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Race, ethnicity, and utilization of outpatient rehabilitation for treatment of post COVID-19 condition

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Abstract

Introduction: Outpatient rehabilitation is recommended in the treatment of post coronavirus disease 2019 (COVID-19) condition. Although racial and ethnic disparities in the incidence and severity of COVID-19 have been well documented, little is known about the use of outpatient rehabilitation among patients with post COVID-19 condition.

Objective: To examine factors associated with outpatient rehabilitation use following COVID-19 and to ascertain whether differential incidence of sequelae explain variation in post COVID-19 rehabilitation utilization by race and ethnicity.

Design: Case–control study.

Setting: Community.

Participants: U.S. adults with COVID-19 during 2020 in the TriNetX database.

Intervention: N/A.

Main Outcome Measures: Receipt of outpatient rehabilitation services within 6 months of COVID-19 diagnosis and incidence of post COVID-19 condition symptoms (weakness, fatigue, pain, cognitive impairment, mobility difficulties, and dyspnea).

Results: From 406,630 laboratory-confirmed COVID-19 cases, we identified 8724 individuals who received outpatient rehabilitation and matched 28,719 controls. Of rehabilitation users, 43.3% were 40 years old or younger, 54.8% were female, 58.2% were White, 17.9% were African American/Black, 2.1% were Asian, 13.0% were Hispanic, 39.2% had no comorbidities, and 40.3% had been hospitalized for COVID-19. Dyspnea (20.4%), fatigue (12.4%), and weakness (8.2%) were the most frequently identified symptoms. Although there were no racial differences in the incidence of the six post COVID-19 condition symptoms considered, African American/Black individuals were significantly less likely than their White counterparts to receive outpatient rehabilitation (odds ratio [OR] = 0.89; 95% confidence interval [CI]: 0.84–0.96; $p = .003$). Hispanic individuals had higher outpatient rehabilitation utilization (OR = 1.22; 95% CI: 1.11–1.33; $p < .001$) and a significantly higher incidence of post COVID-19 fatigue.

Conclusions: In this large nationally representative study, African American/Black race was associated with lower utilization of outpatient rehabilitation services despite a similar incidence of post COVID-19 condition symptoms. Further research is needed to better understand access barriers to rehabilitation services for post COVID-19 condition recovery care and address racial inequalities in receipt of care.

INTRODUCTION

Research has shown that a significant proportion of individuals who contract coronavirus disease 2019 (COVID-19) experience ongoing post-acute sequelae following their acute severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection. As defined by the World Health Organization, these sequelae are known as post COVID-19 condition, which is characterized by new or persistent symptoms that usually occur within 3 months from the onset of acute infection, and that last for at least 2 months.[1–5] Sequelae can affect almost every organ system of the body and range from physical symptoms, such as fatigue and weakness, to neuropsychiatric deficits, such as cognitive dysfunction or "brain fog."[1,2,6,7]

Post COVID-19 condition has been estimated to affect at least 10% of survivors of COVID-19 infection.[3,4,8] [3,4,8] A subset of individuals continue to experience symptoms at least 6 months after infection.[3] One systematic review reported that nearly half of all COVID-19 survivors endorse an ongoing impairment in their general function at 30 days after infection, with 20.2% reporting a decline in mobility and 14.7% reporting reduced mobility.[4]

Expert guidance statements recommend the cautious use of rehabilitation in the recovery from post COVID-19 condition. Recommendations include, but are not limited to, the use of occupational therapy and physical therapy in assessing patient deficits and developing personalized therapy approaches to recover pre-COVID-19 function and quality of life while avoiding overexertion and post-exertional malaise.[9–11]

When discussing the long-term implications of SARS-CoV-2 infection, it is critical to recognize that COVID-19 has disproportionately affected racial minorities. The Centers for Disease Control and Prevention (CDC) reported that African American/Black, Hispanic, and American Indigenous individuals comprised 22%, 33%, and 1.3% of all U.S. COVID-19 cases in May 2020, despite making up 13%, 18%, and 0.7% of the national population, respectively.[12] Members of racial minority groups are also more likely to be hospitalized with COVID-19 and experience intensive care unit (ICU) admission and death from COVID-19 at higher rates.[13–18] Although it has not been documented to date, it is plausible that there might also be racial differences in the incidence of post COVID-19 condition.

Despite the potential effectiveness of outpatient rehabilitation in addressing disabling persistent COVID-19 symptoms, little is known about access to these services or factors associated with their utilization. The purpose of this study is to explore the factors associated with outpatient rehabilitation utilization among patients who tested positive for COVID-19 during 2020 across the United States through analysis of a large, diverse, real-time electronic health record database. Given the widespread evidence of racial disparities in the incidence and severity of acute SARS-CoV-2 infection, we examine both the use of rehabilitation services and the incidence of the most common post COVID-19 condition symptoms, with a special focus on potential differences by race and ethnicity.

DATA AND METHODS

Data sources and cohort identification

De-identified COVID-19 patient data were extracted from the TriNetX research network database, a research platform compiling real-time electronic health records data from over 50 U.S. health care organizations. At the time of the search, TriNetX provided real-time access to the electronic health records of more than 80 million patients. Data were downloaded after a search performed for patients 18 years of age or older diagnosed with COVID-19 between January 1 and December 31, 2020. We followed the TriNetX criteria for accurate identification of COVID-19, which has been extensively used in published research, whereby only cases confirmed with positive laboratory test for SARS-CoV-2 and related RNA during the study period were eligible for the study. From this larger COVID-19-positive population, we identified cohorts for our matched case–control analysis.

