Predictors of persistent symptoms after severe acute respiratory coronavirus virus 2 (SARS-CoV-2) infection among healthcare workers: Results of a multisite survey

Aurora E. Pop-Vicas MD, MPH\(^1\), Fauzia Osman MPH\(^1\), Geoffrey Tsaras MD\(^2\), Claire Seigworth MPH\(^3\), L. Silvia Munoz-Price MD, PhD\(^3\) and Nasia Safdar MD, PhD\(^1,4\)

1University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin, 2University of Illinois College of Medicine, Rockford, Illinois, 3Medical College of Wisconsin, Milwaukee, Wisconsin and 4William S. Middleton Memorial Veterans’ Hospital, Madison, Wisconsin

(Received 2 September 2021; accepted 21 February 2022; electronically published 6 April 2022)

The coronavirus disease 2019 (COVID-19) pandemic continues, and healthcare workers (HCWs) are at increased risk of infection.\(^1\) In addition to the morbidity associated with initial illness, persistent postviral symptoms, currently classified as postacute sequelae of COVID-19 (PASC),\(^2\) also affect HCWs, causing further disruptions in their work, home, and social lives.\(^3\) To further characterize PASC in this population, who are otherwise expected to be highly functional and in relatively good health, we sought to identify predictors and functional status of HCWs with persistent symptoms beyond 4 weeks after their initial COVID-19 diagnosis.

**Methods**

We conducted an observational cross-sectional study from February 18 to April 10, 2021, within 3 healthcare systems in 2 Midwestern states (Froedtert & Medical College of Wisconsin, University of Wisconsin Hospital and Clinics in Madison and Swedish American Health in Illinois), with a total of 1,625 beds. Eligible participants included all HCWs identified through occupational health departments. HCWs positive for COVID-19 by occupational health departments were required to notify their occupational health departments. HCWs who underwent outside testing were invited to respond to an anonymous online survey, with e-mails inviting participation sent from occupational health departments on 2 occasions, 3 weeks apart. Each site’s institutional review board exempted the study from approval because it involved deidentified participants.

Functional status in everyday life at the time of the survey was assessed in relation to symptoms presence using the post-COVID-19 functional status scale described by Klok et al.\(^4\) Respondents reporting persistent symptoms (either continued from initial illness or newly developed after initial illness) for longer than 4 weeks after initial positive test were compared with respondents who remained asymptomatic or experienced symptoms ≤ 4 weeks after their initial positive test. Associations between categorical variables were analyzed using \(\chi^2\) tests, and logistic regression was used to determine independent predictors for persistent symptoms. Observations with missing data resulting from unanswered survey items were excluded from the analysis of the corresponding affected variable. A 2-sided \(P\) value of .05 was considered statistically significant. All analyses were conducted in Stata version 16 SE software (StataCorp, College Station, TX).

**Results**

The survey response rate was 25% (1,012 of 4,029 HCWs). Most survey participants (53%) were from the Milwaukee healthcare systems, followed by Madison (27%) and Illinois (20%) healthcare systems, respectively. Demographics, underlying comorbidities, and severity of initial illness were similar among participants, except for a slightly higher incidence of age >50 years (\(P = .02\)) and reported obesity (\(P = .02\)) among HCWs from one institution, and a higher incidence of women among participants from another institution (\(P = .01\)). Also, 701 respondents (70%) had duties that involved direct patient contact, such as nurses, nurse practitioners, and nurse aids (38%), physicians and physician assistants (6%), medical assistants (6%), and others (ie, pharmacists, medical technologists, phlebotomists, dietary specialists, ambulatory clinic personnel, environmental specialists, 20%). Most HCW respondents were female (87%), and most were aged 25–45 years (59%). The race or ethnicity of study participants was white (84%), Hispanic/Latino (6%), Black or African American (4%).
Table 1. Predictors of Persistent Symptoms Beyond 4 Weeks After Initial Infection Among Healthcare Workers, by Univariate and Multivariate Analysis

