Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Original Article

COVID-19 clinical outcomes by patient disability status: A retrospective cohort study

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ABSTRACT

Background: People with disabilities might experience worse clinical outcomes of SARS-CoV-2 infection, but evidence is limited.
Objective: To investigate if people with disabilities requiring assistance are more likely to experience severe COVID-19 or death.
Methods: Data from the Johns Hopkins COVID-19 Precision Medicine Analytics Platform Registry (JH-CROWN) included 6494 adult patients diagnosed with COVID-19 and admitted between March 4, 2020 −October 29, 2021. Severe COVID-19 and death were defined using the occurrence and timing of clinical events. Assistive needs due to disabilities were reported by patients or their proxies upon admission. Multivariable-adjusted Cox proportional hazards models were used to examine the associations between disability status and severe COVID-19 or death. Primary models adjusted for demographics and secondary models additionally adjusted for clinical covariates.
Results: In this clinical cohort (47−73 years, 49% female, 39% Black), patients with disabilities requiring assistance had 1.35 times (95% confidence interval [CI]:1.01, 1.81) the hazard of severe COVID-19 among patients <65 years, but not among those ≥65 years, equating to an additional 17.5 severe COVID-19 cases (95% CI:7.7, 28.2) per 100 patients. A lower risk of mortality was found among patients <65 years, but this finding was not robust due to the small number of deaths.
Conclusions: People with disabilities requiring assistance aged <65 years are more likely to develop severe COVID-19. Although our study is limited by using a medical model of disability, these analyses intend to further our understanding of COVID-19 outcomes among people with disabilities. Also, standardized disability data collection within electronic health records is needed.

Approximately 67 million or one in four US adults over the age of 18 has a disability.[1] People with disabilities are at increased risk of SARS-CoV-2 infection and poorer COVID-19 outcomes due to living in congregate care settings, having a higher prevalence of underlying health conditions, and facing disparities in healthcare.[2] Identifying inequities in the COVID-19 response for people with disabilities is critical, and data examining the COVID-19 healthcare experiences and clinical outcomes of people with disabilities are needed to more fully understand how the pandemic has impacted people with disabilities.

Large-scale population-based studies conducted in countries

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with national healthcare systems have reported associations between disability status and COVID-19-related hospital admission and death.[3–7] But due to a lack of standardized collection of disability data in healthcare settings, most previous US-based studies have used data from registries of residents in congregate care settings, recipients of disability-related services, or publicly available administrative data.[8–12] As a result, there is a paucity of detailed clinical information to characterize the healthcare experiences and capture COVID-19-related clinical events for people with disabilities.[13–15]

To address these gaps, we conducted a retrospective cohort study using electronic health record (EHR) inpatient data from five hospitals in the Maryland/Washington D.C. region to investigate whether disability, defined as the need for assistive care during emergency department (ED) encounters, is associated with the risk of severe COVID-19 or mortality.

Methods

Study population

The Johns Hopkins COVID-19 Precision Medicine Analytics Platform Registry (JH-CROWN) is a database that includes comprehensive clinical information (demographics, admission, discharge, transfer, diagnoses, laboratory results, medications, procedures, social history, and clinical notes) on patients having suspected or confirmed SARS-CoV-2 infection from the Johns Hopkins Medicine System.[16,17] This healthcare system includes five hospitals (Johns Hopkins Hospital, Baltimore, Maryland; Bayview Hospital, Baltimore, Maryland; Howard County General Hospital, Columbia, Maryland; Suburban Hospital, Bethesda, Maryland; and Sibley Hospital, Washington, D.C.) serving around seven million people in the Maryland/Washington D.C. area and has over 2000 beds and approximately 300 thousand annual emergency visits.[16]

Patients aged ≥18 years diagnosed with COVID-19 and admitted to the Johns Hopkins Medicine System through EDs between March 4, 2020 and October 29, 2021 were included in this study. The Johns Hopkins Medical Institutions institutional review board approved the study as minimal risk and waived informed consent requirements.

