




# Patient-reported functional outcomes 30 days after hospitalization for COVID-19

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## Abstract

**Background:** Many coronavirus disease 2019 (COVID-19) survivors experience persistent symptoms, such as fatigue, dyspnea, and musculoskeletal pain. However, less is known about the impact of COVID-19 on longer term functional outcomes.

**Objective:** To evaluate patient-reported activity of daily living (ADL) function and fatigue symptoms 30 days after hospitalization for COVID-19.

**Design:** Cross-sectional study.

**Setting:** Tertiary care university hospital.

**Participants:** Adults 18 years or older hospitalized for COVID-19 and survived to 30 days after discharge.

**Methods:** A standardized telephone questionnaire was administered 30 days after hospital discharge.

**Main Outcome Measures:** Ability to perform basic and instrumental ADLs and fatigue symptoms severity (Patient-Reported Outcome Measurement Information System [PROMIS] Fatigue Short Form 7a) were assessed by self-report.

**Results:** Participants ( $n = 55$ ) were 22–95 years old. Compared to pre-COVID hospitalization, 52% developed new difficulty and 6% new dependence with performing basic ADLs (bADLs), 48% developed new difficulty and 11% new dependence with instrumental ADLs (iADLs), and 69% experienced a clinically significant worsening in their fatigue symptom severity. The average fatigue symptom severity T-score before hospitalization was  $44.2 \pm 7.4$  and after hospitalization was  $54.5 \pm 9.8$ . In exploratory multivariate analyses, each additional COVID symptom at presentation was associated with a predicted increase of 1.43 units (95% confidence interval [CI], 0.45–2.42) in the 30-day fatigue symptom severity T-score, each additional day of hospitalization was associated with an 1.2 times increased odds of worsening fatigue (95% CI, 0.98–1.5;  $p = .08$ ), and each unit increase in baseline body mass index was associated with 0.8 times decreased odds of new bADL or iADL dependence at 30 days (95% CI, 0.65–0.99).

**Conclusions:** New functional impairments are common at 30 days after discharge among survivors of hospitalization for COVID-19. Early rehabilitation, advance care planning, and referrals to appropriate therapies should be considered in postacute COVID-19 care to maximize patients' functional outcomes. However, ongoing research is still needed regarding management of these patients.

## INTRODUCTION

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was declared a global pandemic in March 2020 and has resulted in hundreds of millions of COVID-19 survivors<sup>1</sup> and millions of individuals being hospitalized for acute COVID-19.<sup>2</sup> Hospitalization for an acute illness is a key risk factor for the development of new physical disability and at least half of all physical disability in older adults arises in the setting of an acute hospitalization.<sup>3</sup> In addition, long-term adverse effects on physical health and function following acute COVID-19 are common.<sup>4,5</sup> Symptoms, such as fatigue, dyspnea, or joint pain, persisting beyond 4 weeks after acute infection are referred to as postacute COVID-19 syndrome or postacute sequelae of SARS-CoV-2 infection (PASC) and affect 35%–80% survivors of moderate or severe COVID-19.<sup>4,5</sup> Moreover, new functional impairment has been observed among survivors of hospitalization for COVID-19.<sup>4,6,7</sup> However, detailed understanding of the nature and extent of new functional deficits experienced by survivors of hospitalization for COVID-19 is lacking.

Given the increasing number of survivors of hospitalization for COVID-19, it is critical to have an improved understanding of long-term functional outcomes of hospitalization for COVID-19 in order to clarify patients' rehabilitation needs and inform development of evidence-based interventions to prevent new disability. The purpose of this study is to describe key patient-reported functional outcomes (performance of activities of daily living [ADLs]) and fatigue symptoms 30 days after hospital discharge among adult survivors of hospitalization for COVID-19 and to explore potential risk factors for these adverse functional outcomes in these patients.

## METHODS

### Participants

A single-center cross-sectional analysis of data from an observational cohort of adult survivors of hospitalization for COVID-19 ( $N = 55$ ) was performed from April 2020 to April 2021. In order to be eligible for the study, participants were 18 years or older and their primary reason for hospitalization had to be COVID-19 as determined by review of the medical records. COVID-19 diagnosis was based on positive polymerase chain reaction testing from a nasopharyngeal swab. Individuals who tested positive for COVID-19 as part of routine screening but in whom COVID-19 was not felt to be the primary reason for hospitalization were excluded. Individuals without English proficiency or unable to provide informed consent and

prisoners were also excluded. The study was approved by the institutional review board.

