Original Research
Impact of the Coronavirus Disease 2019 Pandemic on Physical and Mental Health of Patients With COPD: Results From a Longitudinal Cohort Study Conducted in the United States (2020-2021)


¹Division of Pulmonary and Critical Care Medicine, Joan and Sanford I. Weill Department of Medicine, Weill Cornell Medicine, New York, New York, United States

²Division of Pulmonary, Critical Care, Sleep, and Allergy, University of Illinois at Chicago, Chicago, Illinois, United States

³Center for Clinical Trials and Evidence Synthesis, Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, United States

⁴Department of Thoracic Medicine and Surgery, Lewis Katz School of Medicine at Temple University, Philadelphia, Pennsylvania, United States

⁵Pulmonary and Critical Care Medicine, University of Vermont, Burlington, Vermont, United States

⁶Division of Pulmonary and Critical Care Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland, United States

⁷Division of Pulmonary and Critical Care Medicine, Department of Internal Medicine, Washington University School of Medicine, St. Louis, Missouri, United States

*Contributed equally as first author

Address correspondence to:
Janet T. Holbrook
415 N. Washington Street
Baltimore, MD 21231
Telephone: 443-287-5791
Email: janet.holbrook@jhu.edu

Running Head: COVID-19 Pandemic Impact on COPD Patients

Keywords: COVID-19, COPD, depression, anxiety, vaccine hesitancy, vaccination
Abbreviations:
ACRC: Airways Clinical Research Centers
BD: post-bronchodilator
CAT: COPD Assessment Test (CAT)
COPD: chronic obstructive pulmonary disease
COVID-19: Coronavirus Disease 2019
FEV₁: forced expiratory volume in one second
FVC: forced vital capacity
GAD-7: Generalized Anxiety Disorder-7
HRCT: high-resolution computed tomography
HU: Hounsfield Units
IQR: Interquartile range (25th-75th percentile)
LEEP: Losartan Evaluation for Emphysema Trial
NHANES: National Health and Nutrition Surveys
PHQ-8: Patient Health Questionnaire-8
PROMIS: Patient Reported Outcomes Measurement Information System

Funding support: This research was funded by grants from the American Lung Association and the National Institutes of Health-NHLBI (U01HL128951 and U01HL128954)
Clinical Trial Registration: NCT00720226

Date of Acceptance: August 17, 2022 | Published Online Date: August 23, 2022


Declaration of Interest: The authors have no conflicts of interest to report.

Note: This article has an online supplement.
ABSTRACT

BACKGROUND: Patients with chronic obstructive pulmonary disease (COPD) are at higher risk for severe Coronavirus Disease 2019 (COVID-19). From the pandemic’s onset there has been concern regarding effects on health and well-being of high-risk patients.

METHODS: This was an ancillary study to the Losartan Effects on Emphysema Progression (LEEP) Trial designed to collect descriptive information longitudinally about the health and wellbeing of COPD patients who were enrolled in a clinical trial were interviewed by telephone about their health status every 2 weeks and their mental health, knowledge, and behaviors every 8 weeks from June 2020 to April 2021. The were no pre-specified hypotheses.

RESULTS: We enrolled 157 of the 220 participants from the parent LEEP trial. Their median age was 69 years, 55% were male, and 82% were White; median FEV1 % predicted was 48%. Nine confirmed COVID-19 infections were reported, two resulting in hospitalization. Rates of elevated anxiety or depressive symptoms were 8% and 19% respectively in June 2020 and remained relatively stable during follow-up. By April 2021, 85% of participants said they were “very likely” to receive a vaccine; 91% were vaccinated (≥1 dose) by the end of December 2021.

CONCLUSION: Our select cohort of moderate to severe COPD patients who were well integrated into a health care network coped well with the COVID-19 pandemic. Few participants were diagnosed with COVID-19, levels of depression and anxiety were stable, most adopted accepted risk reduction behaviors and did not become socially isolated; most were vaccinated by the end of 2021.
INTRODUCTION

The Coronavirus Disease 2019 (COVID-19) pandemic has had a devastating impact on health worldwide, resulting in excess morbidity and mortality, especially among individuals with co-morbidities. Patients with chronic obstructive pulmonary disease (COPD) are at increased risk for more severe COVID-19 infection, including an elevated risk of ICU admission, mechanical ventilation, and death from COVID-19. Additionally, there is concern that social restrictions and heightened awareness of health risks may lead to increased rates of depression or anxiety, both of which are associated with poor medication adherence morbidity and mortality in people with COPD. There are conflicting reports about the effects of the pandemic on those with chronic respiratory disease, in particular COPD. While some studies report negative consequences from social restrictions and lockdown, others describe a remarkable resilience in these high-risk populations.

