PASC in Solid Organ Transplant Recipients With Self-reported SARS-CoV-2 Infection

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INTRODUCTION

The SARS-CoV-2 is responsible for COVID-19. In the acute phase, SARS-CoV-2 affects multiple organ systems, including the respiratory, gastrointestinal, and neurologic systems.1 Early in the pandemic, people with mild to moderate COVID-19 were believed to have a short-term course of acute illness. However, emerging data have shown the persistence of symptoms in a subgroup of patients, which manifested by long-lasting cognitive, mental, and physical symptoms beyond the acute infection period. We aimed to estimate the frequency of PASC symptoms in solid organ transplant (SOT) recipients and compared their frequency between those with SARS-CoV-2 infection requiring hospitalization and those who did not require hospitalization. Methods. A survey consisting of 7 standardized questionnaires was administered to 111 SOT recipients with history of SARS-CoV-2 infection diagnosed >4 wk before survey administration. Results. Median (interquartile range) time from SARS-CoV-2 diagnosis was 167 d (138–221). Hospitalization for SARS-CoV-2 infection was reported in 33 (30%) participants. Symptoms after the COVID episode were perceived as following: significant trauma (53%), cognitive decline (50%), fatigue (41%), depression (36%), breathing problems (35%), anxiety (23%), dysgeusia (22%), dysosmia (21%), and pain (19%). Hospitalized patients had poorer median scores in cognition (Quick Dementia Rating System survey score: 2.0 versus 0.5, P = 0.003), quality of life (Health-related Quality of Life survey: 2.0 versus 1.0, P = 0.015), physical health (Global physical health scale: 10.0 versus 11.0, P = 0.005), respiratory status (Breathlessness, Cough and Sputum Scale: 1.0 versus 0.0, P = 0.035), and pain (Pain score: 3 versus 0 out of 10, P = 0.003). Among patients with infection >6 mo prior, some symptoms were still present as following: abnormal breathing (42%), cough (40%), dysosmia (29%), and dysgeusia (34%). Conclusions. SOT recipients reported a high frequency of PASC symptoms. Multidisciplinary approach is needed to care for these patients beyond the acute phase.
can manifest for several weeks to months. In fact, it is now accepted that the course of SARS-CoV-2 infection is composed of 3 phases: acute infection in the first 2 wk, postacute hyperinflammatory state between weeks 2 and 4, and postacute sequelae, which manifest 5 wk or later following the acute infection.

Postacute sequelae of SARS-CoV-2 infection (PASC), that is, COVID-19 “Long Hauler,” is an increasingly recognized phenomenon and manifested by long-lasting respiratory symptoms, cardiac dysfunction, kidney dysfunction, distortion of smell and taste senses, and changes in mental, neurocognitive, and physical function resulting in decreased quality of life. There is no unified definition for PASC, but it has been suggested to include the persistence of acute COVID-19 symptoms or development of sequelae beyond 4 wks from the time of COVID-19 diagnosis. The estimated prevalence of PASC in the general population ranges between 5% and 80% with the highest percentage to date reported among people who were hospitalized for COVID-19.

In parallel, solid organ transplantation (SOT) and immunosuppressive drugs are known to have significant neurotropic effects, which can lead to mental, neurocognitive, and physical disorders potentially exacerbating these long-term effects of COVID-19 infection. Mental, neurocognitive, and physical manifestations of PASC seem likely to occur in SOT recipients with SARS-CoV-2 infection. However, data on their prevalence and impact on quality of life in SOT recipients are limited.

In this study, we aimed to estimate the frequency of cognitive, mental, and physical impairments in SOT recipients with history of SARS-CoV-2 infection in the short-term (1–6 mo) and long-term periods (>6 mo), as reported by study participants through a series of surveys. We also compared the frequency of these complications between those with SARS-CoV-2 infection requiring hospitalization and those who did not require hospitalization.

