawal S, Hoffman HJ, Honda M, Huedo-Medina TB, Duffy VB. The taste and smell protocol in the 2011-2014 US National Health and Nutrition Examination Survey (NHANES): test-retest reliability and validity testing. *Chemosens Percept*. 2015;8:138-148.

5. Hopkins C, Alanin M, Philpott C, et al. Management of new onset loss of sense of smell during the COVID-19 pandemic - BRS Consensus Guidelines. *Clin Otolaryngol*. 2020. https://doi.org/10.1111/coa.13636

6. Lechien JR, Cabaraux P, Chiesa-Estomba CM, et al. Psychophysical olfactory tests and detection of COVID-19 in patients with sudden onset olfactory dysfunction: a prospective study. *Ear Nose Throat J*. 2020;99:579-583.

7. Gerkin RC, Ohla K, Veldhuizen MG, et al. Recent smell loss is the best predictor of COVID-19: a preregistered, cross-sectional study. *medRxiv*. 2020. https://doi.org/10.1101/2020.07.22.20157263

8. Parma V, Ohla K, Veldhuizen MG, et al. More than smell-COVID-19 is associated with severe impairment of smell, taste, and chemesthesis. *Chem Senses*. 2020;45:609-622.

9. Tong JY, Wong A, Zhu D, Fastenberg JH, Tham T. The prevalence of olfactory and gustatory dysfunction in COVID-19 patients: a systematic review and meta-analysis. *Otolaryngol Head Neck Surg*. 2020;163(1):3-11.

10. Lee Y, Min P, Lee S, Kim S. Prevalence and duration of acute loss of smell or taste in COVID-19 patients. *J Korean Med Sci*. 2020;35(18):e174. https://doi.org/10.3346/jkms.2020.35.e174

**SUPPORTING INFORMATION**

Additional supporting information may be found online in the Supporting Information section.