Quantitative information on the effects of the pandemic on COPD patients is required to determine the needs of this vulnerable population now and to prepare for public health emergencies in the future. In this study, we examined the impact of the COVID-19 pandemic on patients with moderate to severe COPD living in the United States from June 2020 to April 2021. Specifically, we examined their physical and mental health, their knowledge and beliefs about COVID-19, and their risk-reduction behaviors to better understand how patients were impacted by and coped with the pandemic during its first year.

METHODS

Participants

This study was conducted as an ancillary study to the Losartan Effects on Emphysema Progression (LEEP) trial (NCT02696564), a randomized clinical trial designed to evaluate the effect of losartan on the progression of the emphysema based on high-resolution computed tomography (HRCT). LEEP was conducted by the American Lung Association Airways Clinical Research Centers (ACRC) in collaboration with the Pulmonary Trials Cooperative. Ongoing and completed participants were invited to participate between May 2020 and November 2020. LEEP eligibility criteria included post-bronchodilator (BD) forced expiratory
volume in one second (FEV₁) 20-80% predicted, forced vital capacity (FVC) ratio ≤ 0.70, age 40 years or older, a history of 10 pack-years or greater of cigarette smoking, and a HRCT scan with between 5 and 35% of voxels with density < -950 Hounsfield Units (HU). Twenty-one of the 26 ACRC sites participated in the ancillary study. All sites participating in the ancillary study received local institutional review board approval before contacting participants and all ancillary study participants provided informed consent.

At the genesis of this ancillary study in March 2020, the objective was to evaluate whether current treatment with losartan versus placebo affected COVID-19 infection rates in the participants under active follow-up in the LEEP trial. Secondary objectives were to evaluate overall infection rates and to describe effects of the pandemic on physical and mental health status, and social support networks in the entire group and perform exploratory analysis for potential risk modifiers in well-characterized COPD patients. Given the few cases of COVID-19 observed, our primary and some of our secondary objectives were not achievable. A protocol for the study is posted as a supplement (Supplement).

Data collection

Study interviews were conducted by trained study staff at each study by phone every 2 weeks to query participants about COVID-19 exposures, symptoms, testing, and healthcare utilization since the last interview. At the first interview and every 8 weeks thereafter, participants were also asked about their knowledge of and attitudes towards COVID-19 and administered the following 5 validated questionnaires (Supplementary Table 1): the COPD Assessment Test (CAT), used to evaluate the impact of COPD symptoms on a patient’s life¹⁹; Generalized Anxiety Disorder-7 (GAD-7), used to measure symptoms of general anxiety in the prior 2 weeks²⁰; Patient Health Questionnaire (PHQ-8), used to evaluate symptoms of depression in the prior 2 weeks²¹; Patient Reported Outcomes Measurement Information System (PROMIS) Social Isolation Short Form 4a, used to measure social isolation²²; and the NIH Toolbox Items Bank v2.0 – Instrumental Support, used to evaluate instrumental support, a type of social support that is considered tangible and/or physical²³.

All health outcomes, including COVID-19 diagnosis and test results, were based on self-reports. The COVID-19 case definition was a report of an infection confirmed by a positive test result, regardless of the type of test. Individuals at elevated risk of depression, anxiety, or social
isolation based on their response to standard questionnaires were referred to local mental health and community support resources maintained by each site. Most data are based on information collected between May 2020 and May 2021. Vaccination rates are based on data collected as of December 30th, 2021.

Statistical analysis

Descriptive analyses were used to summarize participant characteristics at enrollment and during follow-up. Data from all interviews were evaluated to determine the incidence of COVID-19 infections and hospitalizations during the follow-up period. Data from the standard and COVID-19 specific questionnaires were evaluated over 6 approximately two-month periods beginning in May 2020 and with the last period ending in May 2021. If two sets of standard or COVID-19 specific questionnaires were available for a participant in one two-month period, the first one was selected for inclusion in the analysis.

