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

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Self-reported symptoms from exposure to Covid-19 provide support to clinical diagnosis, triage and prognosis: An exploratory analysis

Nancy A. Dreyer a,*, Matthew Reynolds a, Christina DeFilippo Mack a, Emma Brinkley a, Natalia Petruski-Ivleva a, Kalyani Hawaldar a, Stephen Toovey b, Jonathan Morris c

a Real World Solutions, IQVIA Cambridge, Massachusetts, USA
b Pegasus Research, Switzerland
c Health Care Solutions, IQVIA, USA

ARTICLE INFO

Keywords:
Infectious disease
Epidemiology
COVID-19
Direct to patient
Anosmia
Ageusia

ABSTRACT

Background: Symptomatic COVID-19 is prevalent in the community. We identify factors indicating COVID-19 positivity in non-hospitalized patients and prognosticators of moderate-to-severe disease.

Methods: Appeals conducted in April–June 2020 in social media, collaborating medical societies and patient advocacy groups recruited 20,476 participants ≥18 years who believed they had COVID-19 exposure. Volunteers consented online and reported height, weight, concomitant illnesses, medication and supplement use, residential, occupational or community COVID-19 exposure, symptoms and symptom severity on a 4-point scale. Of the 12,117 curated analytic population 2279 reported a COVID-19 viral test result: 865 positive (COVID+) and 1414 negative (COVID-).

Results: The triad of anosmia, ageusia and fever best distinguished COVID+ from COVID-participants (OR 6.07, 95% CI: 4.39 to 8.47). COVID+ subjects with BMI ≥30, concomitant respiratory disorders or an organ transplant had increased risk of moderate-to-severe dyspnoea. Race and anti-autoimmunity medication did not affect moderate-to-severe dyspnea risk.

Conclusions: The triad of anosmia, ageusia and fever differentiates COVID-19. Elevated risks of severe symptoms outside the hospital were most evident among the obese and those with pulmonary comorbidity. Race and use of medication for autoimmune disease did not predict severe disease. These findings should facilitate rapid COVID-19 diagnosis and triage in settings without testing.

1. Introduction

Limited information is available concerning the symptomatology of human coronavirus disease 2019 (COVID-19) outside of the hospital [1, 2]. Here we follow a research model developed in collaboration with the European Medicines Agency that validated person-generated health-data as a reliable method for pharmacovigilance [3], and use established best practices for patient registries that have been particularly useful in pandemic threats [4–6]. We build on these models using community-driven research to characterize symptoms indicative of a positive COVID-19 viral test result and identify risk factors for development of serious symptoms of COVID-19 infection outside the hospital setting.

2. Methods

Respondent-driven sampling in the US from April 2nd to July 14th, 2020 inclusive, yielded 20,476 adults who completed registration, demographics and symptoms forms at www.helpstopCOVID19.com. Participants were recruited using social media, with additional awareness raising activities undertaken by medical societies and patient advocacy groups. Every state in the US is represented, with most participants coming from populous states with high infection rates: California (9%), New York (9%), Florida (7%) and Texas (6%). Participants provided information about testing and test results; noting that only viral testing was available during this sampling timeframe and most participants reported not having been tested (70%). Reported were: COVID-19 like symptoms using a checklist [7] and ranked the reported symptoms on a 4-point severity scale from very mild to severe; comorbidities;
presence of fever, use of prescription and non-prescription medication, vitamins and supplements; occupation as well as age, gender, race and ethnicity. Survey respondents were invited to participate in longitudinal follow-up twice a week for four weeks and every two weeks for the following two months. Participants were not required to answer every question. No remuneration was provided.

A curated analytic data set (n = 12,117) was created for adults who completed baseline screening of symptoms and demographics, and which excluded likely fabricated entries based on a combination of clinical flags (e.g., body mass index (BMI) <15 or >60, height < 4 ft) and likely duplicates, determined by nearly identical respondent entries within 10 minutes of each other. No missing data were imputed. Participants who tested positive (COVID+) were compared to those who tested negative (COVID−). Odds ratios (OR) and 95% confidence interval (CI) were used to estimate the likelihood that a symptom or characteristic (or constellation thereof) would be present given a positive test result. A multivariable logistic regression was used to estimate the OR (95%CI) of developing moderate or severe dyspnea among COVID− participants. Two models were applied – a reduced model that included demographic characteristics and a full model that added comorbidities and medication use.