COVID-19 disease severity and mortality

The primary outcomes for this study are the development of severe COVID-19 and death. These outcomes were defined at the time of peak severity based on flowsheets in JH-CROWN that capture clinical events, including respiratory and organ support, as well as mortality. Severe COVID-19 was defined as receipt of high-flow nasal cannula (HFNC), non-invasive positive pressure ventilation (NIPPV), intubation and mechanical ventilation (IMV), or other signs of organ failure (hemodialysis, vasopressors, or extracorporeal membrane oxygenation [ECMO]).[18] Corresponding dates of symptom onset, admission, development of outcomes, and discharge were also captured.

Disability status

Patients or their proxies presenting to the Johns Hopkins ED were asked by the clinical staff about their assistive needs due to disabilities. Patients were defined as having disabilities requiring assistance if they reported any assistive needs due to vision, hearing, cognitive, developmental, physical/mobility, or respiratory difficulties. And patients reported none of the assistive needs served as our reference group. Details of the question are included in eMethods.

Other covariates

Patient demographics included age (continuous in years), sex (male; female), race/ethnicity (White; Black; other [American Indian or Alaska Native, Asian, Hispanic, Native Hawaiian or other Pacific Islander, other]), and marital status (married; single; other [widowed, divorced, legally separated, significant other, other]). Admission source was categorized as community; skilled nursing facility, intermediate care facility, or assisted living facility; other sources (e.g., healthcare facilities).

Do-not-resuscitate (DNR)/do-not-intubate (DNI) is the physician order chosen by patients based on their wishes to limit healthcare providers' resuscitation actions in the case of cardiac or respiratory arrest. DNR/DNI status was recorded as no DNR/DNI, DNR/DNI on admission, DNR/DNI within 24 h of admission, and DNR/DNI >24 h of admission. Given that the DNR/DNI status during hospitalization might be complicated by disease progression instead of reflecting patients' wishes to restrict the healthcare they receive, we primarily considered DNR/DNI on admission (Yes/No).[19,20]

Body mass index (BMI, kg/m^2) was calculated using measured height and weight and analyzed continuously. The BMI measure closest to the admission date was included for analysis (93% had BMI measure within [−60, 2] days of admission date). Comorbid conditions assessed for computing the modified Charlson Comorbidity Index (mCCI) included acute myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic obstructive pulmonary disease, rheumatoid disease, peptic ulcer disease, liver disease, diabetes mellitus, hemiplegia/paraplegia, renal disease, cancer and metastatic solid tumor, and AIDS/HIV based on ICD-10 codes, and each condition was assigned a weight based on mortality risk and resource use.[21,22] For analysis, mCCI was categorized as 0, 1–2, 3–4, and ≥5.

The administration of medications to treat COVID-19, including remdesivir, dexamethasone, and tocilizumab, was recorded. COVID-19 vaccination status was also obtained to determine whether patients were fully vaccinated (14 days after receiving the second dose) when they were admitted. Patients were categorized as being fully vaccinated on admission (date of being fully vaccinated earlier than the admission date) or not fully vaccinated on admission (second dose not completed or fully vaccinated after the admission date).

Statistical analysis

Descriptive analysis

Patient characteristics were described and compared using Wilcoxon rank-sum test for continuous variables and Pearson's chi-squared test for categorical variables.

Severe COVID-19

Among patients who did not have severe COVID-19 on admission, we estimated the hazard ratios (HR) of developing severe COVID-19 during hospitalization associated with having disabilities requiring assistance using multivariable-adjusted Cox proportional hazards models. The origin was time of admission. Censoring events were discharge without severe COVID-19. The proportional hazards assumption was assessed using the Schoenfeld residuals. The linearity assumption was assessed by graphical representation. To directly estimate the risk ratios, we also ran multivariable-adjusted Poisson regression with robust standard errors.

Considering that clinical procedures received by patients with DNR/DNI on admission are limited and thus could impact COVID-19 disease severity during hospitalization, we excluded 241 patients with a DNR/DNI order on admission from our primary analyses. In

addition, as supported by exploratory data analysis and prior evidence that older adults experience worse COVID-19 outcomes, our primary analyses were stratified by age (18–64 years vs. ≥65 years).[23]

Cox models yield estimates on the multiplicative scale. Given that the additive scale is more relevant to public health decision-making, we also estimated the risk differences.[24] We used marginal standardization, which fits separate logistic regression models in each exposure group (i.e., any disability and no disability) to obtain the predicted risk.[25]

In our primary models (model 1), we adjusted for age in years (within age-stratified groups), sex, race/ethnicity, marital status, and admission source. In secondary models (model 2), we additionally adjusted for BMI and mCCI. Given that the clinical covariates in model 2 may be a consequence of disability status, and therefore potential mediators of the relationship between disability status and COVID-19 clinical outcomes, model 1 was specified a priori as the primary model for inference.[26,27]

Mortality

The methods used to estimate the association between disabilities requiring assistance and mortality are the same as those described above for severe COVID-19, except that 375 patients with severe COVID-19 on admission were included in this analysis.