**MATERIALS AND METHODS**

**Study Design**

This is a cross-sectional survey study conducted among a total of 111 patients with history of SOT and a self-reported diagnosis of SARS-CoV-2 infection. The study was conducted over the period from June 2021 to August 2021. A Research Electronic Data Capture form was created to administer the survey. The study was approved by the Institutional Review Board at the Johns Hopkins School of Medicine. Participants were consented electronically.

**Study Population**

Participants were recruited from a larger prospective observational study of vaccine safety and efficacy outcomes among SOT recipients as previously reported. In the parent study, SOT recipients from multiple different US transplant centers self-enrolled online, and hence all information was self-reported by study participants, and the investigators did not have access to patient medical records from their transplant centers. English-speaking SOT recipients ≥18 y old who self-reported as testing positive for SARS-CoV-2 were eligible to participate in the current survey study. Participant demographics (age, sex, race, education, occupation, transplant type and date, date of SARS-CoV-2 infection diagnosis, medications) were obtained via self-report.

Patients were divided into 2 groups: those who reported hospital admission due to SARS-CoV-2 infection (n = 33 patients), and those who reported not being admitted to the hospital because of SARS-CoV-2 infection (n = 78). To assess persistence of symptoms, we also stratified our population according to the time when they were diagnosed with SARS-CoV-2 infection: those with remote infection who were diagnosed over 6 mo before the date of survey administration (n = 33), and those with recent infection diagnosed within the past 6 mo (n = 76). We excluded those with SARS-CoV-2 infection within the last month.

**Description of Survey**

The following standardized questionnaires were used in the survey:

**Quick Dementia Rating System, Patient Version**

The Quick Dementia Rating System (QDRS) patient version is a 10-item questionnaire assessing subjective changes across 10 domains of cognition, mood, and daily functioning. Scores range from 0 to 30 with higher scores representing greater perceived impairment. Scores ≥1.5 and ≥6 reflect clinically meaningful mild and moderate functional decline, respectively. The QDRS survey questions can be found in Tables S1 and S2 (SDC, http://links.lww.com/TP/C552). The second response of each item was assigned a score of 0.5. The rest of the responses were assigned a score of 1.

**Patient Health Questionnaire-9**

The Patient Health Questionnaire-9 (PHQ-9) is a 9-item depression screening questionnaire designed for use in medical settings. Participants are asked to rate 9 depression symptoms on a 0 (not at all) to 3 (nearly every day) scale. Cut points have been established for mild (0–5), moderate (6–9), moderately severe (10–14), and severe (≥15) symptoms. The PHQ-9 survey questions can be found in Tables S3 and S4 (SDC, http://links.lww.com/TP/C552).

**The General Anxiety Disorder-7**

The General Anxiety Disorder-7 (GAD-7) is a 7-item anxiety screening questionnaire. Participants are asked to rate how bothered they have been by 7 anxiety symptoms on a 0 (not at all) to 3 (nearly every day) scale. Cut points have been established for normal (≤4 of 21), mild (5–9 of 21), moderate (10–14 of 20), and severe (>15 of 21) symptoms. The GAD-7 survey questions can be found in Tables S5 and S6 (SDC, http://links.lww.com/TP/C552).

**Impact of Events Scale-6**

The Impact of Events Scale-6 (IES-6) is a 6-item post-traumatic stress screening questionnaire that has been validated for use in medical populations. Participants are asked to rate statements on a 0 (not at all) to 4 (quite a bit) scale. IES-6 score of 0–1.74 indicates minimal trauma and score of 1.75 and higher indicates significant trauma.
Health-related Quality of Life EuroQol-5D

This survey assesses health-related quality of life by surveying 5 dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension has 5 levels: no problems, slight problems, moderate problems, severe problems, and extreme problems.29,30 The EuroQol-5D survey questions can be found in Tables S7 and S8 (SDC, http://links.lww.com/TP/C552).

The PROMIS Global Physical Health Scale

The patient-reported outcomes measurement information system (PROMIS) Global Physical Health Scale (GHS) instrument consists of 10 global health items that represent 5 core PROMIS domains (physical function, pain, fatigue, emotional distress, social health). We used 4 questions that cover 3 out of the 5 domains: physical function, pain, and fatigue. Three of these are administered using 5-category response scales, and 1 item (rating of pain on average) uses a response scale of 0–10.31 The PROMIS GHS survey questions can be found in Tables S11 and S12 (SDC, http://links.lww.com/TP/C552).