### Primary measures

A standardized telephone questionnaire addressing physical functioning and persistent symptoms was administered 30 days after hospital discharge. The Health Assessment Questionnaire-Disability Index (HAQ-DI), a comprehensive, patient-oriented assessment tool, was used to assess self-reported functional status and general disability.<sup>8</sup> The HAQ-DI along with several additional questions queried participants on their performance of basic activities of daily living (bADLs) such as transferring, bathing, eating, dressing, and toileting and instrumental activities of daily living (iADLs) such as meal preparation, grocery shopping, using the telephone, taking medications, and managing finances. Participants were asked whether they have any difficulty performing each task; and if yes, how much difficulty they have (a little, some, a lot, or unable to perform without help). Fatigue symptom severity was assessed using the Patient-Reported Outcome Measures Information System (PROMIS) Fatigue Short Form 7a.<sup>9</sup> PROMIS is a set of patient-centered, precise, and validated assessment tools developed by the National Institutes of Health used across multiple conditions, including in COVID-19.<sup>10</sup> Higher T-scores reflect more severe fatigue symptoms. We also evaluated the proportions of patients whose fatigue T-scores declined by the minimally important difference (MID) of  $\geq 5$  points.<sup>11</sup> Baseline scores for all measures we obtained retrospectively at the time of the 30-day telephone interview.

### Other measures

Demographic information, including gender, ethnicity, race, marital status, and socioeconomic status was assessed by self-report. Past medical history, such as prehospitalization comorbidities, was assessed by combination of self-report and review of the medical record. Clinical information about the individual's COVID-19 hospitalization (eg, hospital length of stay, admission to the intensive care unit [ICU], need for mechanical ventilation, medications received) was collected by review of the medical record. COVID-19 symptoms (eg, fatigue, dyspnea, joint pain, muscle pain) at the time of COVID-19 diagnosis and at 30 days after hospital discharge were assessed by self-report. The FRAIL scale was used to assess frailty status and includes five components (fatigue, resistance, ambulation, illness, and loss of weight). The scores range from 0–5 with 0 indicating robust health status, 1–2 prefrail, and 3–5 frail.<sup>12</sup> Anxiety

**TABLE 1** Participant baseline and hospitalization characteristics<sup>a</sup>

	Male <i>n</i> = 26 (47%)	Female <i>n</i> = 29 (53%)	Total <i>n</i> = 55
<b>Baseline characteristics</b>			
Age in years, mean ± SD	67.7 ± 14.1	51.4 ± 16.9	59.1 ± 17.5
Age ≥ 65 years	13 (50)	7 (24)	20 (36)
Female gender	0	29 (100)	29 (53)
Race			
African American	7 (27)	4 (14)	11 (20)
American Indian, Alaska Native	0	1 (3)	1 (2)
Asian American	3 (12)	1 (3)	4 (7)
Native Hawaiian, Pacific Islander	1 (4)	2 (7)	3 (5)
White	15 (58)	20 (69)	35 (64)
Other	0	1 (3)	1 (2)
Hispanic ethnicity	3 (12)	6 (21)	9 (16)
Limited socioeconomic status ( <i>y/n</i> )	4 (15)	2 (7)	6 (11)
BMI, mean ± SD <sup>b</sup>	29.9 ± 6.9	33.0 ± 8.9	31.4 ± 8.0
BMI < 25	10 (38)	4 (16)	14 (27)
BMI 25 to <30	2 (8)	5 (20)	7 (14)
BMI 30 to <40	13 (50)	12 (48)	25 (49)
BMI > 40	1 (4)	4 (16)	5 (10)
Comorbidities ( <i>y/n</i> )			
Falls in the last year	5 (19)	8 (28)	13 (24)
Non-skin cancer	7 (27)	3 (10)	10 (18)
Congestive heart failure	4 (15)	4 (14)	8 (15)
Coronary artery disease	8 (31)	4 (14)	12 (22)
Stroke	3 (12)	1 (3)	4 (7)
Rheumatoid arthritis	3 (12)	0	3 (5)
Depression	1 (4)	6 (21)	7 (13)
Diabetes	7 (27)	11 (38)	18 (33)
Hypertension	12 (46)	6 (21)	18 (33)
Asthma/COPD	6 (23)	6 (21)	12 (22)
Renal impairment	5 (19)	6 (21)	11 (20)
FRAIL Scale score, mean ± SD	0.7 ± 0.9	0.8 ± 1.1	0.8 ± 1.0
Any basic or instrumental ADL difficulty	11 (44)	20 (69)	31 (56)
Any basic or instrumental ADL dependence	2 (8)	7 (24)	9 (16)
PROMIS Fatigue Short Form 7a score, mean ± SD	43.3 ± 6.0	44.9 ± 8.5	44.2 ± 7.4
HAQ Disability Index score, mean ± SD	0.2 ± 0.4	0.3 ± 0.5	0.3 ± 0.4
HADS—Anxiety Subscale score, mean ± SD	1.4 ± 1.7	2.8 ± 2.4	2.1 ± 2.2
HADS—Depression Subscale score, mean ± SD	3.3 ± 2.2	3.5 ± 2.8	3.4 ± 2.5
<b>Hospitalization characteristics</b>			
# of initial COVID symptoms (out of 23 possible), mean ± SD	4.5 ± 2.1	5.8 ± 2.8	5.2 ± 2.6
Hospital length of stay in days, mean ± SD	12.8 ± 11.1	10.9 ± 11.4	11.8 ± 11.2
ICU admission ( <i>y/n</i> )	13 (50)	10 (34)	23 (42)
ICU length of stay in days, mean ± SD	7.1 ± 6.0	5.8 ± 4.3	6.5 ± 5.3
Mechanical ventilation ( <i>y/n</i> )	3 (12)	6 (21)	9 (16)
Days of mechanical ventilation, mean ± SD	11.0 ± 5.2	5.8 ± 7.1	7.6 ± 6.7
ECMO ( <i>y/n</i> )	1 (4)	0	1 (2)
Days of ECMO, mean ± SD	5.0	0	5.0
Vasopressor support ( <i>y/n</i> )	4 (15)	5 (17)	9 (16)