Differences in prevalence of characteristics among time periods were evaluated with logistic regression models with covariates for sex and race using generalized estimating equations and adjusting for repeated measurements; an autoregressive covariance structure was used. The first period, June 2020, was the reference period and P-values reported for period differences are from contrasts of subsequent periods with June 2020. Rates of hospitalization from data collected in the ancillary study were compared to the rates in the LEEP cohort from May 2017 to March 1st, 2020. Data were analyzed with SAS version 9.4 and Stata/IC 15.1 for comparison of rates.

RESULTS

Characteristics of the Study Population

Of the 220 patients enrolled in the parent LEEP study, 185 were contacted about the COVID-19 ancillary study, 157 of whom enrolled (Figure 1). Contacted participants who elected not to enroll cited “time” as the main reason for not participating. Most participant, 104 (66%) study had completed the LEEP trial, overall 50% had been randomly assigned to losartan (Table 1).
The median age of ancillary study participants was 66 years; most were White (82%) and male (56%) (Table 1). The median post-BD FEV$_1$ percent predicted at trial enrollment was 48% predicted, with over 75% of participants having CAT scores greater than 10 at enrollment, indicating that this was a cohort of severe, symptomatic COPD patients (Table 2). Most participants (73%) enrolled between May 2020 and July 2020 with 73 to 138 participants being interviewed in each 8-week period (Supplemental Figure 1). The median length of follow-up was 38 weeks and the median number of interviews completed per participant was 19 (Supplemental Figure 2).

**Impact of COVID-19 on Physical Health**

Between May 2020 and May 2021, 9 participants reported a diagnosis of COVID-19 that was confirmed by a positive test, one of whom was asymptomatic. Two reported being hospitalized for COVID-19 infection, including one before enrolling in the ancillary study (Figure 1). 36 hospitalizations not-related to COVID-19 were reported by 30 participants, including 7 for COPD exacerbations and 9 for other respiratory problems. The rate of all-cause hospitalizations in this ancillary study was similar to the rate in the entire LEEP cohort prior to March 1, 2020, 0.31 and 0.35 per person-year, respectively (P=0.63). However, hospitalization rates for COPD exacerbations were reduced in this ancillary study compared to the pre-pandemic rate observed in the LEEP trial (0.06 vs 0.14 per person-year, P=0.05). We recorded 6 deaths during follow-up, none of which were attributed to COVID-19. Patients remained fairly symptomatic during the follow up period, with most patients having medium impact of symptoms (CAT Scores 10-20) and nearly 30% having high or very high symptom burden (CAT Scores 21-30) (Figure 2).

**The Impact of COVID-19 on Social Support and Mental Health**

At enrollment, the median (IQR) scores on the NIH Toolbox measure of Instrumental Support and the PROMIS Social Isolation 4a questionnaires T-scores were 51 (39, 63) and 43 (35, 51), indicating that most participants had assistance, if needed, with activities of daily living and had social support networks (Table 2). These scores remained stable throughout follow-up (Figure 3).

The prevalence of moderate to severe symptoms of anxiety (GAD-7 $\geq$ 10) or depression (PHQ-8 $\geq$ 10) was 8% (6 participants) and 19% (14 participants), respectively, in June 2020.
The prevalence of moderate to severe anxiety remained low throughout the study period, dropping to 2% by February 2021, a rate which was significantly lower than the rate at study onset (P=0.05). The prevalence of moderate to severe depression also decreased to 8% in October and December 2020, which were significantly lower as compared to June 2020 (P=0.03 for both periods), but rebounded to higher rates in February (12%) and April 2021 (15%).

Knowledge, Perceptions, and Attitudes about the COVID-19 Pandemic

Study participants relied on a variety of sources for gathering information on COVID-19. The most trusted sources of information and guidance about COVID-19 were state and local government (76%), local news (76%), the Center for Disease Control (76%), and healthcare providers (69%) (Supplemental Figure 3). Only 22% endorsed social media as trustworthy sources of information about COVID-19. Participants were well-informed about how COVID-19 was transmitted, with 97% knowing that asymptomatic people can be infectious. Over 75% knew that loss of smell or taste were distinctive symptoms of infection in June 2020, which increased to 90% by August 2020.