Breathlessness, Cough, and Sputum Scale

Breathlessness, Cough, and Sputum Scale (BCSS) is a patient-reported outcome measure evaluating symptoms in patients with chronic obstructive pulmonary disease and has been used to assess respiratory symptoms in other pulmonary conditions.32 The BCSS is a daily diary that asks patients to rate the severity of the 3 symptoms, each on a 5-point scale; higher scores indicate more severe symptoms.33,34 The BCSS survey questions can be found in Table S13 (SDC, http://links.lww.com/TP/C552).

Nonstandardized COVID-19 Symptoms Questionnaire

We developed a 3-item questionnaire to assess severity of SARS-CoV-2 infection-specific symptoms: dysosmia, dysgeusia, and diarrhea. Each question is on 4-point scale. Respondents were asked about smell and taste symptoms on the day they took the survey, and about diarrhea in the past 2 wk before the survey. The survey questions can be found in Table S14 (SDC, http://links.lww.com/TP/C552).

Survey Administration

An electronic survey, hosted on Research Electronic Data Capture database hosted at Johns Hopkins, was created and consisted of patient demographics (age, sex, race, education, occupation, transplant type and date, date of COVID-19 diagnosis, medications), in addition to the surveys mentioned above.

Analysis

We compared the characteristics of patients between the groups using Fisher’s exact test for categorical variables and Wilcoxon rank-sum test for continuous variables. An α of 0.05 was used to determine statistical significance. Item-level analyses are exploratory in nature. All analyses were performed using Stata/SE 15.1.

The raw score of QDRS was transformed into 2 severity strata with scores ≥1.5 and ≥6 reflecting clinically...
meaningful mild and moderate functional decline, respectively. It was also stratified into 6 categories that include normal (<1.5), mild functional decline (1.5–5.9), moderate functional decline (6–12.4), moderately severe functional decline (12.5–17.4), and severe functional decline (>17.4). The raw score of PHQ-9 for severity of depression was transformed into minimal (0–4), mild (5–9), moderate (10–14), moderately severe (15–19), and severe depression (20–27). The raw score of GAD-7 for anxiety was transformed into no anxiety (0–4), mild (5–9), moderate (10–14), and severe anxiety (15–21). IES-6 was transformed into minimal trauma (0–1.74) and traumatic (1.75 and above). The extent of physical impairment in smell, taste, and bowel movements was evaluated separately using a 4-tier severity index. All the other scales (EQ-5D, PROMIS GHS, BCSS) were analyzed using raw scores. For the PROMIS survey, we used 4 questions that cover 3 out of the 5 domains of the survey. We then used univariable ordinal logistic regression to study factors (age, sex, race, type of organ transplant, mycophenolate mofetil, or mycophenolic acid use) potentially associated with the risk of having a higher level of severity in QDRS, PHQ-9, GAD-7, and the extent of physical impairment in taste, smell, and bowel movements. Univariable logistic regression examined factors associated with clinically significant trauma-related distress defined by IES-6. Univariable Poisson regression examined factors associated with higher raw score in EQ-5D, PROMIS GHS, and BCSS.

RESULTS

Population Characteristics

The surveys were distributed to 167 eligible SOT recipients, of whom 111 (66%) responded (Table 1). Median (interquartile range) age was 58 y (46, 65). Most patients were female (55%) and White (76.6%). Most patients were recipients of kidney transplants (60.4%) followed by liver (20.7%), heart (11.7%), lung (9%), and kidney/pancreas (7.2%) transplants. Around 30% (33 of 111) reported hospitalization for COVID-19 infection. Using available vaccination records by the time when this project was analyzed, 19 of the 111 participants reported having received at least 1 COVID-19 vaccination before the self-reported diagnosis of COVID-19 (n=18 two doses, n=1 one/first dose). An additional 63 participants reported having received vaccination (n=1 three doses, n=36 two doses, n=6 one/first dose) after their COVID-19 diagnosis.