(Continues)

TABLE 1 (Continued)

	Male <i>n</i> = 26 (47%)	Female <i>n</i> = 29 (53%)	Total <i>n</i> = 55
Dexamethasone (y/n)	15 (58)	14 (48)	29 (53)
Therapeutic anticoagulation (y/n)	3 (12)	0	3 (5)
Remdesivir (y/n)	17 (65)	12 (41)	29 (53)
Received any PT/OT/SLP (y/n), <i>n</i> (%)	12 (46)	12 (41)	24 (44)
Discharged to ARF/SNF (y/n), <i>n</i> (%)	1 (4)	2 (7)	3 (6)

Abbreviations: ADL, activities of daily living; ARF, acute rehabilitation facility; BMI, body mass index; COPD, chronic obstructive pulmonary disease; ECMO, extracorporeal membrane oxygenation; HADS, Hospital Anxiety and Depression Scale; HAQ, Health Assessment Questionnaire; ICU, intensive care unit; OT, occupational therapy; PROMIS, Patient-Reported Outcome Measures Information System; PT, physical therapy; SLP, speech language pathology; SNF, skilled nursing facility.

<sup>a</sup>Values are *n*(%) unless otherwise specified.

<sup>b</sup>Note: four people are missing BMI because height was missing.

and depressive symptoms were assessed using the Hospital Anxiety and Depression Scale (HADS),<sup>13</sup> which is composed of seven questions for anxiety and seven questions for depression.

## Statistical analysis

SAS version 9.4 (Cary, NC) was used to perform analyses. Descriptive analyses, stratified by gender, produced frequencies of patient and hospital variables as numbers and percentages or means and SD. Baseline and hospitalization variables included age, gender, race, body mass index (BMI), presence of comorbidities at admission (congestive heart failure, coronary artery disease, diabetes, hypertension, asthma/chronic obstructive pulmonary disease, and renal disease), number of COVID symptoms at hospital admission (fever, diarrhea, cough, shortness of breath, loss of taste or smell, fatigue, loss or lack of appetite, confusion, nausea/vomiting, runny nose, congestion, hypoxia, chest tightness/pain, voice change, sore throat, dizziness, muscle pain, joint pain, trouble swallowing, headache, and malaise), hospital length of stay, history of ICU admission, ICU length of stay, need for mechanical ventilation, and number of days of mechanical ventilation, need for vasopressors, receipt of COVID-19-related medications (remdesivir, dexamethasone, therapeutic anticoagulation), inpatient physical therapy services received, and discharge disposition. Baseline, prehospitalization functional performance and symptom scores were compared using descriptive statistics.