| Characteristic                              | Persistent Symptoms (N=679, No. (%)) | No Persistent Symptoms (N=333, No. (%)) | Odds Ratio | 95% CI          | P Value | Adjusted Odds Ratioa | 95% CI          | P Value |
|---------------------------------------------|--------------------------------------|----------------------------------------|------------|----------------|---------|----------------------|----------------|---------|
| **Demographics**                            |                                      |                                        |            |                |         |                      |                |         |
| Age                                         |                                      |                                        |            |                |         |                      |                |         |
| 18–24 y                                     | 42 (6)                               | 31 (9)                                | 0.64       | 0.39–1.08      | .07     |                      |                |         |
| 25–35 y                                     | 202 (30)                             | 112 (34)                              | 0.83       | 0.63–1.12      | .21     |                      |                |         |
| 36–45 y                                     | 200 (29)                             | 86 (26)                               | 1.19       | 0.88–1.63      | .23     |                      |                |         |
| 46–55 y                                     | 129 (19)                             | 51 (15)                               | 1.29       | 0.89–1.89      | .15     |                      |                |         |
| 56–65 y                                     | 100 (15)                             | 49 (15)                               | 1.00       | 0.68–1.48      | 1.00    |                      |                |         |
| >65 y                                       | 5 (1)                                | 4 (1)                                 | 0.61       | 0.13–3.08      | .46     |                      |                |         |
| Sex, female                                 | 606 (89)                             | 273 (82)                              | 1.82       | 1.24–2.68      | .001    | 1.75                 | 1.17–2.62      | .007    |
| **Race/Ethnicity**                          |                                      |                                        |            |                |         |                      |                |         |
| White                                       | 574 (85)                             | 276 (83)                              | 1.13       | 0.78–1.63      | .50     |                      |                |         |
| African American                            | 32 (5)                               | 8 (2)                                 | 2.01       | 0.89–5.10      | .08     |                      |                |         |
| Hispanic/Latino                             | 39 (6)                               | 21 (6)                                | 0.91       | 0.51–1.65      | .72     |                      |                |         |
| Duties with direct patient contact          | 461 (68)                             | 240 (72)                              | 0.88       | 0.59–1.09      | .14     |                      |                |         |
| **Underlying conditions**                   |                                      |                                        |            |                |         |                      |                |         |
| None                                        | 346 (51)                             | 214 (64)                              | 0.58       | 0.44–0.76      | <.001   | 0.81                 | 0.57–1.15      | .24     |
| Diabetes mellitus                           | 20 (3)                               | 15 (5)                                | 0.64       | 0.31–1.37      | .20     |                      |                |         |
| Hypertension                                | 90 (13)                              | 41 (12)                               | 1.08       | 0.72–1.66      | .67     |                      |                |         |
| Cardiovascular disease                      | 10 (1)                               | 4 (1)                                 | 1.23       | 0.35–5.41      | .78     |                      |                |         |
| Asthma                                      | 105 (15)                             | 28 (8)                                | 1.99       | 1.27–3.21      | .002    | 1.47                 | 0.88–2.47      | .14     |
| Obstructive sleep apnea                     | 33 (5)                               | 8 (2)                                 | 2.08       | 0.93–5.27      | .06     |                      |                |         |
| Obesityb                                    | 144 (21)                             | 41 (12)                               | 1.92       | 1.30–2.86      | <.001   | 1.50                 | 0.96–2.33      | .07     |
| Pregnancy                                   | 11 (2)                               | 22 (7)                                | 0.23       | 0.10–0.51      | <.001   |                      |                |         |
| Immune suppressed                           | 25 (4)                               | 2 (1)                                 | 6.33       | 1.56–55.36     | .004    |                      |                |         |
| **Severity of initial illness**             |                                      |                                        |            |                |         |                      |                |         |
| Medical evaluation/treatment:               |                                      |                                        |            |                |         |                      |                |         |
| In-person encounter                         | 74 (11)                              | 11 (3)                                | 3.58       | 1.85–7.58      | <.001   | 2.49                 | 1.27–4.88      | .008    |
| Telemedicine encounter                      | 121 (18)                             | 28 (8)                                | 2.36       | 1.51–3.78      | <.001   | 1.84                 | 1.16–2.90      | .009    |
| Urgent care clinic                          | 58 (9)                               | 5 (2)                                 | 6.13       | 2.44–19.74     | <.001   |                      |                |         |
| Emergency department                        | 62 (9)                               | 6 (2)                                 | 5.47       | 2.34–15.64     | <.001   |                      |                |         |
| Hospitalized                                | 18 (3)                               | 1 (0)                                 | 9.04       | 1.41–377.73    | .01     |                      |                |         |
| Experienced ≥ 7 symptoms c                  | 423 (62)                             | 93 (28)                               | 4.26       | 3.18–5.74      | <.001   | 3.65                 | 2.72–4.90      | <.001   |
| **Clinical symptoms during acute infection**|                                      |                                        |            |                |         |                      |                |         |
| Asymptomatic                                | 0 (0)                                | 17 (5)                                | **         | **             | <.001   |                      |                |         |
| Fever                                       | 365 (54)                             | 126 (38)                              | 1.91       | 1.45–2.52      | <.001   |                      |                |         |
| Chills                                      | 402 (59)                             | 107 (32)                              | 3.07       | 2.30–4.08      | <.001   |                      |                |         |
| Sinus congestion                            | 463 (68)                             | 186 (56)                              | 1.69       | 1.28–2.24      | <.001   |                      |                |         |
| Sore throat                                 | 296 (44)                             | 118 (35)                              | 1.41       | 1.06–1.85      | .01     |                      |                |         |