3. Results

A total of 12,117 participants were included in the curated dataset (71% female; median age 43 years and 24% non-Caucasian), out of which n = 2279 (19%) reported a COVID-19 test result. Baseline data are shown for 2279 participants, including COVID+ (n = 863) and COVID− (n = 1414). Participants reporting a COVID-19 test result had a mean age of 41 years, with 13% over 60 years of age, and nearly twice as many females as males; 20% of participants reported education level of “high school or less” (Table 1).

Fever, cough, fatigue and aches and pains were the most commonly reported symptoms, with more symptoms reported on average by COVID− than COVID-participants (5.5 vs 3.4) (Table 2). Five symptoms had strong associations with COVID+: anosmia (OR 4.81 95%CI 3.84, 6.02), ageusia (OR 4.41 95%CI 3.55, 5.47), bluish color of lips and face (OR 3.29 95%CI 2.05, 5.27), fever (OR 3.24 95%CI 2.69, 3.89), and vomiting (OR 2.38 95%CI 1.76, 3.22) (Table 2). The triad of anosmia, ageusia and fever was strongly associated with a positive COVID-19 test (OR 6.07 95%CI 4.39, 8.47); participants were six times more likely to report has nine symptoms, in contrast to a mean of just two for those without either symptom.

Moderate or severe dyspnea was more frequently reported by COVID+ (24%) than COVID− (15%) participants. Among COVID+ participants the risk of moderate or severe dyspnea did not differ by age, gender, race, or ethnicity. Particularly, risk was elevated among the obese (BMI >30) (OR 2.30 95%CI 1.40, 3.78) and those taking medications for respiratory disorders (OR 3.68 95%CI 2.04, 6.62). There was no strong evidence of elevated risk for dyspnea among participants with cardiovascular disease or those taking medications for diabetes, hypertension and autoimmune conditions (Table 3).

4. Discussion

This research program is unusual in its evaluation of symptomatology for COVID-19 in the community setting [8] and may be particularly useful in a number of travel medicine related settings, e.g. on board cruise ships and in other maritime settings, including naval vessels; during military deployments and in remote or resource poor settings [9–13]. Anosmia and ageusia were the most likely symptoms indicative of a positive test results, and participants reporting either of these had more symptoms and of greater severity [8]. This is in line with previous findings and experimental evidence supporting involvement of the olfactory apparatus [14,15]. The triad of anosmia, ageusia and fever

Table 1

| Characteristics of participants included in the curated dataset and by reported COVID-19 test result. |