In addition, we used descriptive statistics to evaluate the following outcomes at 30 days: (1) new (compared to prehospitalization) difficulty with any bADL or iADL, (2) new (compared to prehospitalization) dependence with (unable to perform or needing help to perform) any bADL or iADL, (3) PROMIS Fatigue T-score, and (4) worsening (compared to prehospitalization) by at least the MID of the PROMIS Fatigue T-score. The first two ADL-related outcomes were selected because ADLs are representative of physical function,

and the third and fourth fatigue-related outcomes were selected as variables because fatigue is also reflective of physical function and is common in survivors of COVID.

Lastly, in prespecified exploratory analyses, we evaluated whether patient baseline and hospitalization characteristics were associated with the ADL and fatigue outcomes. For each outcome, exposures with  $p \leq .1$  in univariate regression analyses were included in multivariate regression analyses. Logistic regression was used to estimate odds ratios and 95% confidence intervals (95% CIs) for binary outcomes and linear regression was used to estimate mean parameter estimates and 95% CIs for continuous outcomes.

## RESULTS

### Patient baseline and hospitalization characteristics

A total of 87 individuals were eligible for the study but 17 could not be reached regarding participation, 11 individuals declined to participate, and 4 individuals provided consent but were lost to follow up before 30-day outcomes data could be collected. Thus, a total of 55 participants were included in the study (Table 1). Twenty-nine (53%) were female, 26 (47%) were male. Ages ranged from 22-95 (mean  $59.1 \pm .17.5$ ) years. Thirty-five (64%) were White and 11 (20%) were African American. Eleven percent reported a limited socioeconomic status. The most common preexisting comorbidities were hypertension (33%), diabetes (33%), and falls within the last year (24%). At baseline, 23 (42%) were prefrail/frail, 31 (56%) had difficulty with ADLs. Average BMI ( $\pm$ SD) was  $31.4 \pm 8.0$ .

The mean hospital length of stay was  $11.8 \pm 11.2$  days. Twenty-three participants (42%) required ICU admission, with the average length of ICU stay  $6.5 \pm 5.3$  days. Nine patients (16%) were mechanically ventilated and 29 (53%) were treated with dexamethasone.

**TABLE 2** Activities of daily living and fatigue outcomes 30 days after discharge from COVID-19 hospitalization<sup>a</sup>

	Male <i>n</i> = 26 (47%)	Female <i>n</i> = 29 (53%)	Total <i>N</i> = 55
Basic activities of daily living (bADLs) <sup>b</sup>			
New <sup>c</sup> difficulty with any bADL	11 (44)	17 (59)	28 (52)
Transferring	8 (32)	13 (45)	21 (39)
Bathing/showering	7 (28)	10 (34)	17 (31)
Eating	1 (4)	2 (7)	3 (6)
Dressing	7 (28)	9 (31)	16 (30)
Toileting	4 (16)	3 (10)	7 (13)
New <sup>c</sup> dependence with any bADL	1 (4)	2 (7)	3 (6)
Transferring	1 (4)	2 (7)	3 (6)
Bathing/showering	0	0	0
Eating	0	0	0
Dressing	0	0	0
Toileting	0	0	0
Instrumental activities of daily living (iADLs)			
New <sup>c</sup> difficulty with any iADL	8 (32)	18 (62)	26 (48)
Preparing meals	3 (12)	12 (41)	15 (28)
Grocery shopping	5 (20)	15 (52)	20 (37)
Using telephone	2 (8)	4 (14)	6 (11)
Taking medications	3 (12)	3 (10)	6 (11)
Managing finances	3 (12)	2 (7)	5 (9)
New <sup>c</sup> dependence with any iADL	1 (4)	5 (17)	6 (11)
Preparing meals	0	1 (3)	1 (2)
Grocery shopping	1 (4)	5 (17)	6 (11)
Using telephone	0	0	0
Taking medications	0	0	0
Managing finances	0	0	0
New <sup>c</sup> difficulty with any bADLs OR iADLs	11 (44)	20 (69)	31 (57)
New <sup>c</sup> dependence with any bADLs OR iADLs	2 (8)	7 (24)	9 (17)
PROMIS Fatigue Short Form 7a			
Score, mean ± SD	51.6 ± 7.6	57.0 ± 11.0	54.5 ± 9.8
New <sup>c</sup> significant worsening <sup>d</sup>	18 (69)	20 (69)	38 (69)

Note: MID for PROMIS Fatigue Short Form 7a = 5.<sup>11</sup>

Abbreviations: MID, minimally important difference; PROMIS, patient-reported outcome measures information system.