Survey Responses

Quick Dementia Rating System Survey

Results of the QDRS survey are shown in Figure 1, Tables 2–4. Around 50% of patients reported at least mild functional decline defined by a QDRS score of ≥1.5. This percentage was higher in the hospitalized group compared with the nonhospitalized group although not statistically significant (61% versus 45%, P=0.15) (Table 4), and was not different between those with recent versus remote infection (50% versus 49%, P=1.0). Hospitalized participants had worse scores in the components of memory, decision-making and problem-solving abilities, level of activities inside and outside the home, and mood changes (Tables S1 and S2, SDC, http://links.lww.com/TP/C552).

Patient Health Questionnaire-9 Survey

Results of the PHQ-9 survey are shown in Figure 2, Tables 2–4. Around 36% of patients reported at least mild depression symptoms defined by a PHQ-9 score of 5 and above. This percentage was not different between the hospitalized and nonhospitalized groups (39% versus 35%, P=0.50) (Table 4) and was not different between those with recent versus remote COVID-19 infection (37% versus 34%, P=1.0). Hospitalized patients had worse scores in the components of sleeping difficulties, appetite changes, and self-esteem (Tables S3 and S4, SDC, http://links.lww.com/TP/C552).

General Anxiety Disorder-7 Survey

Results of the GAD-7 survey are shown in Figure 3, Tables 2–4. Around 23% of patients reported at least mild anxiety defined by a GAD-7 score of 5 and above. This percentage was not different between the hospitalized and nonhospitalized groups (27% versus 22%, P=0.62), or between those with recent versus remote COVID-19 infection (21% versus 29%, P=0.47). There were no differences in answers to the different components of the GAD-7 survey between the hospitalized and nonhospitalized groups (Tables S5 and S6, SDC, http://links.lww.com/TP/C552).

Impact of Events Scale-6 Survey

Results of the IES-6 survey are shown in Figure 4, Tables 2–4. Around 53% of patients reported significant trauma-related distress defined by an IES-6 score of 1.75 and above. This was not different between the hospitalized and nonhospitalized groups (58% versus 51%, P=0.39), or between those with recent versus remote COVID-19 infection (57% versus 46%, P=0.40). There were no differences in answers to the components of the IES-6 survey between the hospitalized and nonhospitalized groups (Tables S7 and S8, SDC, http://links.lww.com/TP/C552).

Health-related Quality of Life EuroQol-5D Survey

Results of the EuroQol-5D are shown in Figure 5, Tables 2–4. Hospitalized patients had worse scores in the components of pain and anxiety/depression. Mobility problems and pain were still common in the remote COVID-19 infection group, 40% and 55%, respectively (Tables S9 and S10, SDC, http://links.lww.com/TP/C552).

The PROMIS Global Health Instrument

Results of the PROMIS survey are shown in Figure 6, Tables 2–4. Among the components of the PROMIS...
survey, 83% reported mild fatigue, and 41% reported moderate fatigue. Hospitalized patients had worse perceived pain score on a 0–10 scale (3 versus 0, \(P = 0.003\)). Participants who reported hospitalization more frequently had perceived problems with daily activities such as walking, climbing stairs, carrying groceries, or moving a chair (66% versus 40%, exact \(P = 0.013\)) (Table S11 and S12, SDC, http://links.lww.com/TP/C552).

BCSS

Results of the BCSS are shown in Figure 7, Tables 2–4. Among components of the BCSS survey, 35% of all patients had perceived abnormal breathing and 31% reported some cough. Hospitalized patients reported more cough (45% versus 24%, exact \(P = 0.021\)) and up to 40% of patients with remote COVID-19 infection still reported some cough (Table S13, SDC, http://links.lww.com/TP/C552).