Outcomes

The primary outcome of interest was receipt of outpatient rehabilitation services within 6 months following COVID-19 diagnosis. The follow-up period of 6 months was chosen to best capture rehabilitation use specific for treatment of COVID-19 sequelae given the natural history of post COVID-19 condition. Codes for physical, occupational, respiratory, and cognitive therapies, combined with an indicator for outpatient setting for provision of services, were used to identify utilization and type of post COVID-19 rehabilitation therapies. The incidence of six frequently reported post COVID-19 condition symptoms—weakness, fatigue, pain, cognitive dysfunction, mobility difficulties, and dyspnea—was identified using International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) codes as secondary outcomes. For the incidence analyses, COVID-19 survivors with any of the six symptoms (weakness, fatigue, pain, cognitive impairment, mobility difficulties, and dyspnea) within the 6 months prior to their COVID-19 diagnosis were excluded from the analyses.

Matching and control variables

Patients' age, sex, number of comorbidities, prior use of rehabilitation services, and exposure time (i.e., days

TABLE 1 Summary characteristics of overall COVID-19-positive population, post COVID-19 condition rehabilitation users, and matched controls

	Overall COVID-19 population ***N*** **= 406,630**	**Post-COVID rehab users** ***N*** **= 8724**	**Matched controls** ***N*** **= 28,719**
Age			
Mean ± SD	45.6 ± 17.7	45.4 ± 17.6	45.6 ± 17.8
Median (IQR)	44.0 (29)	44.0 (29)	44.0 (29)
Age categories, *n* (%)*			
18–40	175,875 (43.2)	3844 (44.0)	12,509 (43.5)
41–50	69,241 (17.0)	1453 (16.6)	4843 (16.8
51–60	70,179 (17.2)	1502 (17.2)	4921 (17.1)
61–70	51,491 (12.6)	1089 (12.4)	3616 (12.5)
71–80	28,046 (6.9)	573 (6.5)	1916 (6.6)
81–90	11,798 (2.9)	263 (3.0)	914 (3.1)
Sex, *n* (%)*			
Female	221,269 (54.4)	4785 (54.8)	15,667 (54.5)
Male	182,530 (44.8)	3892 (44.6)	12,899 (44.9)
Race, *n* (%)			
Asian	8388 (2.0)	186 (2.1)	595 (2.0)
African American/Black	73,288 (18.0)	1561 (17.8)	6254 (21.7)
White	236,501 (58.1)	5075 (58.1)	14,483 (50.4)
Unknown	85,832 (21.1)	1841 (21.1)	7243 (25.2)
Ethnicity, *n* (%)			
Hispanic	53,054 (13.0)	1130 (12.9)	2954 (10.2)
Not Hispanic	251,706 (61.9)	5362 (61.4)	16,773 (58.4)
Unknown	101,870 (25.0)	2232 (25.5)	8992 (31.3)
Number of comorbidities, *n* (%)*			
0	284,353 (69.9)	3420 (39.2)	12,332 (42.9)
1–2	71,549 (17.6)	2041 (23.4)	6737 (23.4)
3–4	27,822 (6.8)	1388 (15.9)	4528 (15.7)
5–6	12,142 (2.9)	873 (10.0)	2599 (9.0)
7+	10,764 (2.6)	1002 (11.5)	2523 (8.7)
Hospitalized for COVID-19, *n* (%)			
0	364,429 (89.6)	5206 (59.6)	24,240 (84.4)
1	42,201 (10.4)	3518 (40.4)	4479 (15.6)
Used rehabilitation pre-COVID-19,* *n* (%)			
0	395,315 (97.2)	7296 (83.6)	25,565 (89.0)
1	11,315 (2.8)	1428 (16.4)	3154 (11.0)
Region, *n* (%)			
Midwest	90,456 (22.2)	1913 (21.9)	4079 (14.2)
Northeast	94,897 (23.34	1992 (22.8)	9309 (32.4)
South	149,772 (36.8)	3238 (37.1)	13,087 (45.6)
West	71,409 (17.6)	1579 (18.1)	2216 (7.7)

Note: Asterisk identifies characteristics used in the matching of COVID survivors who used outpatient rehabilitation services within 6 months of a coronavirus disease 2019 (COVID-19) diagnosis (cases) and non-outpatient rehabilitation users (controls). Matching with no replacement was conducted at the 1:*n* ratio, where *n* is the maximum number of matching cases for each given vector of case characteristics. Some columns may not add to 100% due to a small proportion (<2%) with missing information.

COVID-19, coronavirus disease 2019; IQR, interquartile range; SD, standard deviation.

since COVID-19 diagnosis) were used as matching variables. Electronic health records for the 6 months prior to each individual's confirmed COVID-19 diagnosis were used to calculate comorbidities using the Elixhauser index.[19] For all confirmed COVID-19 patients, we also examined health care utilization 6 months prior to the

positive SARS-CoV-2 test to identify prior use or ongoing use of rehabilitation services unrelated to the COVID-19 diagnosis.