<sup>a</sup>Values are *n*(%) unless otherwise specified.

<sup>b</sup>One man was missing ADL assessments.

<sup>c</sup>New = Compared to prehospitalization baseline.

<sup>d</sup>Significant worsening is defined as worsening from baseline to follow-up ≥ minimally important difference.

Twenty-four patients (44%) received any physical therapy, occupational therapy, and speech-language therapy during admission. Three patients (6%) were discharged to an acute rehabilitation facility or skilled nursing facility.

### Patient-reported functional outcomes at 30 days after COVID-19 hospitalization discharge

At 30 days posthospitalization, 28 (52%) patients had at least one new difficulty and 3 (6%) had at least one

new dependence with bADLs (Table 2), with difficulty/dependence with transferring being the most common. Twenty-six (48%) had at least one new iADL difficulty and 6 (11%) had at least one new iADL dependence, with grocery shopping being the most common area of difficulty or dependence. Overall, 31 (57%) of participants had at least one new difficulty with either bADLs or iADLs. The average PROMIS fatigue score increased from 44.2 ± 7.4 at baseline (Table 1) to 54.5 ± 9.8 at 30 days posthospitalization, with 38 (69%) individuals with a significant worsening.

**TABLE 3** Odds ratios (for binary outcomes), parameter estimates (from continuous outcomes), and *p* values from univariate regression analyses between exposure variables and patient-reported functional outcomes 30 days after discharge from COVID-19 hospitalization

	New difficulty with any bADLs OR iADLs	New dependence with any bADLs OR iADLs	PROMIS Fatigue Short Form 7a Score (continuous)	New worsening of the MID on PROMIS Fatigue Short Form 7a
Value reported	OR	OR	B-coeff	OR
Age (continuous)	1 (0.97-1.03)	1.01 (0.97-1.05)	-0.08 (-0.23-0.07)	0.98 (0.95-1.02)
Age ≥ 65 vs. age < 65	0.74 (0.24-2.28)	0.91 (0.2-4.12)	-3.39 (-8.9-2.12)	<b>0.36 (0.11-1.18)*</b>
Female gender	<b>2.83 (0.93-8.62)*</b>	3.66 (0.68-19.56)	<b>5.4 (0.22-10.57)**</b>	0.99 (0.31-3.11)
Non-white vs. white race	1.44 (0.46-4.54)	0.91 (0.2-4.12)	0.46 (-5.13-6.05)	2.36 (0.65-8.61)
Limited socioeconomic status	1.56 (0.26-9.32)	—	0.47 (-8.15-9.09)	2.42 (0.26-22.51)
Body mass index, continuous	1.02 (0.95-1.1)	<b>0.9 (0.79-1.02)*</b>	0.05 (-0.31-0.41)	1.02 (0.94-1.11)
Congestive heart failure	2.52 (0.46-13.83)	0.68 (0.07-6.31)	0.37 (-7.26-7.99)	1.41 (0.25-7.8)
Coronary artery disease	1.05 (0.29-3.85)	—	-2.8 (-9.26-3.67)	0.54 (0.14-2.04)
Diabetes	1.09 (0.34-3.49)	1.11 (0.24-5.08)	2.1 (-3.59-7.8)	0.85 (0.25-2.83)
Hypertension	0.77 (0.24-2.44)	—	<b>-4.74 (-10.32-0.84)*</b>	0.58 (0.18-1.92)
Asthma, chronic obstructive pulmonary disease	1.39 (0.35-5.44)	1.14 (0.2-6.47)	1.8 (-4.69-8.29)	2.68 (0.52-13.84)
Renal disease	0.86 (0.23-3.28)	0.44 (0.05-3.93)	-2.08 (-8.77-4.62)	<b>0.28 (0.07-1.09)*</b>
FRAIL score (cont.)	1.46 (0.81-2.63)	1.07 (0.53-2.17)	1.01 (-1.59-3.62)	<b>0.63 (0.36-1.08)*</b>
Any difficulty with basic OR instrumental ADLs at baseline	1.26 (0.4-3.98)	1 (0.22-4.56)	-1.52 (-7.3-4.26)	<b>0.29 (0.09-0.96)**</b>
Health Assessment Questionnaire score at baseline	3.39 (0.72-15.86)	1.58 (0.33-7.52)	2.59 (-3.81-8.99)	<b>0.28 (0.07-1.1)*</b>
Patient-Reported Outcome Measures Information System Fatigue Score at baseline	1.05 (0.97-1.13)	1.08 (0.98-1.19)	<b>0.53 (0.2-0.87)***</b>	0.94 (0.86-1.02)
HADS Anxiety baseline	<b>1.25 (0.96-1.63)</b> <i>p</i> = .10	<b>1.62 (1.09-2.42)**</b>	<b>1.47 (0.27-2.67)**</b>	0.95 (0.73-1.24)
HADS Depression baseline	<b>1.29 (0.97-1.7)*</b>	<b>1.27 (0.98-1.66)*</b>	<b>0.89 (-0.18-1.96)*</b>	1.01 (0.8-1.27)
# of initial COVID symptoms (cont.)	0.98 (0.79-1.21)	<b>1.35 (1-1.81)*</b>	<b>1.52 (0.54-2.49)***</b>	<b>1.33 (1.01-1.74)**</b>
Hospital length of stay in days	1.01 (0.96-1.07)	1.02 (0.97-1.08)	0.11 (-0.13-0.35)	<b>1.15 (1.01-1.3)**</b>
ICU admission (y/n)	0.5 (0.17-1.52)	1.09 (0.26-4.63)	-0.9 (-6.34-4.55)	<b>5.18 (1.28-21.02)**</b>
ICU length of stay in days <sup>a</sup>	0.97 (0.86-1.09)	1.04 (0.91-1.2)	0.08 (-0.5-0.66)	<b>1.24 (0.97-1.59)*</b>
Mechanical ventilation (vs. not)	0.43 (0.09-2.05)	1.66 (0.26-10.44)	3.03 (-4.18-10.25)	1.68 (0.28-10.11)
Days of mechanical ventilation <sup>1</sup>	0.94 (0.82-1.09)	1.08 (0.93-1.25)	0.34 (-0.37-1.04)	1.28 (0.81-2.02)
Vasopressor support	0.91 (0.22-3.86)	0.58 (0.06-5.3)	-1.51 (-8.76-5.75)	4.27 (0.49-37.2)
Dexamethasone	0.53 (0.18-1.58)	0.7 (0.17-2.95)	-1.73 (-7.09-3.63)	1.96 (0.62-6.27)