Sensitivity analyses

We conducted several sensitivity analyses: (1) We estimated associations of having disabilities requiring assistance with death for 241 patients with DNR/DNI on admission; (2) We estimated associations between having disabilities requiring assistance and severe COVID-19 on admission, as these patients were excluded when analyzing severe COVID-19 during hospitalization; (3) As many residents in nursing homes and assisted living facilities have disabilities and living in these facilities is associated with worse COVID-19 outcomes, we restricted our analytical sample to patients admitted from the community (over 80%)[28]; (4) With the availability of COVID-19 vaccines in December 2020 and the mass immunization efforts, we investigated if the observed associations varied by year of admission (2020/2021) in the regression models. We also restricted our sample to patients not fully vaccinated on admission (over 95%) to investigate if vaccination status changed our observed associations; (5) To better capture patients' clinical experiences, time between symptom onset and admission (only 40% of patients who got tested within the hospital system have available data) as well as the use of medications were described and compared among patients having any vs. no assistive needs due to disabilities.

Analyses were conducted using Stata version 17.0 (Stata Corporation, College Station, TX) and R, Version 4.0.2 (R Foundation for Statistical Computing, Vienna, Austria). A two-sided *P*-value <0.05 was considered statistically significant.

Results

Derivation of the analytic samples

Among 6494 patients aged ≥18 years diagnosed with COVID-19 and admitted to the Johns Hopkins Medicine System through ED between March 4, 2020 and October 29, 2021, we excluded 5 patients with missing disability data, 42 with missing COVID-19 outcomes, 241 with missing covariates (age, N = 1; race/ethnicity, N = 35; marital status, N = 198; admission source, N = 7), and 241 with DNR/DNI on admission. When examining mortality, we included 5965 patients in the primary model (demographics) and 4966 in the secondary model (demographics and clinical covariates). When examining severe COVID-19, an additional 375 patients admitted with severe COVID-19 were excluded, leaving a final analytical sample of 5590 patients in the primary model and 4667 in the secondary model (eFig. 1).

Descriptive analysis

Of the 5965 patients in our primary analysis, the median age was 61 years (25th–75th percentiles, 47–73 years; 58% < 65 years), 49% were female, 39% were Black, 84% were admitted from the community, and 74% had at least one comorbidity. Overall, 375 (6%) of patients had severe COVID-19 on admission, 1174 (21%) patients developed severe COVID-19 during hospitalization, and 495 (8%) died (Table 1). The median length of stay was 5.0 days and was longer among patients having disabilities requiring assistance (6.7 days) when compared to those without assistive needs (4.9 days), and this difference comparing having any vs. no assistive needs due to disabilities was observed among patients aged <65 years (6.2 vs. 4.2 days) but not among patients aged ≥65 years (6.7 vs. 6.3 days).

A total of 546 (9%) patients reported disabilities requiring assistance; 199 aged <65 years and 347 aged ≥65 years (Table 1). The most common disabilities reported included physical/mobility difficulties only (N = 290), followed by cognitive only (N = 60), respiratory only (N = 50), hearing only (N = 42), developmental only (N = 22), and vision only (N = 13). A total of 69 patients reported multiple disabilities. Older patients had higher proportions of hearing, cognitive, and multiple disabilities, but lower proportions of vision, developmental, physical/mobility, and respiratory disabilities (eTable 1).

Patients with disabilities requiring assistance were older, more likely to self-identify as White and have comorbidities, and less likely to be married and admitted from the community, when compared to patients without disabilities requiring assistance (Table 1).