In addition to severity of the acute SARS-CoV-2 infection, proxied by hospitalization, the patients' race (African American/Black, Asian, White, other race), ethnicity (Hispanic, not Hispanic), and Census region of residence were used as control variables in multivariable regression analysis. Race and ethnicity classifications in this study are used as reported by electronic health records within the TriNetX research network database.

Analysis

To circumvent the inherent selection bias resulting from observational data, we performed a matched case–control analysis when examining the association between race and ethnicity and use of outpatient rehabilitation services. COVID-19 patients who survived at least 6 months after COVID diagnosis were stratified into two groups based on use of outpatient rehabilitation services within the 6-month post-COVID diagnosis follow-up period. Cases consisted of COVID-19 survivors who had an outpatient encounter with codes identifying receipt of physical therapy, occupational therapy, cognitive therapy, or respiratory therapy. To these, controls were matched based on the individual's age (±1 year), sex, number of comorbidities (0, 1–2, 3–4, 5–6, 7+), and prior use of outpatient rehabilitation (within 6 months before their laboratory confirmed COVID-19 diagnosis). Controls were selected from among the COVID-19 survivors who did not utilize outpatient rehabilitation during the 6-month post-COVID diagnosis follow-up period, with use of a random sampling with no replacement. To maximize the analytical sample, cases were matched at a 1:*n* ratio to controls, where *n* is the highest number of matching observations per strata that ensured that all cases were successfully matched.

The odds ratios (ORs) between race/ethnicity and use of outpatient rehabilitation services were estimated with conditional logistic regression to account for the matching, with covariate adjustments for the severity of SARS-CoV-2 infection, proxied by acute care hospitalization for COVID-19, and region of residence, factors on which case–control matching was not feasible. Finally, to examine whether differences in outpatient rehabilitation service use may be explained by differential incidence of post COVID-19 condition symptoms among cases and controls, we estimated multivariable logistic regressions.

All statistical analyses were performed using Stata 15.

TABLE 2 Factors associated with use of outpatient rehabilitation among COVID-19 survivors

	Odds ratio	*p*Value	95% CI
Race			
White	Reference		
African American/Black	0.89*	.003	0.84–0.96
Asian	1.07	.45	0.89–1.29
Other	0.99	.93	0.71–1.34
Ethnicity			
Not Hispanic	Reference		
Hispanic	1.22*	<.001	1.11–1.33
Hospitalized for COVID	3.71*	<.001	3.50–3.93

Note: Results based on the $N = 37{,}443$ matched case–control sample. Rehabilitation users (cases) were matched to controls based on age, sex, number of comorbidities, and prior use of outpatient rehabilitation services in the 6 months preceding the COVID diagnosis. In addition to matching characteristics, where there was an imbalance between cases and controls (prior use of outpatient rehabilitation and number of comorbidities), the regression also included indicators for region of residence (South, Midwest, Northeast, West, unknown) and controls for unknown race and unknown ethnicity.
CI, confidence interval; COVID-19, coronavirus disease 2019.

RESULTS

We identified a total of 406,630 laboratory-confirmed COVID-19 individuals within the TriNetX database

TABLE 3 Incidence of post COVID-19 condition symptoms within 6 months of COVID-19 diagnosis, by race and ethnicity

		Race			Ethnicity	
	Total COVID Population	African American/Black	White	Other	Hispanic	Not Hispanic
Weakness[a,b]	2928 (8.2)	550 (7.0)	1643 (8.4)	735 (7.3)	357 (8.7)	1776 (8.0)
Fatigue[a,b]	4309 (12.4)	864 (11.1)	2362 (12.1)	1083 (10.7)	546 (13.4)	2549 (11.5)
Mobility problems[a]	1660 (4.6)	329 (4.2)	943 (4.8)	388 (3.8)	182 (4.5)	1046 (4.7)
Cognitive Impairment[a]	2708 (7.6)	547 (7.0)	1506 (7.7)	655 (6.5)	323 (7.9)	1664 (7.5)
Pain	1484 (4.1)	294 (3.8)	801 (4.1)	389 (3.9)	173 (4.2)	906 (4.1)
Dyspnea[a,b]	7630 (20.4)	1437 (18.4)	4271 (21.9)	1916 (19.0)	898 (22.0)	4573 (20.7)

[a]Denotes sequela for which racial differences are significant at the $p < .01$ level.
[b]Denotes sequela for which ethnicity differences are significant at the $p < .01$ level.
COVID-19, coronavirus disease 2019.

TABLE 4 Factors associated with incidence of post COVID-19 condition symptoms among case–control matched sample