(Continued)
Asian (3%). For comparison, among all 33,009 HCWs employed by the participating institutions, 79% were women and 64% performed direct patient-care duties.

Persistent symptoms beyond the initial 4 weeks were reported by 679 (67%) of participants and included anosmia or ageusia (36%), excessive fatigue (34%), dyspnea (24%), difficulty concentrating in (21%), insomnia (14%), anxiety (13%), memory loss (13%), palpitations or tachycardia (12%), diffuse myalgias (11%), depression (10%), and chest pain (8%). Persistent symptoms lasted up to 6 weeks in 161 survey respondents (16%), up to 3 months in 119 HCW respondents (12%), and up to 6 months in 41 HCWs (4%). Furthermore, 353 HCWs (35%) reported ongoing symptoms at the time of the survey (range, 44 days–11 months). Only 333 HCWs (33%) reported no symptoms beyond the initial 4 weeks.

Demographic and clinical characteristics between HCWs with and without persistent symptoms beyond the initial 4 weeks are summarized in Table 1. The survey results indicated several independent predictors of persistent symptoms: ≥7 symptoms during initial infection, an initial evaluation and treatment through an in-person or a telemedicine encounter, and female sex. The area under the receiver operating curve for this model was 0.73.

After COVID-19 diagnosis, 987 HCW respondents (98%) resumed all previous duties at work; 19 HCWs (1.89%) required work duty restrictions, and 1 HCW (0.1%) who was hospitalized in the intensive care unit was not able to return to work.

Functional status descriptions and scores among HCWs with and without persistent symptoms are summarized in Table 2. None of the HCWs without persistent symptoms reported any limitations in their everyday duties or activities. Severe limitations in Table 2. Differences in Reported Everyday Functional Status Among Healthcare Workers With and Without Persistent Symptoms >4 Weeks Beyond Initial Infection, by Univariate Analysisa
everyday life with dependence on others for care (scale grade 4) were not reported by any respondent.