COVID-19 Symptoms Questionnaire

Overall, 22% of patients reported dysosmia and up to 29% of patients with remote COVID-19 infection reported dysosmia (Table S14, SDC, http://links.lww.com/TP/C552). Around 22% of patients reported dysgeusia and up to 34% of patients with remote COVID-19 infections reported dysosmia. Around 32% reported at least mild diarrhea and that percentage remained elevated even in the remote infection group (32%). There was no difference in

FIGURE 1. Distribution of QRDS category by time from infection and hospitalization status. QDRS, Quick Dementia Rating System.
the percentage of people with abnormal smell sensation, taste sensation, or diarrhea between the hospitalized and nonhospitalized groups, or between the recent and remote COVID-19 infection groups (Table S14, SDC, http://links.lww.com/TP/C552).

**Regression Analysis**

There was no association between age, sex, race, type of organ transplant, mycophenolate use, and the results of the QDRS, PHQ-9, GAD-7, IES-6, EuroQol-5D, PROMIS, and BCSS surveys except that Mycophenolate use was associated with less perception of trauma (odds ratio 0.38; confidence intervals, 0.15–0.97) and older age was associated with worse BCSS score (Beta Coefficient 0.02; confidence intervals 0.00–0.04).

**DISCUSSION**

In this observational study of long-term sequelae of SARS-CoV-2 infection in SOT recipients, there was a high frequency of perceived cognitive, mental, and physical impairments in the period beyond the acute phase of SARS-CoV-2 infection. Some of these impairments were more common and profound in those who reported hospitalization because of SARS-CoV-2 infection, and some continued to be reported >6 mo after diagnosis. The high frequency of reported impairments in the group with remote infection (>6 mo) could have been related, at least in part, to the limited treatment options available early in the pandemic course. This may indicate decreased risk of PASC among patients whose infection fell later in the course of the pandemic, and who were thus able to benefit from treatments that were unavailable early in the pandemic.

The early recognition of these long-term consequences has led to the development of multidisciplinary clinics in some institutions. Literature on the long-term sequelae of SARS-CoV-2 infection in the general population is evolving. However, most studies in the general population understandably focused on people who were hospitalized for SARS-CoV-2 infection. Individuals with SOT constitute a unique group because of their preexisting comorbidities and burden of immunosuppression. Data on long-term sequelae of SARS-CoV-2 infection in SOT patients, whether hospitalized or not, are very limited.

In this study, up to 50% of SOT recipients were found to have evidence of perceived cognitive, mood, and functional decline by the QDRS questionnaire. In particular, those who reported hospitalization for SARS-CoV-2 infection were more likely to report a decline in mood (60%), decision-making and problem-solving (54%), and memory (45%). With regard to mental disorders, there was a remarkably high frequency of reported symptoms of depression, anxiety, and significant trauma related to being diagnosed with SARS-CoV-2 infection. The frequency of reported depression and anxiety symptoms was higher than their reported prevalence in SOT recipients without SARS-CoV-2 infection in literature.
### TABLE 4.
Classification of response to QDRS, PHQ-9, GAD-7, and IES-6 questionnaires by hospitalization status and time from SARS-CoV-2 infection