Most participants believed that personal actions such as wearing masks, social-distancing (maintaining 6 feet distance), and avoiding public places were effective in preventing COVID-19 transmission, and practiced those behaviors (Figure 5). There was a decline in participants avoiding restaurants and bars as the pandemic continued, dropping from 84% in June 2020 to 62% in April 2021 (P<0.001). The percentage of participants canceling travel plans also declined, decreasing to 23% in April 2021 from 46% in June 2020 (P<0.0001).

Concern about the pandemic affecting their COPD declined from 64% in June 2020 to 35% in June 2021 (P<0.001) (Figure 6), which corresponds to the decline in concerns about access medical care from 22% in June 2020 to 9% in April 2021. Willingness to receive a COVID-19 vaccine fluctuated during the study period (Figure 6), dropping initially from 72% in June 2020 to 56% in October 2020 (p=0.08) but subsequently rebounding to 83% by April 2021 (P=0.003). As of December 31, 2021, 91% of 138 participants had received 1 or more doses of a COVID-19 vaccine; the vaccination status of 18 participants is unknown.
DISCUSSION

In this study, we examined the impact of the COVID-19 pandemic during the first year on the physical and mental health of a well-characterized cohort of patients with moderate to severe COPD with evidence of emphysema on CT enrolled in a clinical trial. We found similar rates of both hospitalization and of moderate to severe depression and anxiety compared to rates prior to the pandemic, but hospitalizations for COPD exacerbations were reduced in the pandemic. Our results indicate that our cohort of moderate-severe, symptomatic COPD stayed strongly connected to healthcare systems and coped well during the pandemic. It should be noted that as participants in a clinical trial, these patients were a select group with strong ties to health care providers and high levels of health literacy, which limits the generalizability of our results.

We observed 9 COVID-19 infections in almost 100 person years but only 2 of the 9 participants were hospitalized for COVID-19, which was much lower than the rate of 62% reported for COPD patients diagnosed with COVID-19 infections in the National COVID Cohort Collaborative. None of the 9 died from COVID-19. We also observed lower rates of hospitalization for COPD exacerbations in our cohort than those observed in the clinical trial during the first two years study (2017-2019), which is consistent with reductions reported in a systematic review of hospitalization for COPD exacerbations. We speculate that the rapid adoption of COVID-19 risk reduction behaviors led to fewer respiratory viral infections which often trigger severe COPD exacerbations. Because of the few COVID-19 cases observed in our study we were unable to conduct planned analyses about potential factors affecting risk or severity of COVID-19 in patients with COPD.

While risk reduction behaviors were protective from COVID infection, there was concern that these behaviors could cut patients off from their support systems. In turn, this deprivation of support systems could lead to increased stress, anxiety, feelings of isolation or depression, all of which have been shown to be associated with higher risk of exacerbation risk and other poor outcomes in COPD patients. The rates of depression observed in our study (19%) which was similar to the prevalence of elevated depression scores in a less severe group of 2022 COPD patients in 2016 enrolled in a cohort study conducted by our group using the same depression screening questionnaire. The observed rates are also similar to rates of 15% and 19% reported in a nationally representative sample of US adults age 60 or older surveyed in the COVID-19 and Life Stressors Impact on Mental Health and Well-being in 2020 and 2021.
respectively\textsuperscript{30}. Therefore, while a rate of close to 20% may be alarming, the rates of depression in people with moderate to severe COPD are higher than those of the general population\textsuperscript{31}. The observed prevalence of moderate to severe symptoms of anxiety of 8\% was similar to what we reported in the aforementioned cohort of COPD patients study in 2016, which was 13\% using the same instrument\textsuperscript{29}. Some studies that asked participants about changes in mental health specifically due to the pandemic reported increased anxiety\textsuperscript{13,14}. Our study and others\textsuperscript{15,16,32} that used validated measures of anxiety, such as the GAD-7, which do not reference COVID-19, and reported no increase in anxiety.

Our participants reported high levels of social support and low levels of isolation which likely contributed to the relatively low rates of depression and anxiety. Anecdotally, many participants reported that they enjoyed the study interviews and looked forward to them, and it is possible that being in the study may have affected the very rates of depression and anxiety that we were trying to measure. Taken together, these findings suggest that for this select group of COPD patients who were already coping with physical limitation, the impact of pandemic restrictions on the prevalence of depression and anxiety may be less than in healthier, more active groups.