**Discussion**

Approximately two-thirds of HCWs in our study reported persistent symptoms consistent with PASC. This incidence was higher than the 26% reported in a Swedish HCW cohort but lower than the 73% reported in a multicenter, prospective HCW cohort from Switzerland. Although functional status was generally good, 9% of HCWs with PASC reported significant limitations in performing their routine daily activities, suggesting that some HCW with PASC would benefit from workplace accommodations. Developing workplace policies that are best suited to the needs of those returning to demanding healthcare professions after initial infection is particularly important in preserving the well-being of a workforce at high risk of exhaustion and burnout that continues to be stressed beyond limits during this pandemic.

Female sex and more severe initial illness (ie, ≥7 initial symptoms and need for medical evaluation and treatment via in-person or telemedicine encounters) were predictors of PASC, confirming that the previously reported model by Sudre et al, which identified ≥5 symptoms during the first week of illness as a predictor of PASC for the general population is applicable to HCWs. Age ≥50 years, number of pre-existing comorbidities, asthma, and obesity have also been identified as risk factors for PASC in recent studies. Both asthma and obesity were associated with persistent symptoms in our univariate analysis. These findings highlight a high-risk HCW subset that should be closely monitored for PASC development, with prompt evaluation and management of persistent symptoms.

Our study was limited by possible recall bias and the subjective nature of symptom reporting associated with survey design. Given the 25% response rate, selection bias was also possible, although respondent demographics reflected those of the HCWs in the region. The study was performed before HCW COVID-19 vaccination was completed and before the δ (delta) and o (omicron) pandemic waves. These latter variants may have had different epidemiologies, risk factors, clinical manifestations, and outcomes in fully vaccinated HCWs.

In summary, the PASC burden in HCWs is substantial and underscores the urgent need for interventions and resources to mitigate the persistent effects of SARS-CoV-2 infection in this critical workforce.

**Acknowledgments.**

**Financial support.** This study was supported by the Department of Medicine, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin.

**Conflicts of interest.** All authors report no conflicts of interest relevant to this article.

**References**

1. Nguyen LH, Drew DA, Graham MS, et al. Risk of COVID-19 among frontline healthcare workers and the general community: a prospective cohort study. Lancet Public Health 2020;5:e475–e483.
2. Groff D, Sun A, Ssentongo AE, et al. Short-term and long-term rates of post-acute sequelae of SARS-CoV-2 infection: a systematic review. JAMA Netw Open 2021;4(10):e2128568.
3. Havervall S, Rosell A, Phillipson M, et al. Symptoms and functional impairment assessed 8 months after mild COVID-19 among healthcare workers. JAMA 2021. doi: 10.1001/jama.2021.5612.
4. Klok FA, Boon G, Barco S, et al. The post-COVID-19 functional status scale: a tool to measure functional status over time after COVID-19. Eur Respir J 2020;56(1). doi: 10.1183/13993003.01494-2020.
5. Strahm C, Seneghini M, Gusewell S, et al. Symptoms compatible with long COVID in healthcare workers with and without SARS-CoV-2 infection—results of a prospective multicenter cohort. Clin Infect Dis 2022. doi: 10.1093/cid/ciac054.
6. Praschan N, Josephy-Hernandez S, Kim DD, et al. Implications of COVID-19 sequelae for healthcare personnel. Lancet Respir Med 2021;9:230–231.
7. Dzau VJ, Kirch D, Nasca T. Preventing a parallel pandemic—a national strategy to protect clinicians’ well-being. N Engl J Med 2020;383:513–515.
8. Sudre CH, Murray B, Varsavsky T, et al. Attributes and predictors of long COVID. Nat Med 2021. doi: 10.1038/s41591-021-01292-y.
9. Tenforde MW, Kim SS, Lindsell C, et al. Symptom duration and risk factors for delayed return to usual health among outpatients with COVID-19 in a multinational healthcare systems network—United States, March–June 2020. Morb Mortal Wkly Rep 2020;69:993–998.
10. Aminian A, Bena J, Pantalone KM, Burguera B. Association of obesity with postacute sequelae of COVID-19. Diabetes Obes Metab 2021;23:2183–2188.