	Weakness (*N* = 35,693)	Fatigue (*N* = 34,680)	Mobility difficulty (*N* = 36,101)	Cognitive impairment (*N* = 35,605)	Pain (*N* = 36,258)	Dyspnea (*N* = 32,998)
Age ≤40 (reference)	–	–	–	–	–	
41–50	1.09 [0.97–1.22]	1.01 [0.91–1.12]	1.00 [0.84–1.18]	1.08 [0.95–1.23]	0.99 [0.84–1.18]	0.93 [0.81–1.08]
51–60	0.99 [0.88–1.12]	1.03 [0.93–1.14]	1.16 [0.99–1.37]	0.97 [0.85–1.11]	0.99 [0.85–1.17]	1.01 [0.87–1.16]
61–70	0.95 [0.83–1.10]	1.08 [0.96–1.21]	0.97 [0.80–1.18]	0.97 [0.83–1.13]	0.95 [0.78–1.15]	
71–80	1.05 [0.88–1.25]	0.81[0.69–1.25]	1.11 [0.88–1.41]	0.95 [0.78–1.16]	1.03 [0.81–1.32]	0.93 [0.79–1.10]
81+	1.19 [0.94–1.15]	1.03 [0.84–1.28]	1.10 [0.79–1.55]	0.85 [0.63–1.15]	1.17 [0.84–1.61]	0.92 [0.74–1.14]
Sex: Female	1.01 [0.93–1.10]	1.02 [0.95–1.10]	1.04 [0.93–1.17]	1.04 [0.94–1.14]	0.98 [0.87–1.11]	0.97 [0.87–1.07]
Race						
Asian	1.02 [0.75–1.38]	0.80 [0.60–1.05]	0.86 [0.55–1.35]	1.01 [0.72–1.14]	0.77 [0.48–1.22]	1.13 [0.80–1.60]
African American/Black	0.98 [0.87–1.10]	1.03 [0.93–1.13]	0.98 [0.84–1.15]	1.11 [0.98–1.26]	0.96 [0.82–1.13]	0.95 [0.82–1.09]
Other	1.39 [0.87–2.22] -	1.16 [0.75–1.80] -	0.73 [0.32–1.66] -	0.84 [0.45–1.57]	1.55 [0.84–2.88] -	1.09 [0.60–1.98]
White (reference)	–	–	–		–	
Ethnicity						
Hispanic	1.08 [0.93–1.25]	1.25* [1.10–1.41]	0.96 [0.78–1.18]	1.11 [0.94–1.30]	0.98 [0.79–1.02]	0.94 [0.79–1.12]
Number of Comorbidities						
0 (reference)	–	–	–	–	–	
1–2	1.27* [1.12–1.43]	1.43*[1.30–1.58]	1.47* [1.24–1.74]	1.09 [0.95–1.25]	1.33* [1.14–1.55]	0.97 [0.85–1.11]
3–4	1.54* [1.35–1.74]	1.74* [1.57–1.93]	1.92* [1.62–2.29]	1.31* [1.14–1.51]	1.15* [1.06–1.37]	1.22* [1.05–1.42]
5–6	2.06* [1.79–2.37]	2.04* [1.81–2.31]	2.63*[2.16–3.15]	2.00* [1.72–2.33]	1.39* [1.12–1.71]	1.62* [1.35–1.94]
7+	2.61* [2.28–2.99]	2.21*[1.95–2.50]	3.26* [2.71–3.91]	2.55* [2.20–2.95]	1.58*[1.29–1.94]	1.51* [1.24–1.83]
Hospitalized for COVID-19	2.66* [2.44–2.91]	1.38* [1.27–1.49]	2.14* [1.89–2.41]	3.21* [2.91–3.53]	1.02 [0.88–1.16]	2.03* [1.83–2.25]
Used rehabilitation pre-COVID-19	1.07 [0.94–1.22]	1.06 [0.95–1.18]	0.88 [0.73–1.05]	0.94 [0.81–1.08]	1.24* [1.02–1.46]	0.60* [0.51–0.71]

Note: Individuals who had an encounter with the specific condition within the 6-month period preceding their COVID positive test were excluded from the analyses of incident (new) sequelae. The regressions also include indicators for region of residence (South, Midwest, Northeast, West, unknown) and controls for unknown race and unknown ethnicity. An asterisk indicates odds ratios that are statistically significant at the $p < .05$ level.
COVID-19, coronavirus disease 2019.

during 2020. Of those, 54% were female, 43% were 40 years of age or younger, 9.8% were older than 70 years old, 18% were African American/Black and 13% were of Hispanic descent. COVID-19 survivors were generally healthy, with 69.9% having no comorbidities and less than 3% having impairment or disability that required receipt of outpatient rehabilitation services prior to their SARS-CoV-2 infection. Overall, slightly more than 10% required hospitalization to treat their acute COVID-19 infection and 2.1% received outpatient rehabilitation to treat post COVID-19 condition symptoms within 6 months following diagnosis.

The characteristics of the 406,630 COVID-positive individuals, the 8724 cases, and their 28,719 matched controls are shown in Table 1. As expected, COVID-19 survivors who used outpatient rehabilitation for treatment of post COVID-19 condition symptoms were more likely than the general population of COVID-19 survivors to have been hospitalized for COVID-19 (40.4% vs. 10.4%, $p < .001$). They also had more comorbidities than the general COVID-19-positive population, with 21.5% having five or more comorbid conditions. There were no significant differences between cases and the general population of COVID-19 survivors with respect to age, sex, race, ethnicity, or region of residence.

Although our 1:*n* matching scheme resulted in some imbalance across groups, there were no significant differences between cases and controls with respect to matching variables except in number of comorbidities (39.2% vs. 42.9%, respectively, $p < .001$) and prior use of outpatient rehabilitation services (16.4% vs. 11%, $p < .001$). With respect to characteristics not used in the matching process, unadjusted comparisons indicate that cases were significantly more likely to be White (58.2% vs. 50.4%, $p < .001$) and less likely to be African American/Black (17.7% vs. 21.8%, $p < .001$), more likely to be Hispanic (12.9% vs. 10.2%, $p < .01$), and markedly more likely to have been hospitalized for COVID-19 (40.4% vs. 15.6%, $p < .001$).