A major strength of our study is that we leveraged an ongoing clinical trial to collect longitudinal information about the impact of the pandemic on a well-characterized cohort of participants with moderate to severe COPD who were socioeconomically diverse and from different regions of United States. However, generalizability of our findings is limited to a select group of patients with significant morbidity that are well connected to the health care and not representative of COPD patients at large. Additionally, we did not have pre-pandemic measurements of depression and anxiety from the same population and therefore rely on rates from other studies for comparison. Finally, it should be noted that risk avoidance behaviors were self-reported, but it would be extremely difficult to objectively assess compliance of behaviors such as mask wearing and hand hygiene for a large, geographically diverse population.

Nevertheless, our study participants demonstrated remarkable resilience in coping with the risks and restrictions associated with the COVID-19 pandemic as there was no uptick in symptoms of depression or anxiety. They acquired knowledge about COVID-19 from reputable sources, quickly adopted risk avoidance behaviors, and voiced acceptance with vaccine recommendations, all of which likely contributed to the few cases of COVID-19 and the
reduction in severe COPD exacerbations. These results emphasize the need to examine the impact of the COVID-19 pandemic on vulnerable populations across multiple domains of health.
References


Table 1. Baseline characteristics of LEEP-COVID study participants

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total (n=220)</th>
<th>Enrolled (n=157)</th>
<th>Not Enrolled (n=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at enrollment, median (IQR)³</td>
<td>68 (64, 74)</td>
<td>69 (64, 75)</td>
<td>66 (63, 72)</td>
</tr>
<tr>
<td>Male (%)</td>
<td>127 (58)</td>
<td>85 (54)</td>
<td>42 (66)</td>
</tr>
<tr>
<td>Ethnicity: Not Hispanic/Latino (%)</td>
<td>212 (96)</td>
<td>155 (99)</td>
<td>7 (11)</td>
</tr>
<tr>
<td>Race (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black/African American</td>
<td>42 (19)</td>
<td>27 (17)</td>
<td>15 (23)</td>
</tr>
<tr>
<td>White</td>
<td>175 (80)</td>
<td>128 (82)</td>
<td>47 (73)</td>
</tr>
<tr>
<td>Other</td>
<td>3 (2)</td>
<td>1 (1)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Geographic region (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central</td>
<td>78 (35)</td>
<td>57 (36)</td>
<td>21 (33)</td>
</tr>
<tr>
<td>Northeastern</td>
<td>68 (31)</td>
<td>47 (30)</td>
<td>17 (27)</td>
</tr>
<tr>
<td>Southeastern</td>
<td>45 (20)</td>
<td>33 (21)</td>
<td>15 (23)</td>
</tr>
<tr>
<td>Western</td>
<td>18 (12)</td>
<td>30 (13)</td>
<td>11 (38)</td>
</tr>
<tr>
<td>Education (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some high school or less</td>
<td>18 (8)</td>
<td>8 (5)</td>
<td>10 (16)</td>
</tr>
<tr>
<td>High school graduate/GED</td>
<td>49 (22)</td>
<td>37 (24)</td>
<td>12 (19)</td>
</tr>
<tr>
<td>Vocational/some college</td>
<td>81 (37)</td>
<td>56 (36)</td>
<td>25 (39)</td>
</tr>
<tr>
<td>College degree</td>
<td>40 (18)</td>
<td>29 (19)</td>
<td>11 (17)</td>
</tr>
<tr>
<td>Professional or graduate degree</td>
<td>31 (14)</td>
<td>26 (17)</td>
<td>5 (8)</td>
</tr>
<tr>
<td>Marital Status (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>54 (58)</td>
<td>34 (22)</td>
<td>20 (31)</td>
</tr>
<tr>
<td>Divorced</td>
<td>36 (16)</td>
<td>23 (15)</td>
<td>13 (20)</td>
</tr>
<tr>
<td>Married</td>
<td>89 (40)</td>
<td>69 (44)</td>
<td>20 (31)</td>
</tr>
<tr>
<td>Widowed</td>
<td>6 (3)</td>
<td>4 (3)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Employment status (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full or part-time</td>
<td>51 (23)</td>
<td>37 (24)</td>
<td>14 (22)</td>
</tr>
<tr>
<td>Retired/disabled</td>
<td>158 (72)</td>
<td>111 (71)</td>
<td>48 (75)</td>
</tr>
<tr>
<td>Other</td>
<td>11 (5)</td>
<td>9 (6)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Income (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$30K</td>
<td>94 (43)</td>
<td>59 (38)</td>
<td>35 (55)</td>
</tr>
<tr>
<td>$30 to $49K</td>
<td>32 (15)</td>
<td>24 (15)</td>
<td>8 (12)</td>
</tr>
<tr>
<td>$50 to $75K</td>
<td>30 (14)</td>
<td>23 (15)</td>
<td>7 (11)</td>
</tr>
<tr>
<td>&gt;$75K</td>
<td>42 (19)</td>
<td>32 (21)</td>
<td>10 (16)</td>
</tr>
<tr>
<td>Unknown</td>
<td>22 (10)</td>
<td>18 (11)</td>
<td>4 (6)</td>
</tr>
<tr>
<td>Smoker</td>
<td>52 (24)</td>
<td>32 (21)</td>
<td>20 (31)</td>
</tr>
<tr>
<td>LEEP Trial Information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under active follow-up</td>
<td>66 (30)</td>
<td>53 (24)</td>
<td>12 (21)</td>
</tr>
<tr>
<td>Assigned to losartan</td>
<td>108 (49)</td>
<td>79 (50)</td>
<td>29 (46)</td>
</tr>
<tr>
<td>Post-bronchodilator %FEV₁³</td>
<td>47 (36, 59)</td>
<td>48 (36, 62)</td>
<td>44 (33, 55)</td>
</tr>
</tbody>
</table>