| Total | All | COVID+ | COVID− |
|-------|-----|--------|--------|
|       | n = 12,117 | n = 863 | n = 1414 |
| Demographics | | | |
| Age in years, mean (SD) | 43 (14) | 40 (13) | 41 (13) |
| Age group | N (%) | N (%) | N (%) |
| 19–29 | 2382 (19.6) | 207 (23.9) | 285 (20.2) |
| 30–39 | 2634 (21.7) | 206 (23.8) | 324 (22.9) |
| 40–49 | 2613 (21.6) | 200 (23.1) | 341 (24.1) |
| 50–59 | 2219 (18.3) | 126 (14.6) | 248 (17.5) |
| 60+ | 1572 (13.0) | 70 (8.1) | 124 (8.8) |
| Did not respond | 697 (5.8) | 56 (6.5) | 92 (6.5) |
| Gender | | | |
| Female | 8638 (71.3) | 591 (68.3) | 1001 (70.8) |
| Male | 3326 (27.4) | 268 (31.0) | 396 (28.0) |
| Self-reported as others | 153 (1.3) | 6 (0.7) | 17 (1.2) |
| Race | | | |
| Black or African American | 924 (7.6) | 121 (14.0) | 120 (8.5) |
| White | 9208 (76.0) | 554 (64.0) | 1042 (73.7) |
| Other/Multi racial | 1957 (16.2) | 188 (21.7) | 251 (17.8) |
| Did not respond | 28 (0.2) | 2 (0.2) | 1 (0.1) |
| Ethnicity, Hispanic | 1439 (11.9) | 193 (22.3) | 183 (12.9) |
| Education | | | |
| High school or less | 2333 (19.3) | 170 (19.7) | 230 (16.3) |
| Some college/2-year degree | 4284 (35.4) | 296 (34.2) | 445 (31.5) |
| 4-year college degree | 2802 (23.1) | 209 (24.2) | 338 (23.9) |
| >4-year college degree | 2658 (21.9) | 188 (21.7) | 396 (28.0) |
| Did not respond | 40 (0.3) | 2 (0.2) | 5 (0.4) |
| BMI category | | | |
| Normal (<25) | 3859 (31.8) | 245 (28.3) | 463 (32.7) |
| Overweight (25–30) | 3037 (25.1) | 194 (22.4) | 354 (25.0) |
| Obese (>30) | 4004 (33.0) | 320 (37.0) | 455 (32.2) |
| Comorbidities | | | |
| Pregnant | 85 (0.7) | 11 (1.3) | 10 (0.7) |
| Nicotine addiction (Smoker) | 2090 (17.2) | 98 (11.3) | 255 (18.0) |
| Lung disease | 1485 (12.3) | 114 (13.2) | 224 (15.8) |
| Organ transplant | 99 (0.8) | 22 (2.5) | 17 (1.2) |
| Cancer | 126 (1.0) | 25 (2.9) | 16 (1.1) |
| Cardiovascular disease | 735 (6.1) | 54 (6.2) | 107 (7.6) |
| Taking prescription medications for the following conditions | | | |
| Hypertension | 2153 (17.8) | 151 (17.5) | 252 (17.8) |
| Diabetes | 973 (8.0) | 84 (9.7) | 128 (9.1) |
| Autoimmune disease | 897 (7.4) | 42 (4.9) | 135 (9.5) |
| Lung disease | 1128 (9.3) | 72 (8.3) | 184 (13.0) |
| Household exposure to COVID-19 or influenza-like illness | | | |
| Yes | 2600 (21.5) | 371 (42.9) | 331 (23.4) |

Abbreviations: COVID+, participants who reported having had a positive COVID-19 test result; COVID−, participants who reported having had a negative COVID-19 test result; SD, standard deviation.

a Approximately 10–12% of participants did not respond to one or more of these questions.

b N = 852 (7%) of all participants, n = 80 (9.2%) of COVID+ and n = 97 (6.9%) of COVID−participants did not provide an answer in this section.

provided a particularly powerful symptom constellation differentiating COVID+ from COVID−in the community. This triad may offer an expedient way to identify probable COVID-19 infections in the community, especially in the absence of reliable, widespread testing [9,16,17]. The triad could be taken as pathognomonic during the pandemic and trigger anti-COVID interventions in the absence of reliable near-patient diagnostics. This may be particularly helpful in many travel medicine or community based settings including resource-poor, logistically challenged or remote settings, as well as in closed community settings e.g. the correctional prisons, care homes, seagoing vessels. Further support for a clinical diagnosis of COVID-19 might also be a history of vomiting. Although non-specific, vomiting is in general not a feature of respiratory tract infections in the community [18,19].

Severe dyspnea is indicative of severe disease that may require hospitalization and may presage possible pulmonary fibrosis or other sequelae [20–23]. While our findings are congruent with obesity being a known risk factor for severe disease, the association of significant
The absence of increased risk of severe disease in users of disease modifying agents does not increase the risk of complications from seasonal influenza [24]. The findings of increased risk of severe disease in the presence of obesity were in line with existing evidence on COVID-19 [25] and are somewhat in contrast with previous findings of increased risk of severe disease in obese patients and those on medication for autoimmune disorders, including if and how they are being treated for these underlying conditions; a possible explanation may be that individuals with more severe conditions were underrepresented in our study, but this remains speculative. Further validation may be derived from additional data collection and analysis from subsequent waves of infection, a process that has already been initiated.