Severe COVID-19

Figure 1 presents the number and proportion of patients who developed severe COVID-19 by disability status and age. For patients aged <65 years, there were two peaks in the absolute number of severe COVID-19 cases, approximately during April to May 2020 and November 2020 to April 2021. The proportions of admitted patients who developed severe COVID-19 were higher during these peak times, especially among patients with disabilities requiring assistance. For patients aged ≥65 years, the timing of the peaks in the absolute number of severe COVID-19 was similar, but the proportion of patients having severe COVID-19 generally remained constant.

The median time from admission to severe COVID-19 was 1.0 days, with a shorter median time among the younger age group (0.8 vs. 1.5 days for <65 and ≥ 65 years, respectively). For both age groups, the estimated time to severe symptoms was similar comparing any vs. no assistive needs due to disabilities (<65 years, 1.1 vs. 0.8 days; ≥65 years, 1.3 vs. 1.5 days).

People with disabilities requiring assistance had a 35% (HR: 1.35, 95% confidence interval [CI]: 1.01, 1.81) increased hazard of developing severe COVID-19 among patients aged <65 years (Table 2), equating to an excess of 17.5 severe COVID-19 cases (95% CI: 7.7, 28.2) per 100 patients (eTable 2). Adjustment for BMI and comorbidities attenuated the estimates (HR: 1.21, 95% CI: 0.88, 1.66). Results were consistent when risk ratios were estimated (eTable 3). No association was observed for older patients.

Table 1
Patient characteristics by disability status and age.

Characteristic		Overall N = 5965 (100%)	Age <65 years N = 3439 (58%)		Age ≥65 years N = 2526 (42%)	
			Any disability[a] N = 199 (6%)	No disability N = 3240 (94%)	Any disability[a] N = 347 (14%)	No disability N = 2179 (86%)
Age, median (IQR), year		61 (47, 73)	57 (44, 61)	49 (38, 58)	78 (71, 85)	75 (70, 83)
Female, no. (%)		2924 (49.0)	95 (47.7)	1550 (47.8)	173 (49.9)	1106 (50.8)
Race/ethnicity, no. (%)	White	2165 (36.3)	64 (32.2)	818 (25.2)	184 (53.0)	1099 (50.4)
	Black	2319 (38.9)	118 (59.3)	1387 (42.8)	138 (39.8)	676 (31.0)
	Other	1481 (24.8)	17 (8.5)	1035 (31.9)	25 (7.2)	404 (18.5)
Marital status, no. (%)	Married	2502 (41.9)	36 (18.1)	1373 (42.4)	120 (34.6)	973 (44.7)
	Single	2139 (35.9)	131 (65.8)	1478 (45.6)	81 (23.3)	449 (20.6)
	Widowed/divorced/separated/ other	1324 (22.2)	32 (16.1)	389 (12.0)	146 (42.1)	757 (34.7)
Admission source, no. (%)	Community	4994 (83.7)	168 (84.4)	2913 (89.9)	239 (68.9)	1674 (76.8)
	ALF/ICF/SNF	449 (7.5)	14 (7.0)	44 (1.4)	73 (21.0)	318 (14.6)
	Other	522 (8.8)	17 (8.5)	283 (8.7)	35 (10.1)	187 (8.6)
Body mass index, median (IQR), kg/m^2		29.0 (24.7, 34.5)	29.6 (24.0, 38.4)	31.0 (26.5, 36.7)	26.5 (22.5, 31.0)	26.9 (23.5, 31.1)
Modified Charlson Comorbidity Index[b], no. (%)	0	1553 (26.0)	12 (6.0)	1226 (37.8)	15 (4.3)	300 (13.8)
	1–2	1940 (32.5)	48 (24.1)	1196 (36.9)	80 (23.1)	616 (28.3)
	3–4	959 (16.1)	42 (21.1)	345 (10.6)	76 (21.9)	496 (22.8)
	≥5	1513 (25.4)	97 (48.7)	473 (14.6)	176 (50.7)	767 (35.2)
Severe COVID-19, no. (%)	On admission	375 (6.3)	11 (5.5)	167 (5.2)	21 (6.1)	176 (8.1)
	During hospitalization	1174 (21.0)	54 (28.7)	547 (17.8)	69 (21.2)	504 (25.2)
Death, no. (%)		495 (8.3)	7 (3.5)	125 (3.9)	50 (14.4)	313 (14.4)

Abbreviations: ALF, assisted living facility; ICF, intermediate care facility; SNF, skilled nursing facility; IQR, interquartile range.
[a] Disability was defined as assistive needs reported due to vision, hearing, cognitive, developmental, physical/mobility, or respiratory difficulties.
[b] Comorbid conditions included acute myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic obstructive pulmonary disease, rheumatoid disease, peptic ulcer disease, liver disease, diabetes mellitus, hemiplegia/paraplegia, renal disease, cancer and metastatic solid tumor, and AIDS/HIV.