Race, ethnicity and use of post-COVID outpatient rehabilitation

ORs from the conditional logit model shown in Table 2 indicate that African American/Black COVID-19 survivors were significantly less likely (OR = 0.89; 95% CI: 0.84–0.96) than their white counterparts to receive outpatient rehabilitation, despite adjustments for severity of infection, comorbid conditions, and other potential confounders. There were no differences in the likelihood of rehabilitation utilization between White COVID-19 survivors and those who were Asian or of other races. Regardless of race, Hispanic individuals were significantly more likely (OR = 1.22; 95% CI: 1.11–1.33, $p < .001$) than non-Hispanic individuals to use outpatient rehabilitation for post COVID-19 condition symptoms. Finally, consistent with unadjusted findings, individuals who were hospitalized for their acute SARS-CoV-2 infection were nearly four times more likely (OR = 3.71; 95% CI: 3.50–3.93) than those with less severe disease to use rehabilitation during the 6 months after diagnosis.

Incidence of post COVID-19 condition symptoms

One possible explanation for the differential use of outpatient rehabilitation services by COVID-19 survivors of different races and ethnicities is the potential differential incidence of specific post COVID-19 condition symptoms. To examine this possibility, we first documented the incidence of six commonly reported COVID-related symptoms—weakness, fatigue, mobility problems, cognitive impairment, pain, and dyspnea—within our matched sample overall and by race/ethnicity (Table 3).

Of the symptoms considered, dyspnea was the most common reason to seek rehabilitation care after COVID-19 and affected 20.4% of COVID-19-positive individuals. This was followed by fatigue (12.4%), weakness (8.2%), and cognitive impairment (7.6%). This hierarchy held across all races and ethnicities.

As shown in Table 3, there were small but statistically significant differences by race in the incidence of COVID-related fatigue, weakness, mobility difficulties, cognitive impairment, and dyspnea, with White COVID survivors consistently reporting a higher incidence of post COVID-19 condition symptoms than African American/Black individuals and those of other races. Apart from dyspnea and fatigue, for which Hispanic individuals had a higher unadjusted incidence, post COVID-19 condition symptoms did not differ by ethnicity.

ORs from multivariable regressions shown in Table 4 indicate that, after controlling for comorbidities and other potential confounders, race was not associated with a differential incidence of any of the six post COVID-19 condition symptoms considered. In contrast, differences by ethnicity in the incidence of fatigue persisted despite control for possible confounders. Number of comorbidities and, in most cases, severity of acute infection as proxied by COVID-19 hospitalization were the only factors consistently associated with development of new cases of weakness, fatigue, mobility problems, cognitive impairment, pain, and dyspnea.

DISCUSSION

In this large and nationally representative study of outpatient rehabilitation utilization among individuals testing positive for SARS-CoV-2 in 2020, we found that, despite a similar incidence of common post COVID-19

condition symptoms, African American/Black individuals were significantly less likely to receive rehabilitation services than their White counterparts. This racial difference, which persisted despite adjustments for severity of infection, comorbid conditions, and other potential confounders, was not observed among other racial groups. With respect to ethnicity, our results reveal that individuals of Hispanic descent had a higher utilization of COVID-related outpatient rehabilitation services than their non-Hispanic counterparts. The higher utilization of COVID-related outpatient rehabilitation among Hispanic individuals may be explained, in part, by the higher incidence of post-COVID fatigue among this group of survivors—the one post-COVID symptom for which differences by ethnicity persisted after we controlled for potential confounders.

COVID-19 has been shown to lead to significant ongoing limitations in function, mobility, cognition, and quality of life.[1–4] In the current study, the incidence of six commonly reported post COVID-19 condition symptoms were explored in COVID-19 survivors who utilized outpatient rehabilitation services. Of these, dyspnea and fatigue were the most frequent symptoms documented within 6 months of COVID-19 infection, followed by weakness and cognitive impairment. These findings are consistent with previous literature on post COVID-19 condition that has found dyspnea, fatigue, and cognitive dysfunction among the most common persistent symptoms.[1,4,8,20]

There has been an increasing call for specialized, comprehensive rehabilitation care to improve function, neuropsychiatric deficits, and quality of life among COVID-19 survivors.[21,22] Significant functional gains have been demonstrated by those recovering from severe COVID-19 in the inpatient rehabilitation setting.[23–27] Although outcomes data for outpatient rehabilitation a sparse, expert guidance statements recommend the cautious inclusion of rehabilitation in the comprehensive care of certain individuals with post COVID-19 condition.[9–11] One prospective, observational cohort study investigating the impact of outpatient rehabilitation on the functioning of individuals with post COVID-19 condition found that those who completed 8 weeks of rehabilitation reported significant improvement in motor function, respiratory muscle strength, fatigue, and overall quality of life.[28] Larger scale prospective studies are currently underway to explore the long-term prognosis of individuals with post COVID-19 condition and to further elucidate the impact of outpatient rehabilitation.[29,30]

Our results revealed that African American/Black individuals had significantly lower rates of outpatient rehabilitation service utilization within 6 months after diagnosis with COVID-19 than individuals of any other race. The observed disparity persisted in a matched sample where cases and controls were tightly matched on age, sex, use of prior outpatient rehabilitation, and comorbidities. Although White individuals experienced slightly higher unadjusted rates of post COVID-19 symptoms, there were no significant racial differences in the incidence of post COVID-19 condition symptoms among COVID-19 survivors after controlling for confounders, such as comorbid conditions and severity of the acute infection. In contrast, African American/Black individuals utilized rehabilitation services at a lower rate despite experiencing similar levels of weakness, fatigue, mobility problems, cognitive impairment, pain, and dyspnea as White COVID-19 survivors.