It is important to keep in mind that these data are voluntarily reported, are not a representative sample of the US population, and thus will not support inferences about distribution of symptoms in the US. Recognizing that self-reported information has limitations, comparisons between respondents may nevertheless indicate true causal relationships and can serve to stimulate further research as the medical and scientific community seek to learn more about this infection. This

| N of participants | Any symptom | Moderate or severe symptom* |
|-------------------|-------------|-----------------------------|
| Symptom | COVID+ | COVID- | OR (95%CI) | COVID+ | COVID- | OR (95%CI) |
| Aches and pains | 382 (44.2) | 433 (30.6) | 1.79 (1.50, 2.13) | 256 (29.6) | 282 (19.9) | 1.69 (1.39, 2.06) |
| Blush color to lips and face | 52 (6.0) | 27 (1.9) | 3.29 (2.05, 5.27) | 24 (2.8) | 13 (0.9) | 3.08 (1.56, 6.07) |
| Cough | 488 (56.4) | 557 (39.4) | 1.99 (1.68, 2.36) | 213 (24.6) | 213 (15.1) | 1.90 (1.53, 2.35) |
| Decreased appetite | 256 (29.6) | 224 (15.8) | 2.23 (1.82, 2.74) | 180 (20.8) | 143 (10.0) | 2.34 (1.84, 2.97) |
| Anosmia (decreased sense of smell) | 296 (34.2) | 138 (9.8) | 4.81 (3.84, 6.02) | 235 (27.2) | 94 (6.6) | 5.25 (4.06, 6.80) |
| Ageusia (decreased sense of taste) | 310 (35.8) | 159 (11.2) | 4.41 (3.55, 5.47) | 232 (26.8) | 105 (7.4) | 4.57 (3.56, 5.87) |
| Diarrhea | 256 (29.6) | 276 (19.7) | 1.72 (1.41, 2.09) | 159 (18.4) | 154 (10.9) | 1.84 (1.45, 2.34) |
| Fatigue | 473 (54.7) | 604 (42.7) | 1.62 (1.36, 1.92) | 311 (36.0) | 389 (27.5) | 1.50 (1.24, 1.80) |
| Fever | 410 (47.4) | 308 (21.8) | 3.24 (2.69, 3.89) | 156 (18.0) | 97 (6.9) | 3.19 (2.43, 4.18) |
| Nasal congestion | 276 (31.9) | 314 (22.2) | 1.64 (1.36, 1.99) | 150 (17.3) | 156 (11.0) | 1.68 (1.32, 2.14) |
| Nausea | 199 (23.0) | 217 (15.3) | 1.65 (1.33, 2.04) | 104 (12.0) | 111 (7.9) | 1.60 (1.21, 1.13) |
| New onset of confusion | 70 (8.1) | 75 (5.3) | 1.57 (1.12, 2.20) | 38 (4.4) | 31 (2.2) | 2.05 (1.26, 3.32) |
| Persistent pain or pressure in the chest | 204 (23.6) | 266 (18.8) | 1.33 (1.08, 1.64) | 140 (16.2) | 167 (11.8) | 1.44 (1.13, 1.84) |
| Runny nose | 239 (27.6) | 266 (18.8) | 1.65 (1.35, 2.01) | 91 (10.5) | 102 (7.2) | 1.51 (1.12, 2.03) |
| Shortness of breath/difficulty breathing | 352 (40.6) | 380 (26.9) | 1.87 (1.56, 2.23) | 205 (23.7) | 210 (14.9) | 1.79 (1.45, 2.22) |
| Sore throat | 268 (31.0) | 322 (22.8) | 1.52 (1.26, 1.84) | 128 (14.8) | 153 (10.8) | 1.44 (1.12, 1.85) |
| Trouble waking up after sleeping | 105 (12.1) | 149 (10.5) | 1.17 (0.90, 1.53) | 66 (7.6) | 106 (7.5) | 1.02 (0.74, 1.40) |
| Vomiting | 108 (12.5) | 80 (5.7) | 2.38 (1.76, 3.22) | 58 (6.7) | 41 (2.9) | 2.41 (1.60, 3.63) |
| Combination of symptoms | 50 (5.8) | 22 (1.6) | 3.88 (2.29, 6.78) | 38 (2.9) | 6.07 (4.39, 8.47) |
| Decreased symptom severity information were excluded from the calculation of ORs.