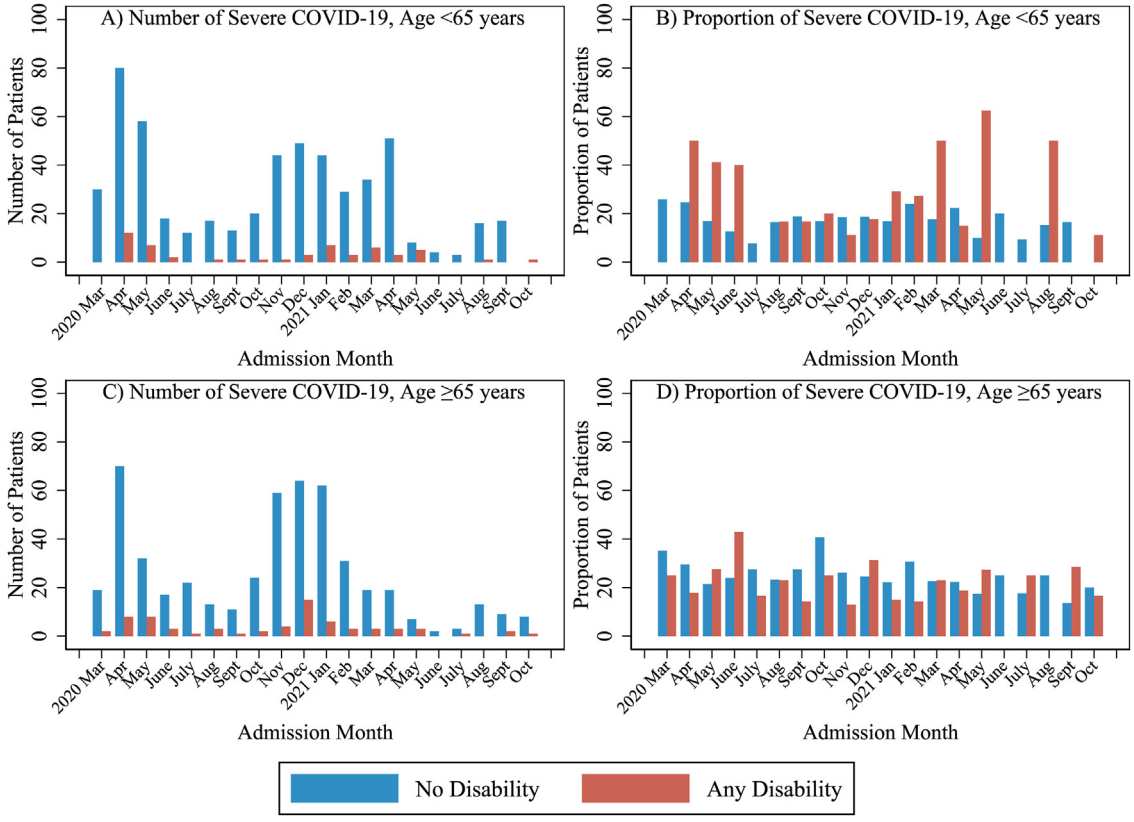

Fig. 1. Number and proportion of patients admitted and developed severe COVID-19 by disability status and age over time.
(A) Number of patients aged <65 years developed severe COVID-19 by admission month; (B) Proportion of patients aged <65 years developed severe COVID-19 (number with severe COVID-19/number admitted) over admission month; (C) Number of patients aged ≥65 years developed severe COVID-19 over admission month; (D) Proportion of patients aged ≥65 years developed severe COVID-19 (number with severe COVID-19/number admitted) by admission month.

Table 2
Hazard ratios and 95% confidence intervals (CI) of the associations between disability status and severe COVID-19 by age among patients without DNR/DNI on admission.