³ Missing values (enrolled, not): Age (0.9), Education (0.1), Marital status (1.2), %FEV₁ (1.2)

Abbreviations: FEV₁ – forced expiratory volume in 1 second, post-bronchodilator

Copyright Chronic Obstructive Pulmonary Diseases: Journal of the COPD Foundation ©2022
Published online August 23, 2022 doi: https://doi.org/10.15326/jcopdf.2022.0287
Table 2: Questionnaire scores at ancillary study enrollment

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COPD Assessment Test - CAT</strong></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>155</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>16 (11, 20)</td>
</tr>
<tr>
<td>Impact, N (%)</td>
<td></td>
</tr>
<tr>
<td>Low Impact (&lt;10)</td>
<td>33 (22)</td>
</tr>
<tr>
<td>Medium Impact (10-20)</td>
<td>88 (57)</td>
</tr>
<tr>
<td>High Impact (21-30)</td>
<td>31 (201)</td>
</tr>
<tr>
<td>Very High Impact (&gt;30)</td>
<td>3 (2)</td>
</tr>
<tr>
<td><strong>Generalized Anxiety Disorder – GAD7 (range: 0-21↓)</strong></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>155</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>1 (0, 4)</td>
</tr>
<tr>
<td>Classification, N (%)</td>
<td></td>
</tr>
<tr>
<td>Normal (0-4), N (%)</td>
<td>119 (77)</td>
</tr>
<tr>
<td>Mild anxiety (5-9), N (%)</td>
<td>26 (17)</td>
</tr>
<tr>
<td>Moderate anxiety (10-14), N (%)</td>
<td>8 (5)</td>
</tr>
<tr>
<td>Severe anxiety (&gt;15), N (%)</td>
<td>2 (1)</td>
</tr>
<tr>
<td><strong>Patient Health Questionnaire 8 – PHQ8 (range: 0-27↓)</strong></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>155</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>3 (1, 7)</td>
</tr>
<tr>
<td>Classification, N (%)</td>
<td></td>
</tr>
<tr>
<td>Normal (0-4), N (%)</td>
<td>101 (65)</td>
</tr>
<tr>
<td>Mild depression (5-9), N (%)</td>
<td>34 (22)</td>
</tr>
<tr>
<td>Moderate depression (10-14), N (%)</td>
<td>14 (9)</td>
</tr>
<tr>
<td>Moderate severe depression (15-19), N (%)</td>
<td>6 (4)</td>
</tr>
<tr>
<td><strong>NIH Tool Box – Instrumental Support (range: 0-40↑)</strong></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>155</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>51 (39, 63)</td>
</tr>
<tr>
<td><strong>PROMIS Social Isolation 4a T-score (↓)</strong></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>154</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>43 (35, 51)</td>
</tr>
</tbody>
</table>

Abbreviation: IQR – interquartile range
↑, ↓ indicates that a higher or lower, respectively, is better.
Titles and Legends for figures

**Figure 1: Study Flow Chart**

**Figure 2: COPD Symptom Impact Score by Period**
Legend for Figure 2: The percentage of participants by CAT score category is on the Y-axis for each period on X-axis.