Abbreviations: COVID+, participants who reported having had a positive COVID-19 test result; COVID-, participants who reported having had a negative COVID-19 test result; OR, odds ratio; CI, confidence interval.

* Participants ranked their symptoms as very mild, mild, moderate or severe. Among participants reporting symptoms, severity was missing for <3% for most except for cough, fatigue and fever (5–8% missing). Participants who did not complete symptom severity information were excluded from the calculation of ORs.

Table 2
COVID-19 like symptoms and likelihood of having a positive COVID-19 test result.
methodology appears to be useful in capturing relevant real world data, particularly symptom severity, without requiring physical presentation of interest or not taking the medication of interest.

Table 3
Risk of moderate or severe shortness of breath among those reporting a positive COVID-19 test result.

|                        | Reduced model (n = 788) | Full model (n = 671) |
|------------------------|-------------------------|----------------------|
|                        | OR (95% CI)             | OR (95% CI)          |
| Age group              |                         |                      |
| 19-29                  | ref                     | ref                  |
| 30-39                  | 0.92 (0.57, 1.49)        | 0.87 (0.50, 1.49)    |
| 40-49                  | 0.99 (0.61, 1.61)        | 0.93 (0.54, 1.60)    |
| 50-59                  | 0.74 (0.42, 1.32)        | 0.71 (0.38, 1.34)    |
| 60+                    | 0.64 (0.31, 1.30)        | 0.47 (0.21, 1.08)    |
| Gender                 |                         |                      |
| Male                   | ref ref                 |                      |
| Female                 | 1.35 (0.91, 2.02)        | 1.33 (0.85, 2.07)    |
| Race                   |                         |                      |
| White                  | ref ref                 |                      |
| Black                  | 1.02 (0.60, 1.73)        | 1.30 (0.73, 2.32)    |
| Other/Multiracial      | 1.56 (0.96, 2.53)        | 1.28 (0.73, 2.25)    |
| BMI category           |                         |                      |
| Underweight or Normal weight (BMI < 25.0) | ref ref              |                      |
| Overweight (25.0–30.0) | 1.95 (1.18, 3.21)        | 1.89 (1.11, 3.22)    |
| Obese (BMI≥30.0)       | 2.31 (1.46, 3.65)        | 2.30 (1.40, 3.78)    |
| Ethnicity Hispanic     |                         |                      |
| No                     | ref ref                 |                      |
| Yes                    | 0.61 (0.37, 0.99)        | 0.67 (0.38, 1.16)    |
| Education              |                         |                      |
| 4-year college degree  | ref ref                 |                      |
| High school or less than high school | 1.20 (0.73, 1.98)   | 1.59 (0.91, 2.80)    |
| Some college or 2-year college degree | 0.84 (0.54, 1.31)  | 0.83 (0.51, 1.35)    |
| More than 4-year college degree | 0.74 (0.45, 1.23) | 0.70 (0.39, 1.25)    |
| Comorbidities and medication usea |                      |                      |
| Nicotine addiction (smoker) | 1.36 (0.78, 2.40) | 1.38 (0.78, 2.34)    |
| Organ Transplant       | 3.07 (0.72, 13.09)       |                      |
| Cancer                 | 0.27 (0.06, 1.22)        |                      |
| Cardiovascular disease | 1.23 (0.54, 2.79)        |                      |
| Medication for hypertension | 0.73 (0.44, 1.22)     |                      |
| Medication for diabetes | 1.21 (0.66, 2.21)       |                      |
| Medication for autoimmune disease | 0.86 (0.35, 2.10) |                      |
| Medication for lung disease | 3.68 (2.04, 6.62)   |                      |

Notes: Shortness of breath and severity assessed at baseline. Participants who reported shortness of breath, but did not report severity of the symptom were excluded from this analysis (n = 11).

Acknowledgements

We would like to acknowledge Dr. Sally McNagney for her clinical insights and Alison Bourke for her contributions to the data capture.

References

[1] Wiersinga WJ, Rhodes A, Cheng AC, Peacock SJ, Prescott HC. Pathophysiology, transmission, diagnosis and treatment of coronavirus disease 2019 (COVID-19). A review. JAMA published online July 20, 2020;324(8):782–93. https://doi.org/10.1001/jama.2020.12699.