Numerous studies have shown that African American/Black and Hispanic patients receive rehabilitation at lower rates than White patients across a variety of practice settings and diagnoses, with access to care impacted by a variety of factors including insurance status, type of insurance coverage, under-referral, transportation and other accessibility barriers, and racial bias.[28,31–34] In exploring rehabilitation services for COVID-19, Ambrose et al. (2021) found that during acute hospitalization for COVID-19, African American/Black patients received inpatient physical therapy services less frequently than patients of any other race despite similar comorbidity scores.[35] Research exploring the predictive demographic factors for post COVID-19 condition and therapy utilization is limited, in some cases by lack of robust demographic information available at the time of data collection.[36] However, racial minority status has been associated with greater persistent breathlessness after COVID-19 infection independent of previous intensive care unit admission, ventilation requirements, pre-existing lung conditions, higher body mass index (BMI), and older age, a finding that stands in contrast with our results based on a large and geographically diverse sample of post-COVID outpatient rehabilitation users.[7] In a cross-sectional study of COVID-19 survivors in Michigan, Robinson-Lane et al. (2021) found that African American/Black individuals reported the lowest physician follow-up rates and longer return-to-work delays than individuals of any other race.[37] This raises the concern that individuals already at higher risk of COVID-19 infection are also at a higher risk of having unmet social and employment needs following their acute infection.[38] Thus untreated post COVID-19 condition may further compound economic as well as health inequities.

It is unsurprising that the number of comorbidities and hospitalization for COVID-19 were associated with increased incidence of post COVID-19 condition symptoms, with hospitalization as the strongest association by far. This is consistent with previous studies that show individuals with worse baseline health status are more likely to experience severe COVID-19 and hospitalization, and that those who experience a greater total number of COVID-19 symptoms or higher levels of care are more likely to experience persistent symptoms.[1,7,8] It is also possible that individuals hospitalized with

COVID-19 benefit from early connection and referral to outpatient rehabilitation services on discharge compared to those who are not hospitalized.

Despite controlling for comorbidities, age, sex, and geographic differences across cases and controls, it is possible that other, unmeasured confounders, such as insurance coverage, may have contributed to the differences in rehabilitation utilization across individuals of different races. At the time of our study, the insurance status of patients in the TriNetX database was limited to a small percentage of hospitalized individuals and absent among individuals who were not hospitalized in 2020. Reliance on these largely incomplete and skewed data would have introduced biases, as the information was restricted to individuals with the most severe COVID-19 cases, who required hospitalization for treatment of their SARS-CoV-2 infection. Although this limitation may have contributed to some of the observed disparity in utilization of rehabilitation services for post COVID-19 condition in our sample, our findings are consistent with those of previous studies assessing racial differences in rehabilitation utilization for a variety of conditions, which have consistently reported that African American/Black patients underutilize or are under-referred to therapy services relative to their White counterparts, even after controlling for insurance coverage and socioeconomic status.[28,31,34]

Other important limitations merit comment. Our sample selection strategy relied on evidence of a COVID-positive test. For this reason, our study excludes individuals with COVID-19 infection for whom there was no electronic health record documentation of a positive test. Therefore, our study is not generalizable to the entire population of COVID-19 survivors but rather represents a lower bound of COVID survivors at risk for post COVID-19 condition. Data limitations also precluded us from examining the experience of other minority racial groups and multiracial individuals. Finally, individuals 70 years of age or older, who comprised <10% of COVID survivors in the 2020 TriNetX database, appear to be underrepresented in our study, possibly due to a high inpatient COVID-19 mortality rate in this age group.[39] As a result, our findings may not fully capture rehabilitation use patterns among older adults surviving COVID-19, particularly as survival rates improve.

CONCLUSION

COVID-19 has disproportionately affected racial minorities and amplified conversations about long-existing disparities in health care. To our knowledge, this is the first study that directly demonstrates a racial disparity in the use of rehabilitation services following COVID-19, with lower rates of outpatient rehabilitation utilization among African American/Black individuals, despite these individuals experiencing similar rates of post COVID-19 condition symptoms. Although vaccination rates have been increasing across the United States, the number of individuals with post COVID-19 condition may continue to rise in the face of new waves of COVID-19 and the spread of new variants. This may be especially true among unvaccinated, partially vaccinated, immunocompromised, and otherwise vulnerable populations who are more likely to develop acute and severe COVID-19 infections.[40,41] Racial differences in outpatient rehabilitation use and potentially unmet needs during recovery may further exacerbate the disproportionate harm COVID-19 has wrought on African American/Black individuals and communities in the United States.[17,18] This supports the need for further research exploring barriers to rehabilitation services and subsequent interventions to overcome racial inequities in rehabilitation access.