	Age group	$N_{Severe\ COVID\text{-}19}/N_{Total}$	Hazard ratios (95% CI)
Model 1[a]	<65 years	547/3073	Reference
		54/188	**1.35 (1.01, 1.81)**[c]
	≥65 years	504/2003	Reference
		69/326	0.84 (0.65, 1.09)
Model 2[b]	<65 years	485/2528	Reference
		48/159	1.21 (0.88, 1.66)
	≥65 years	453/1694	Reference
		64/286	0.80 (0.62, 1.05)

Abbreviations: DNR/DNI, do-not-resuscitate/do-not-intubate.
[a] Model 1: Adjusted for age, sex, race/ethnicity, marital status, and admission source.
[b] Model 2: Adjusted for age, sex, race/ethnicity, marital status, admission source, modified Charlson comorbidity index, and body mass index.
[c] P-value <0.05

Mortality

Figure 2 presents the number and proportion of patients who died by disability status and age. The number of COVID-19-related deaths among younger patients was small. There were two peak times of deaths among older patients: April to May 2020 and November 2020 to January 2021.

The median time to death was 11.1 days post-admission, with a shorter median time among the older age group (13.4 vs. 10.5 days for <65 and ≥ 65 years, respectively) and was similar comparing any vs. no assistive needs due to disabilities groups in both age groups (<65 years, 14.4 vs. 13.4 days; ≥65 years, 10.4 vs. 10.5 days).

Contrary to our hypothesis, having disabilities requiring assistance was associated with a lower hazard of mortality among younger patients (HR: 0.43, 95% CI: 0.20, 0.93, Table 3). Similar results were found when risk ratios were estimated (eTable 4). However, the number of deaths was small among patients with disabilities requiring assistance (N = 7). And this observation did not hold when different age cut-off points were used. When we examined patients aged 50–60 years and 60–70 years, an unexpectedly higher proportion of deaths were found among patients without disabilities requiring assistance (eFig. 2). In secondary analyses defining the younger group as patients aged <60 years, no association was found (HR: 0.67, 95% CI: 0.27, 1.70, eTable 5). No differences in mortality by disability status were observed for older patients.

Sensitivity analyses

Compared to patients without DNR/DNI on admission, 241 patients with DNR/DNI were older and were more likely to be female; White race; widowed, divorced, or separated; admitted from a skilled nursing, intermediate care, or assisted living facility; and to have a higher comorbidity index. 23% of patients with a DNR/DNI on admission had disabilities requiring assistance, compared to 9% of patients without DNR/DNI (eTable 6). Having disabilities requiring assistance was not associated with an increased risk of death among patients with DNR/DNI (eTable 7).

We did not find an association between having disabilities requiring assistance and severe COVID-19 on admission (eTable 8). When restricting to patients admitted from the community, results remained similar, though only borderline significance was found in