[2] Oran DP, Topol EJ. Prevalence of asymptomatic SARS-CoV-2 infection. A narrative review. Annals of internal Medicine 1 September 2020;173(5):362–7. https://doi.org/10.7326/M20-3022.

[3] Dreyer NA, Blackburn SCF, Mt-Isa S, Richardson JL, Thomas S, Laursen M. Zetstra- van der Woude AF, Jamly-Dziurla A, Hilva V, Bourke A, de Jong-van den Berg, LTW. Direct-to-patient research: piloting a new approach to understanding drug safety during pregnancy. JIMR Public Health and Surveillance 2015;1(2). https://doi.org/10.2196/publichealth.4939.e22.

[4] Dreyer NA, Toovey S, Oner AF, Dogan N, Zamani G, Gasimov V, Coker R, Bamgboye EL, Chan PK, Hanshaoworakul W, Lee N, Phommasack B, Touch S, Tsoang O, Swanson S, Toovey S, Dreyer NA. Recognizing true SARS-CoV-1 infections in humans during confirmed outbreaks. J Infect Dev Ctries 2014 Feb 13;8(2):262–7. https://doi.org/10.3855/jidc.3329. PMID: 24518630.

[5] Registries for evaluating patient outcomes. In: Gliklich R, Dreyer N, Leavy M, editors. A user’s guide. Conducted under contract No. 290 2014 00004-C) AHRO publication No. 13(3)-EHCC111. Rockville, MD: agency for healthcare research and quality. April 2014. 1st edition, April 2007; 2nd edition, September, 2010; third edition, 2014. 4th edition, september, 2020.

[6] Dreyer NA, Toovey S, Oner AF, Dogan N, Zamani G, Gasimov V, Adisasmito W, Coker R, Chan PKS, Lee N, Tsoang O, Hanshaoworakul W, Phommasack B, Touch S, Swanson A, Reddy D. Investigating outbreaks of novel infectious disease: an international case study. Journal of Clinical Studies 2013;5 (2):52–3.

[7] https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html.

[8] Menni C, Valdes AM, Freidin MB, Sudre CH, Nguyen LH, Drew DA, Ganesh S, Varsavsky T, Cardoso MJ, El-Sayed Mostafa JS, Visconti A, Hysi P, Bowyer RCE, Magino M, Falchi M, Wolf J, Ourselin S, Chan AT, Stevens CJ, Spector TD. Real-time tracking of self-reported symptoms to predict potential COVID-19. Nat Med 2020; 26:1037–40.

[9] Iken O, Abyakporo U, Ayobami O, Attayo T. COVID-19: travel health and the implications for sub-Saharan Africa. Trav Med Infect Dis 2020;35:101645.

[10] Tomlinson Lucas. More than 30 coronavirus cases on Pacific aircraft carrier, new ones discovered on another carrier in Japan: officials. Fox News Channel; 2020 April 8.

[11] “Coronavirus. Plusieurs cas suspects à bord du porte-avions français Charles de Gaulle” [Coronavirus: several suspected cases on board the French aircraft carrier Charles de Gaulle] (in French). France 2020 April 8.

[12] French aircraft carrier heads home early due to possible COVID-19 cases. Reuters 2020 April 8.

[13] [Zr.Ms. Dollfijn breekt reis af vanwege corona] [Coronavirus: several suspected cases on board the French aircraft carrier Charles de Gaulle] (in French). France 2020 April 8.

[14] Zr.Ms. Dollfijn breekt reis af vanwege corona – Nieuwsbericht – Defensie.nl. Defensie.nl 2020 April 8.

[15] Bondjome S, Finan J, Ciolibay F, et al. Offactory and gustative disorders for the diagnosis of COVID-19. Trav Med Infect Dis 2020;17:101875.

[16] Zhang AJ, Lee AC, Chu H, Chan JF, Fan Z, Li C, Liu F, Chen Y, Yuan S, Poon VK, Chan CC, Cai JP, Wu KL, Siddhar S, Chan YS, Yuen KY. SARS-CoV-2 infects and damages the mature and immature olfactory sensory neurons of hamsters. Clin Infect Dis 2020 Jun 15. https://doi.org/10.1093/cid/ciaa956. Epub ahead of print. PMID: 32667973; PMCID: PMC7454453.