AUTHOR CONTRIBUTIONS

Claudia B. Hentschel, Benjamin A. Abramoff, Timothy R. Dillingham, and Liliana E. Pezzin contributed to the design, implementation of the research, analysis of the results, and writing of the manuscript.

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DISCLOSURES

The authors have no conflicts of interest to disclose related to this work.

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REFERENCES

1. Ramanathan K, Antognini D, Huang C, et al. 6-month consequences of COVID-19 in patients discharged from hospital: a cohort study. *Lancet*. 2021;397(1):220-232.
2. Lopez-Leon S, Wegman-Ostrosky T, Perelman C, et al. More than 50 long-term effects of COVID-19: a systematic review and meta-analysis. *Sci Rep*. 2021;11(1):16144. doi:10.1038/s41598-021-95565-8
3. Nalbandian A, Sehgal K, Gupta A, et al. Post-acute COVID-19 syndrome. *Nat Med*. 2021;27(4):601-615. doi:10.1038/s41591-021-01283-z
4. Groff D, Sun A, Ssentongo AE, et al. Short-term and long-term rates of Postacute sequelae of SARS-CoV-2 infection. *JAMA Netw Open*. 2021;4(10):e2128568. doi:10.1001/jamanetworkopen.2021.28568
5. World Health Organization. A clinical case definition of post COVID-19 condition by a Delphi consensus 2021 (October):27. file:///C:/Users/pbradley/Downloads/WHO-2019-nCoV-Post-COVID-19-condition-Clinical-case-definition-2021.1-eng.pdf.
6. Negrini F, de Sire A, Andrenelli E, Lazzarini SG, Patrini M, Ceravolo MG. Rehabilitation and COVID-19: update of the rapid living systematic review by cochrane rehabilitation field as of