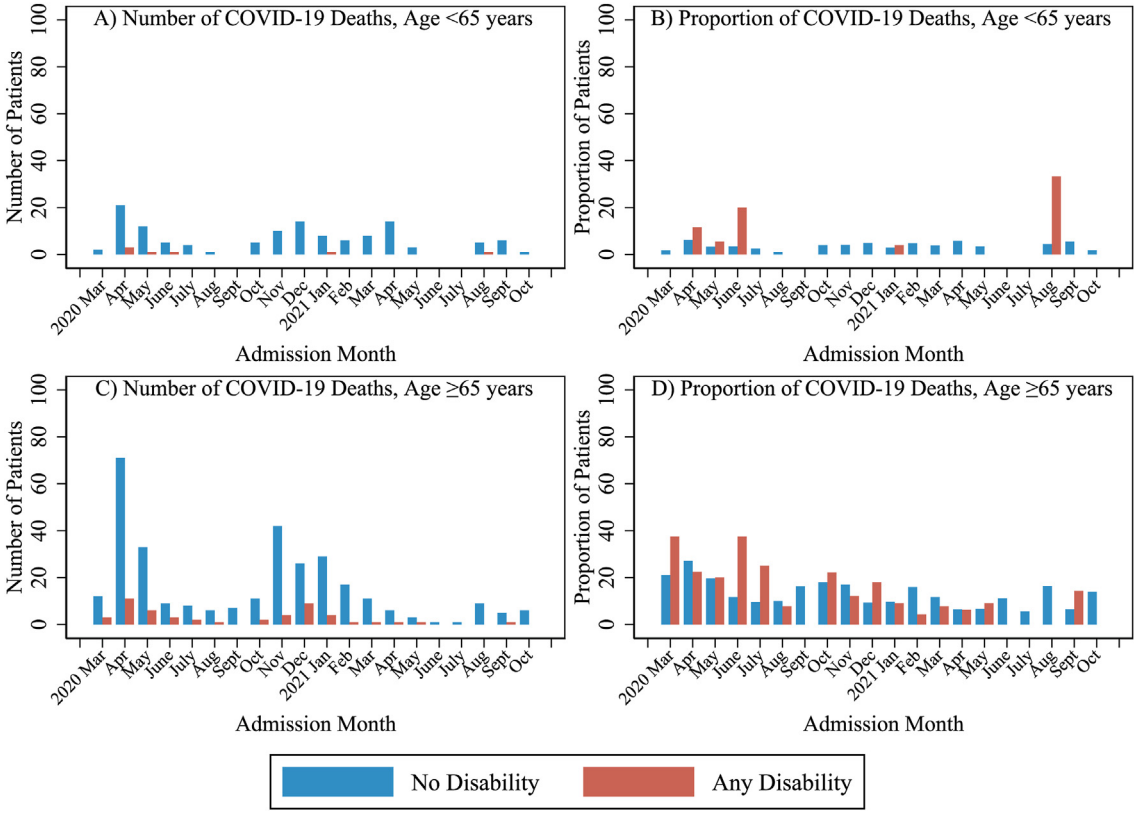

Fig. 2. Number and proportion of patients admitted and died by disability status and age over time.
(A) Number of patients aged <65 years died over admission month; (B) Proportion of patients aged <65 years died (number died/number admitted) over admission month; (C) Number of patients aged ≥65 years died over admission month; (D) Proportion of patients aged ≥65 years died (number died/number admitted) over admission month.

Table 3
Hazard ratios and 95% confidence intervals (CI) of the associations between disability status and mortality by age among patients without DNR/DNI on admission.

	Age group	N_{Death}/N_{Total}	Hazard ratios (95% CI)
Model 1[a]	<65 years	125/3240	Reference
		7/199	**0.43 (0.20, 0.93)**[c]
	≥65 years	313/2179	Reference
		50/347	0.95 (0.70, 1.28)
Model 2[b]	<65 years	101/2667	Reference
		6/168	0.44 (0.19, 1.01)
	≥65 years	256/1827	Reference
		45/304	0.95 (0.69, 1.31)

Abbreviations: DNR/DNI, do-not-resuscitate/do-not-intubate.
[a] Model 1: Adjusted for age, sex, race/ethnicity, marital status, and admission source.
[b] Model 2: Adjusted for age, sex, race/ethnicity, marital status, admission source, modified Charlson comorbidity index, and body mass index.
[c] P-value <0.05

the primary model for the younger age group (HR: 1.30, 95% CI: 0.95, 1.79) (eTable 9).

The association between having disabilities requiring assistance and severe COVID-19 did not differ by the year of admission (eTable 10). A total of 243 (5%) patients were fully vaccinated on admission, with dates of being fully vaccinated ranging from January to October 2021 (eFig. 3). Results of our primary analysis remained consistent after restricting to patients not fully vaccinated on admission (eTable 11).

The median time between symptom onset and admission was 3 days among 2412 patients with available data, with 1330 patients aged <65 years (N = 94 with disabilities requiring assistance) and 1082 patients aged ≥65 years (N = 150 with disabilities requiring assistance). The median time was shorter among patients with disabilities requiring assistance in both the younger (1.5 vs. 3 days) and older (1 vs. 2 days) age groups (eFig. 4). A total of 5763 (97%) patients had data on medication use. Patients with disabilities requiring assistance had lower proportions of receiving remdesivir and dexamethasone but were similar in terms of tocilizumab (eTable 12).

Discussion

Over 20 months (March 2020–October 2021) at one academic hospital system in the Eastern United States, patients with disabilities requiring assistance who were <65 years had a 35% increased risk of severe COVID-19, translating to an additional 18 severe COVID-19 cases per 100 patients.