**Figure 3: T-scores for NIH Instrumental Support and PROMIS 4a by period**
Legend for Figure 3: Mean and 95% confidence intervals for scores on the T-scores for NIH Toolbox Instrumental Support questionnaire and PROMIS 4a Social Isolation questionnaire by period. Dotted black line is reference line for population mean.

**Figure 4: Prevalence of moderate to severe anxiety and depression symptoms by period**
Legend for Figure 4: The percentage of participants with moderate or severe anxiety or depression scores is on the Y-axis for each period on X-axis.

**Figure 5: Risk-reduction behaviors by period**
Legend for Figure 5: The percentage of participants practicing behavior is on the Y-axis for each period on X-axis.

**Figure 6: Beliefs and concerns by period**
Legend for Figure 6: The percentage of participants who responded “very likely” to the question about receiving a COVID-19 vaccine if available, and “quite a lot” or “very much” to questions about COVID-19 affecting their COPD or affecting their access to medical care. The total number of participants with response in each period is displayed above the X-axis.
Figure 1:

- 220 randomized in LEEP
- 7 died pre-COVID
- 15 lost to follow up
- 9 at 5 sites not participating
- 4 other

- 185 contacted
- 26 not interested

- 158 enrolled (57 active participants)
- 1 withdrew

- 157 completed enrollment questionnaires

- 9 COVID-19 infections (2 hospitalized)*
  - 4 recovered with symptoms
  - 4 completely recovered
  - 1 asymptomatic

- 6 deaths*
  - 1 lung cancer
  - 1 heart attack
  - 1 COPD exacerbation
  - 1 renal failure
  - 2 unknown
Figure 2:
Figure 3:
Figure 4:
Figure 5:
Figure 6:
Online Supplement Tables and Figures

Supplemental Table 1: Standard Questionnaires

Supplement Figure 1: Enrollment by Month

Supplement Figure 2: Number of surveillance (bi-weekly) interviews per participant
## Supplemental Table 1: Standard Questionnaires

<table>
<thead>
<tr>
<th>Name</th>
<th>Abbreviations</th>
<th>Measurement</th>
<th>Score Range</th>
<th>Scoring interpretation</th>
</tr>
</thead>
</table>
| COPD Assessment Test1                     | CAT           | Current COPD symptoms and impact on activities.                              | 0-40        | Low impact: <10  
Medium: 10-15  
High: 21-30  
Very high: > 30 |
| Generalized Anxiety Disorder-72          | GAD-7         | Symptoms of anxiety over the prior 2 weeks                                    | 0-21        | No symptoms:  
0-4          
Mild symptom: 5-9          
Moderate: 10-14          
Severe: ≥15r |
| Patient Health Questionnaire3             | PHQ8          | Symptoms of depression in the prior 2 weeks                                  | 0-24        | No symptoms:  
0-4          
Mild symptom: 5-9          
Moderate: 10-19          
Severe: ≥20 |
| Patient Reported Outcomes Measurement Information System Social Isolation Short Form 4a4 | PROMIS-4a | Current feelings about connectedness to others                                | 4-20        | Higher scores indicate more isolation |
| NIH Toolbox Items Bank v2.0 – Instrumental Support5 |              | Tangible support for activities in needed in the prior month                | 8-40        | Higher scores indicate more support     |


Supplement Figure 1: Enrollment by Month.

The number of participants recruited are depicted on the Y-axis and by the number on top of the bars.
Supplement Figure 2: Number of surveillance (bi-weekly) interviews per participant.

The number of participants is depicted on the Y-axis and the number of interviews conducted per participants is depicted on the X-axis.
Supplement Figure 3: Sources of trustworthy information at enrollment

The percentage of participants endorsing a source at the first interview for the ancillary study is on the Y-axis.