[17] https://www.massdevice.com/ida-warns-of-false-positives-with-certain-covid-19-tests-from-bd/.

Funding sources

No funding was received for this work.

CRediT authorship contribution statement

Nancy A. Dreyer: Conceptualization, Methodology, interpretation, Writing - original draft, Supervision. Matthew Reynolds: Conceptualization, Methodology, Supervision. Christina DelFilippo Mack: Conceptualization, Formal analysis, interpretation. Emma Brinkley: Conceptualization, Data curation, Software. Natalia Petruski-Ivela: Formal analysis, Data curation, Writing - original draft. Kalyani Hawaiadar: Data curation, Validation, Formal analysis. Stephen Toovey: Conceptualization, Supervision, Writing - review & editing. Jonathan Morris: Conceptualization, Supervision.

Trial registration

Clinicaltrials.gov NCT04368065, EU PAS register EUPAS36240.
[17] Deeks JJ, Dinnes J, Takwoingi Y, Davenport C, Spijker R, Taylor-Phillips S, et al. Antibody tests for identification of current and past infection with SARS-CoV-2. Cochrane Database of Systematic Reviews. Issue J 2020:CD013652.

[18] Toovey S, Dutkowski R, Smith P, Smith JR. Oseltamivir effectiveness in seasonal influenza patients taking symptomatic therapy: retrospective analysis of RCT data. Int J Clin Pharm Ther 2013 Dec;51(12):932-41. https://doi.org/10.5414/CP201888. PMID: 24120712.

[19] Zayet S, Kadiane-Oussou NJ, Lepiller Q, Zahra H, Royer PY, Toko L, et al. Clinical features of COVID-19 and influenza: a comparative study on Nord Franche-Comte cluster. Microbes and infection. Advance online publication 2020;(20):S1286-4579. https://doi.org/10.1016/j.micinf.2020.05.016.

[20] Fraser E. Long term respiratory complications of covid-19. BMJ 2020;370.

[21] George PM, Wells AU, Jenkins RG. Pulmonary fibrosis and COVID-19: the potential role for antifibrotic therapy. https://doi.org/10.1016/S2213-2600(20)30225-3; 2020.

[22] Vitiello A, Pelliccia C, Ferrara F. COVID-19 patients with pulmonary fibrotic tissue: clinical pharmacological rational of antifibrotic therapy. SN Compr Clin Med. 2020 Aug 27;1-4. doi: 10.1007/s42399-020-00487-7.

[23] Spagnolo P, Balestro E, Aliberti S, Cocconcelli E, Biondini D, Della Casa G, et al. Pulmonary fibrosis secondary to COVID-19: a call to arms? Lancet Respir Med 2020 Aug;8(8):750-2. https://doi.org/10.1016/S2213-2600(20)30222-8.

[24] Blumentals WA, Arreglado A, Napalkov P, Toovey S. Rheumatoid arthritis and the incidence of influenza and influenza-related complications: a retrospective cohort study. BMC Musculoskel Disord 2012;13(158). https://doi.org/10.1186/1471-2474-13-158.

[25] AbdelMassih AF, Ye J, Kamel A, Mishrikiy F, Ismail HA, El Qadi I, Malak L, Mohamed M, Arsanyous M, Hazem M, El-Husseiny M, Ashraf M, Hafez N, Alshbely N, El-Husseiny N, AbdelRaouf N, Shebl N, Hafez N, Youssef N, Afdal P, Hozaireh R, Menshawey R, Saeed R, Elammary Y, Fouda R. Single cell sequencing unraveling genetic basis of shared immunologic switch between Severe COVID19 and Obesity. Obes Med 2020 Sep 24;100303. https://doi.org/10.1016/j.obmed.2020.100303. Epub ahead of print. PMID: 32995660; PMCID: PMC7513689.

[26] Blumentals WA, Nevitt A, Peng MM, Toovey S. Body mass index and the incidence of influenza-associated pneumonia in a UK primary care cohort. Influenza and other respiratory viruses 2012;6(1):28-36. https://doi.org/10.1111/j.1750-2659.2011.00362.x.