April 30, 2021. *Eur J Phys Rehabil Med*. 2021;57(4):663-667. doi:10.23736/S1973-9087.21.07125-2
7. Halpin SJ, McIvor C, Whyatt G, et al. Postdischarge symptoms and rehabilitation needs in survivors of COVID-19 infection: a cross-sectional evaluation. *J Med Virol*. 2021;93(2):1013-1022. doi:10.1002/jmv.26368
8. Sudre CH, Murray B, Varsavsky T, et al. Attributes and predictors of long COVID. *Nat Med*. 2021;27(4):626-631. doi:10.1038/s41591-021-01292-y
9. Herrera JE, Niehaus WN, Whiteson J, et al. Multidisciplinary collaborative consensus guidance statement on the assessment and treatment of fatigue in postacute sequelae of SARS-CoV-2 infection (PASC) patients. *Pm R*. 2021;13(9):1027-1043. doi:10.1002/pmrj.12684
10. Center for Disease Control Management of Post-COVID conditions: evaluating and caring for patients with post-COVID conditions: interim guidance. 2021. https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-care/post-covid-management.html#print
11. Venkatesan P. NICE guideline on long COVID as. *Lancet*. 2020;9(1):128-129.
12. Stokes EK, Zambrano LD, Anderson KN, et al. Coronavirus disease 2019 case surveillance — United States, January 22–May 30, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(24):759-765. doi:10.15585/mmwr.mm6924e2
13. Killerby ME, Link-Gelles R, Haight SC, et al. Characteristics associated with hospitalization among patients. *Morb Mortal Wkly Rep Charact*. 2020;69(25):790-794.
14. Patel A, Abdulaal A, Ariyanayagam D, et al. Investigating the association between ethnicity and health outcomes in SARS-CoV-2 in a London secondary care population. *PloS One*. 2020;15(10):e0240960. doi:10.1371/journal.pone.0240960
15. Razjouyan J, Helmer DA, Li A, et al. Differences in COVID-19-related testing and healthcare utilization by race and ethnicity in the veterans health administration. *J Racial Ethn Heal Disparities*. 2021;9:519-526. doi:10.1007/s40615-021-00982-0
16. Baggett TP, Keyes H, Sporn N, Gaeta JM. Prevalence of SARS-CoV-2 infection in residents of a large homeless shelter in Boston. *JAMA — J Am Med Assoc.* 2020;323(21):2191-2192. doi:10.1001/jama.2020.6887
17. Muñoz-Price LS, Nattinger AB, Rivera F, Hanson R, Gmehlin CG, Perez A. Racial disparities in incidence and outcomes among patients with COVID-19. *JAMA Netw Open*. 2020;3(9):1-13. doi:10.1001/jamanetworkopen.2020.21892
18. Escobar GJ, Adams AS, Liu VX, et al. Racial disparities in COVID-19 testing and retrospective cohort study in an integrated health system. *Ann Intern Med*. 2021;174(6):786-793. doi:10.7326/M20-6979
19. Southern DA, Quan H, Ghali WA. Comparison of the Elixhauser and Charlson/Deyo methods of comorbidity measurement in administrative data. *Med Care*. 2004;42(4):355-360.
20. Halpin S, O'Connor R, Sivan M. Long COVID and chronic COVID syndromes. *J Med Virol*. 2021;93(3):1242-1243. doi:10.1002/jmv.26587
21. Curci C, Negrini F, Ferrillo M, et al. Functional outcome after inpatient rehabilitation in postintensive care unit COVID-19 patients: findings and clinical implications from a real-practice retrospective study. *Eur J Phys Rehabil Med*. 2021;57(3):443-450. doi:10.23736/S1973-9087.20.06660-5
22. Agostini F, Mangone M, Ruiu P, Paolucci T, Santilli V, Bernetti A. Rehabilitation settings during and after COVID-19: an overview of recommendations. *J Rehabil Med*. 2021;53(1):jrm00141. doi:10.2340/16501977-2776
23. Puchner B, Sahanic S, Kirchmair R, et al. Beneficial effects of multi-disciplinary rehabilitation in postacute COVID-19: an observational cohort study. *Eur J Phys Rehabil Med*. 2021;57(2):189-198. doi:10.23736/S1973-9087.21.06549-7
24. Abramoff BA, Dillingham TR, Caldera FE, Ritchie MD, Pezzin LE. Inpatient rehabilitation outcomes after severe COVID-19 infections. *Am J Phys Med Rehabil*. 2021;100(12):1109-1114. doi:10.1097/phm.0000000000001885
25. Olezene CS, Hansen E, Steere HK, et al. Functional outcomes in the inpatient rehabilitation setting following severe COVID-19 infection. *PloS One*. 2021;16(3):e0248824. doi:10.1371/journal.pone.0248824
26. Groah SL, Pham CT, Rounds AK, Semel JJ. Outcomes of patients with COVID-19 after inpatient rehabilitation. *Pm R*. 2021;14:202-209. doi:10.1002/pmrj.12645
27. Journeay WS, Robinson LR, Titman R, MacDonald SL. Characteristics and outcomes of COVID-19-positive individuals admitted for inpatient rehabilitation in Toronto, Canada. *J Rehabil Med Clin Commun*. 2021;29(4):2-7. doi:10.2340/20030711-1000053
28. Roth WM, Lee YJ, Hsu PL. University of Pennsylvania Libraries N. *Compend Newt PA*. 2010;17(3):147-156. doi:10.1080/01425690701737481
29. Bek LM, Berentschot JC, Hellemons ME, et al. CO-FLOW: Covid-19 follow-up care paths and long-term outcomes within the Dutch health care system: study protocol of a multicenter prospective cohort study following patients 2 years after hospital discharge. *BMC Health Serv Res*. 2021;21(1):1-10. doi:10.1186/s12913-021-06813-6
30. Evans RA, Mcauley H, Harrison EM, et al. Physical, cognitive, and mental health impacts of COVID-19 after hospitalisation (PHOSP-COVID): a UKmulticentre, prospective cohort study. *Lancet*. 2021;9:1275-1287. doi:10.1016/S2213-2600(21)00383-0
31. Keeney T, Jette AM, Freedman VA, Cabral H. Racial differences in patterns of use of rehabilitation Services for Adults Aged 65 and older. *J Am Geriatr Soc*. 2017;65(12):2707-2712. doi:10.1111/jgs.15136
32. Graham JE, Chang PFJ, Bergés IM, Granger CV, Ottenbacher KJ. Race/ethnicity and outcomes following inpatient rehabilitation for hip fracture. *J Gerontol — Ser A Biol Sci Med Sci*. 2008;63(8):860-866. doi:10.1093/gerona/63.8.860
33. Carter SK, Rizzo JA. Use of outpatient physical therapy services by people with musculoskeletal conditions. *Phys Ther*. 2007;87(5):497-512. doi:10.2522/ptj.20050218
34. Bartley CN, Atwell K, Cairns B, Charles A. Racial and ethnic disparities in discharge to rehabilitation following burn injury. *J Burn Care Res*. 2019;40(2):143-147. doi:10.1093/jbcr/irz001
35. Ambrose AF, Kurra A, Tsirakidis L, et al. Rehabilitation and in-hospital mortality in COVID-19 patients. *J Gerontol Soc Am*. 2019;77(4):e148-e154.
36. Rogers-Brown JS, Wanga V, Okoro C, et al. Outcomes among patients referred to outpatient rehabilitation clinics after COVID-19 diagnosis — United States, January 2020–march 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70(27):967-971. doi:10.15585/mmwr.mm7027a2
37. Robinson-lane SG, Sutton NR, Chubb H. Race, ethnicity, and 60-day outcomes after hospitalization with COVID-19. *JAMDA*. 2020;22(1):2245-2250. doi:10.1016/j.jamda.2021.08.023
38. Frieden TR, Harold Jaffe DW, Director for Science, et al. Surveillance of health status in minority communities — racial and ethnic Centers for Disease Control and Prevention MMWR editorial and production staff MMWR editorial board. *Centers Dis Control Prev Morb Mortal Wkly Rep*. 2011;60(6):1-44. https://www.cdc.gov/mmwr/pdf/ss/ss6006.pdf
39. Henkens MTHM, Raafs AG, Verdonschot JAJ, et al. Age is the main determinant of COVID-19 related in-hospital mortality with

minimal impact of pre-existing comorbidities, a retrospective cohort study. *BMC Geriatr*. 2022;22(1):1-11. doi:10.1186/s12877-021-02673-1

40. Rubin R. COVID-19 vaccines vs variants — determining how much immunity is enough. *JAMA — J Am Med Assoc*. 2021;325(13):1241-1243. doi:10.1001/jama.2021.3370
41. Centers for Disease Control and Prevention. COVID-NET: A Weekly Summary of U.S. COVID-19 Associated Hospitalizations.

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