Abbreviations: ADL, activities of daily living; bADL, basic activities of daily living; HADS, Hospital Anxiety and Depression Scale; iADL, instrumental activities of daily living; ICU, intensive care unit; MID, minimally important difference; OR, odds ratio.

<sup>a</sup>People without ICU admissions or mechanical ventilation counted as having 0 days in these models.

\**p* ≤ .1.

\*\**p* ≤ .05.

\*\*\**p* ≤ .01.

**TABLE 4** Odds ratios (for binary outcomes), parameter estimates (from continuous outcomes) and *p* values from multivariate regression analyses between exposure variables and patient-reported functional outcomes 30 days after discharge from COVID-19 hospitalization<sup>a</sup>

	<b>Model 1</b> New difficulty with basic OR instrumental ADL	<b>Model 2</b> New dependence with basic OR instrumental ADL	<b>Model 3</b> PROMIS Fatigue Short Form 7a Score (continuous)	<b>Model 4</b> New worsening of the MID on PROMIS Fatigue Short Form 7a
Age ≥ 65	—	—	—	1.3 (0.2-7.2)
Female vs. male	2.6 (0.8-8.9)	—	1.48 (−3.51-6.46)	—
Body mass index (cont.)	—	<b>0.80 (0.65–0.99)**</b>	—	—
Hypertension (y/n)	—	—	<b>−5.0 (−10.3, 0.24)*</b>	—
Renal disease (y/n)	—	—	—	0.3 (0.03-2.8)
Frail score (cont.)	—	—	—	0.5 (0.2-1.7)
# of initial symptoms (cont.)	—	1.27 (0.86-1.88)	<b>1.43 (0.45, 2.42)***</b>	1.3 (0.9-2.0)
Any difficulty with basic OR instrumental ADLs at baseline (y/n)	—	—	—	0.4 (0.1-3.4)
Health Assessment Questionnaire score at baseline (cont.)	—	—	—	1.7 (0.1-29.5)
Patient-Reported Outcome Measures Information System Fatigue score at baseline (cont.)	—	—	<b>0.60 (0.22, 0.98)***</b>	—
HADS anxiety baseline (continuous)	1.1 (0.8-1.5)	1.52 (0.86-2.68)	−0.45 (−1.81, 0.90)	—
HADS depression baseline (continuous)	1.3 (0.9-1.8)	1.38 (0.92-2.07)	0.24 (−0.80, 1.29)	—
Hospital length of stay in days (cont.)	—	—	—	<b>1.2 (0.98–1.5)*</b>
ICU admission (y/n)	—	—	—	2.5 (0.3-24.0)
ICU length of stay in days (cont.) <sup>b</sup>	—	—	—	0.9 (0.7-1.2)