| Result                                      | Overall N (111) | Nonhospitalized n (78) | Hospitalized n (33) | P   | <6 mo n (76) | >6 mo n (35) | P   |
|---------------------------------------------|----------------|------------------------|---------------------|-----|--------------|--------------|-----|
| **QDRS**                                   |                |                        |                     |     |              |              |     |
| 0–1.4 Normal                                | 56 (50.5%)     | 43 (55%)               | 13 (39%)            | 0.15| 38 (50%)     | 18 (51%)     | 0.64|
| 1.5–5.9 Mild decline                        | 43 (38.7%)     | 29 (37%)               | 14 (42%)            | 0.31| 31 (41%)     | 12 (34%)     |     |
| 6–12.4 Moderate decline                     | 12 (10.8%)     | 6 (8%)                 | 6 (18%)             | 0.07| 7 (9%)       | 5 (14%)      |     |
| 12.5–17.4 Moderately severe decline         | 0              | 0                      | 0                   |     | 0            | 0            |     |
| >17.4 Severe decline                        | 0              | 0                      | 0                   |     | 0            | 0            |     |
| Abnormal                                    | 55 (50%)       | 35 (45%)               | 20 (61%)            | 0.15| 38 (50%)     | 17 (49%)     | 1.00|
| **PHQ-9**                                   |                |                        |                     |     |              |              |     |
| 0–4 Minimal depression                      | 63 (56.8%)     | 47 (60%)               | 16 (48%)            | 0.68| 44 (58%)     | 19 (54%)     | 0.84|
| 5–9 Mild depression                         | 25 (22.5%)     | 18 (23%)               | 7 (21%)             | 0.32| 18 (24%)     | 7 (20%)      |     |
| 10–14 Moderate depression                   | 9 (8.1%)       | 5 (6%)                 | 4 (12%)             |     | 5 (7%)       | 4 (11%)      |     |
| 15–19 Moderately severe                     | 5 (4.5%)       | 3 (4%)                 | 2 (6%)              |     | 4 (5%)       | 1 (3%)       |     |
| 20–27 Severe                                | 1 (0.9%)       | 1 (1%)                 | 0 (0%)              |     | 1 (1%)       | 0 (0%)       |     |
| No answer                                   | 8 (7.2%)       | 4 (5%)                 | 4 (12%)             |     | 4 (5%)       | 4 (11%)      |     |
| ≥5                                          | 40 (36%)       | 27 (35%)               | 13 (39%)            | 0.50| 28 (37%)     | 12 (34%)     | 1.00|
| **GAD-7**                                   |                |                        |                     |     |              |              |     |
| 0–4 No anxiety                              | 80 (72.1%)     | 58 (74%)               | 22 (67%)            | 0.80| 56 (74%)     | 24 (69%)     | 0.66|
| 5–9 Mild anxiety                            | 20 (18.0%)     | 13 (17%)               | 7 (21%)             | 0.70| 13 (17%)     | 7 (20%)      |     |
| 10–14 Mod anxiety                           | 4 (3.6%)       | 3 (4%)                 | 1 (3%)              |     | 2 (3%)       | 2 (6%)       |     |
| >15 Severe anxiety                          | 2 (1.8%)       | 1 (1%)                 | 1 (3%)              |     | 1 (1%)       | 1 (3%)       |     |
| No answer                                   | 5 (4.5%)       | 3 (4%)                 | 2 (6%)              |     | 4 (5%)       | 1 (3%)       |     |
| ≥5                                          | 26 (23%)       | 17 (22%)               | 9 (27%)             | 0.62| 16 (21%)     | 10 (29%)     | 0.47|
| **IES-6**                                   |                |                        |                     |     |              |              |     |
| <1.75 No significant trauma                 | 48 (43.2%)     | 37 (47%)               | 11 (33%)            | 0.39| 31 (41%)     | 17 (49%)     | 0.40|
| ≥1.75 Significant trauma                    | 59 (53.2%)     | 40 (51%)               | 19 (58%)            | 0.43| 43 (57%)     | 16 (46%)     |     |
| No answer                                   | 4 (3.6%)       | 1 (1%)                 | 3 (9%)              |     | 2 (3%)       | 2 (6%)       |     |

GAD-7; Generalized Anxiety Disorder-7; IES-6; Impact of Events Scale-6; PHQ-9, Patient Health Questionnaire-9; QDRS, Quick Dementia Rating System.
which is 17.3%–25.5% for depression and 10%–21% for anxiety-related disorders.\textsuperscript{37,38} Although we could not ascertain definitively that these disorders developed after the diagnosis of SARS-CoV-2 infection, around 35% of respondents self-reported that these mood changes developed after the diagnosis of SARS-CoV-2 infection. Studies of mental disorders in the general population after the diagnosis of SARS-CoV-2 infection reported a prevalence of depression of 23% and anxiety of 15%–23% at 4–6 mo after hospitalization with SARS-CoV2 infection.\textsuperscript{5,36,39} We observed a similar frequency of anxiety in SOT patients (23%) and a much higher frequency of depression alone (36%) at the same time interval. In 1 study in the general population, 31% of patients reported posttraumatic stress disorder 1–2 mo after hospitalization for SARS-CoV2 infection, lower than what we observed in our study.\textsuperscript{40} We observed a much higher percentage of feelings of trauma in our population, close to 53%, although variation in definitions might account for some differences.
Studies of physical symptoms and quality of life in the general population after the diagnosis of SARS-CoV-2 infection reported a prevalence of 2%–19.6% for muscle and/or joint pain in patients who were followed for up of 3–6 mo. This is lower than the frequency of perceived pain of 66% that we observed in SOT patients who were hospitalized for SARS-CoV-2 infection. Fatigue was reported in 34.8%–64% in the general population during follow-up of up to 6 mo after hospitalization. We observed higher prevalence of fatigue in SOT patients who were hospitalized for SARS-CoV-2 infection. Around 81% of SOT patients who were hospitalized for SARS-CoV-2 infection reported at least mild fatigue and 45% reported at least moderate fatigue.