Abbreviations: ADL, activities of daily living; HADS, Hospital Anxiety and Depression Scale; ICU, intensive care unit; MID, minimally important difference.

<sup>a</sup>Variable with *p* < 0.1 in univariate models were included in the multivariable models.

<sup>b</sup>People without ICU admissions or mechanical ventilation counted as having 0 days in these models.

\**p* ≤ .1.

\*\**p* ≤ .05.

\*\*\**p* ≤ .01.

## Exploratory regression analyses of potential risk factors for adverse functional outcomes at 30 days after COVID-19 hospitalization discharge

Univariate regression analyses between exposure variables and patient-reported functional outcomes at 30 days after discharge from COVID-19 hospitalization are shown in Table 3. Females showed a trend toward higher odds of having new difficulty (odds ratio [OR], 2.83; 95% CI, 0.93-8.62) or new dependence (OR, 3.66; 95% CI, 0.68-19.56) at 30 days but these did not reach statistical significance. Relative to males, females scored 5.4 (95% CI, 0.22-10.57) T-score points higher for PROMIS fatigue at 30 days. Participants with

a higher number of initial COVID-19 symptoms had greater odds of new dependence with ADLs (OR, 1.35; 95% CI, 1-1.81; *p* = .05), significant worsening of fatigue (OR, 1.33; 95% CI, 1.01-1.74; *p* = .04), and a higher fatigue score by 1.52 points (95% CI, 0.54-2.49) compared to those with a lower number of symptoms. Higher baseline anxiety and depression levels also trended toward greater odds of new difficulty or dependence with ADLs and greater fatigue scores. Longer hospital length of stay and admission to the ICU increased odds of worsening fatigue (OR, 1.15; 95% CI, 1.01-1.3; *p* = .03 and OR, 5.18; 95% CI, 1.28-21.02; *p* = .02 respectively).

Results of multivariate regression analyses are shown in (Table 4). Multivariable model 1 evaluated the

association of female gender, baseline HADS anxiety score, and baseline HADS depression score with new bADL or iADL difficulty, none of which were found to be statistically significantly associated with the outcome. In Model 2, higher BMI was associated with a lower odds of new bADL or iADL dependence (OR, 0.80; 95% CI, 0.65-0.99;  $p = .04$ ) when controlling for number of initial symptoms and HADS anxiety and depression scales. In Model 3, each additional COVID symptom at presentation was associated with an increase of 1.43 T-score points (95% CI, 0.45, 2.42;  $p = .005$ ) for 30-day PROMIS Fatigue, when adjusting for gender, history of hypertension, baseline PROMIS Fatigue score, and baseline HADS anxiety and depression scores. Similarly, each unit increase in the baseline PROMIS fatigue T-score was associated with an 0.60 T-score point increase (95% CI, 0.22–0.98;  $p = .003$ ) in the 30-day PROMIS fatigue score, when adjusting for these same covariates. Lastly, in Model 4 each additional day of hospitalization was associated with 1.2 times increased odds (95% CI, 0.98–1.5;  $p = .08$ ) of worsening fatigue, when controlling for covariates.

## DISCUSSION

In this study, we assessed patient-reported functional outcomes and symptoms 30 days after hospital discharge among adult survivors of hospitalization for COVID-19 and found decreased ADL function and increased fatigue to be common. The trends from our study are similar to those of the general population of acute lung injury survivors<sup>14</sup> in that persistent impairment in physical and cognitive function can occur after recovery from their critical illness. In acute lung injury, critical illness itself was found to be an independent risk factor for the physical and cognitive functional decline.<sup>14</sup> Furthermore, prior coronavirus outbreaks, specifically the SARS epidemic of 2003 and the Middle East respiratory syndrome outbreak of 2012, have also demonstrated these lingering effects, lasting from months to years.<sup>15-17</sup> Based on these patterns, it is not surprising that survivors of hospitalization for COVID-19 experience persistent physical and cognitive functional impairments.

The majority of adults (57%) reported increased difficulty performing any bADL or iADL tasks 30 days after discharge from hospitalization for COVID-19. Our findings demonstrate how common ADL disability is and the continuum of disability experienced by COVID-19 survivors. New dependence (ie, requiring help from another person) with bADLs or iADLs was seen in 17% of participants. Together, the assessment of ADL difficulty and dependence has been demonstrated to complement each other and better depict disability than when evaluating ADL dependence alone.<sup>18</sup>

In exploratory analyses we aimed to explore potential patient- or illness-related characteristics that may be risk

factors for ADL disability and fatigue in these patients. There was an association noted between higher BMI and lower risk of new dependence with bADL or iADLs but there were no other clear predictors for ADL disability in this cohort. This hypothesis-generating finding is unexpected and may reflect selection bias, residual confounding, and/or random chance given the relatively small sample size. Further studies are needed to clarify the relationship between BMI and risk of ADL dependence after hospitalization for COVID-19.

Fatigue has been identified as one of the most common post-COVID symptoms.<sup>5,6,19</sup> In this cohort, an increased number of initial COVID symptoms was associated with an increased PROMIS fatigue score at 30 days. A longer hospital length of stay trended toward an association with significant worsening of fatigue, though the association did not achieve statistical significance. A lower fatigue score at baseline was also associated with higher fatigue score at 30 days post-COVID hospitalization. Although these hypothesis-generating associations should be interpreted with caution and further, larger studies are needed, these observations are consistent with the existing literature. Others have shown that a strong predictor of risk of developing post-acute COVID, or PASC, is greater number of COVID-19 symptoms at presentation<sup>19</sup> and that the severity of illness during acute COVID-19 is significantly associated with ongoing dyspnea, fatigue, weakness, and reduction in quality of life.<sup>6,20</sup>

Age  $\geq 65$  years has been identified as one of the strongest predictors of hospitalization, disease severity, and mortality in COVID-19.<sup>21</sup> In exploratory univariate analyses, age  $\geq 65$  years, compared to age 18-64 years, was not statistically significantly associated any of the ADL or fatigue outcomes assessed (Table 3). Thus, our data suggest that all adults, regardless of age, are at risk for prolonged, clinically significant functional impairment following hospitalization for COVID-19.

This study has certain limitations. The sample size was relatively small, which may have limited our ability to detect significant associations. Findings may or may not generalize to patients with milder COVID-19 who did not require hospitalization. In addition, although patients were hospitalized at three different hospitals within the hospital system, this remains a single-center study. Participants were required to be proficient in English and thus the study may have excluded individuals of lower socioeconomic statuses. There is the potential for recall bias as participants were asked to report their baseline functional status retrospectively. These data highlight the 30-day outcomes of post-COVID patients but the full trajectory of their functional recovery cannot be determined from these results and further research is required. Nevertheless, the study has several strengths, including a racially and ethnically diverse patient sample, systematic and detailed assessment of key patient-reported physical function outcomes at 30 days after hospitalization for COVID-19, and



inclusion of detailed clinical information from patients' COVID-19 hospitalization.

Functional decline or the loss of independence in mobility, ADLs, and iADLs, can have a significant adverse effect on an individual's quality of life and overall well-being.<sup>22</sup>

Given the significant impact of postacute COVID, or PASC, on physical function, these patients will likely benefit from ongoing medical care and a comprehensive rehabilitation program. Although little evidence exists supporting specific treatment approaches to improve functional outcomes after COVID-19, we argue that early rehabilitation, advance care planning, and referrals to appropriate therapies are critically important for all patients following hospitalization for COVID-19 in order to maximize functional outcomes.

## CONCLUSION

New functional impairment, assessed as performance of basic and instrumental ADLs and fatigue symptoms severity, is common at 30 days after discharge among survivors of hospitalization for COVID-19. Early rehabilitation, advance care planning, and referrals to appropriate therapies should be considered in postacute COVID-19 care in order to maximize patients' functional outcomes. However, ongoing research is still needed regarding management of these patients.

## DISCLOSURES


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**CME Question**

Among adult survivors of hospitalization for COVID-19, the strongest predictors of risk of worsening fatigue and/or decreased ADL function at 30 days after discharge are all of the following except:

- a. Increased days of hospitalization
- b. Increased number of initial COVID symptoms
- c. Increased Body Mass Index
- d. Increased baseline PROMIS fatigue T-score units

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