Although patients who had SARS-CoV-2 infection within the past 4 wk were excluded, perceived respiratory symptoms were still very common in our cohort. Around 35% of patients continued to report abnormal breathing and cough at the time of the survey. Studies of the general population who were hospitalized for SARS-CoV-2
infection reported dyspnea and cough in 11.1%–43% and 2.1%–16.7%, respectively, during a follow-up of 1–6 mo.4,9,42-44 We observed a higher frequency of dyspnea (48%) and cough (45%) in hospitalized SOT patients during the same time interval.

In addition, dysosmia, dysgeusia, and diarrhea were also very frequent in our cohort, even in those who had the infection >6 mo ago: 29%, 34%, and 32%, respectively. Dysosmia and dysgeusia were reported in 12%–22.7% in the general population 1–6 mo after the infection, which is close to the percentage that we observed (21%–22%) in the 1–6 mo period.4,5,41,42,44 This percentage becomes smaller 7%–11% in studies that assessed this parameter at 6 mo in the general population, but continued to be high in our cohort beyond 6 mo (29%–30%).5 Studies in the general population after the diagnosis of SARS-CoV-2 infection reported a prevalence of 10.5% for diarrhea 2–6 mo after hospitalization with SARS-CoV-2 infection.4,5,42 It is possible that the higher prevalence of diarrhea in our population is due to gastrointestinal side effects of immunosuppressive drugs.

Our study has some limitations. The parent study was a longitudinal assessment of SOT recipients from multiple centers who self-enrolled online; hence, no non-SOT patients were enrolled, and the study team did not have access to patients’ medical records from their various transplant centers. Because of the nature of the study design, we do not have baseline assessments before SARS-CoV-2 infection, and it is possible that some of these impairments predated the SARS-CoV-2 infection. However, there were several questions in the surveys that specifically asked whether symptoms developed after the SARS-CoV-2 infection. Because of the nature of the study design and lack of contemporaneous control group, there could be confounding factors and bias such as recall and nonresponse bias that may have impacted the results. However, we were focused on describing potential PASC in this particular population of interest, which was also not yet well documented in the literature. In addition, participants’ recruitment into this study is based on self-report of COVID-19 disease. Nevertheless, it is worth noting that a significant proportion of people with suspected COVID-19 disease relied on home testing to confirm diagnosis during more recent waves of COVID-19. Patients from communities of color and of lower socioeconomic status, who have had a disproportionate impact from COVID-19, were underrepresented in this study.45-47 As a result, the true prevalence of PASC in this high-risk population may be even higher than our findings estimate.

In conclusion, our study highlights the major self-reported sequelae of SARS-CoV-2 infection after recovery from acute COVID-19 and showed a high frequency of these perceived complications in both hospitalized and nonhospitalized SOT recipients. These impairments appear to be more common than what has been reported in the general population. These results are highly concerning and should serve as a call to develop an evidence-based multidisciplinary team approach for caring for these patients, and perform further rigorously designed studies for better understanding of this phenomenon. A comprehensive understanding of patient care needs beyond the acute phase will help in the development of infrastructure for COVID-19 clinics for this vulnerable group that will be equipped to provide integrated multispecialty care in the outpatient setting.

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