Our findings suggest that COVID-19 clinical outcomes among patients with disabilities requiring assistance differ by age. Within this cohort, patients with disabilities requiring assistance aged <65 years had an increased risk of severe COVID-19, but this risk was not observed for patients with disabilities requiring assistance aged ≥65 years. Age is the strongest risk factor for adverse COVID-19 outcomes.[29] It may be that risk conferred by older age is so strong that it obscures the impact of other factors, including disability. Our findings must be cast against the backdrop of national COVID-19 outcome data during this period. At a population level, there is an increased risk of severe COVID-19 and mortality for all people aged 65 years and older.

In our study, although we found an increased risk of severe COVID-19 among patients with disabilities requiring assistance who were <65 years, we also found a reduced risk of death. However, this finding should be interpreted with caution given the small number of deaths among younger patients. One possible explanation for this finding is that patients with DNR/DNI on admission were excluded, as patients with disabilities were more likely to have DNR/DNI on admission. However, we found a null association among patients with DNR/DNI, suggesting that this is not driving our results. Alternatively, these findings may reflect practices of the well-resourced hospital system in which this study was conducted. Policies implemented by this system may have prioritized support to patients with disabilities, resulting in the observed reduction in the risk of mortality for patients aged <65 years.

Our findings are consistent with prior work in this area. Studies using disability data from registries of residents in congregate care settings or those receiving disability-related services suggest increased case fatality among people with intellectual and developmental disabilities.[8,9] These settings include a greater proportion of individuals with disabilities compared to the community and are associated with higher rates of SARS-CoV-2 infection and COVID-19 mortality.[28] Our primary analysis included patients admitted from assisted living, skilled nursing, and intermediate care facilities (<20%). However, our findings are not driven by this group, and a sensitivity analysis restricting to patients admitted from the community found similar results. More recently, studies were expanded in terms of geographic regions and incorporated national-level statistics like death certificate data. Similarly, a greater COVID-19 mortality burden was reported among people with intellectual and developmental disabilities in the US.[10,11] In an ecological study using publicly available administrative data from 369 US counties, a higher percentage of non-institutionalized disabled population was associated with a higher rate of COVID-19 mortality at the county level.[12]

Fewer studies have used EHR to identify people with disabilities. A recent report found disproportionately higher COVID-19 incidence and hospitalization rates among Medicare beneficiaries with disabilities from January 2020 to November 2021.[13] In a cross-sectional study with data from 547 US healthcare organizations through November 2020, people with vs. without intellectual disabilities had nearly six times the odds of COVID-19-related mortality (odds ratio: 5.9, 95% CI: 5.3–6.6).[14] Similar to our findings, prior work by Turk et al. found differences in COVID-19 case fatality by age, with higher case fatality in individuals with vs. without intellectual and developmental disabilities in younger, but not older age groups, using data from the TriNetX COVID-19 Research Network, a consortium of global EHR data to support COVID-19 research.[15]

The paucity of US studies examining the relationship between disability status and COVID-19 outcomes is a direct result of the lack of standardized disability data collected within EHR. Other countries with the infrastructure in place have available disability data. For example, in the UK, the Office for National Statistics has reported that the risk of COVID-19-related mortality was approximately 1.5 times greater for people with disabilities compared to people without disabilities.[30] These analyses are possible because disability questions are included in the UK's census and are linked to death records and primary care data. While there remain limitations, including a lack of data by disability categories, this approach allows for “real-time” tracking of the pandemic among people with disabilities. These data also highlight that no single factor uniquely explains the increased risk among people with disabilities. Instead, “place of residence, socio-economic and geographical circumstances, and pre-existing health conditions all play a part,” spotlighting the societal inequities that people with disabilities face.[31]

In our study, the set of disability-related questions asks about assistive needs and was designed to inform care. Our definition of disability status can lead to the inclusion of patients with disabilities who do not require assistance in the reference group. Therefore, our study is comparing patients with disabilities severe

enough to require assistance to patients having disabilities without assistive needs and also patients without disabilities. We acknowledge this important limitation, and our findings might not be generalizable to all people with disabilities. However, this study is a key step toward a more thorough understanding of COVID-19 outcomes among people with disabilities and highlights that there is a clear need for a standardized set of disability status questions to be included as a core part of standard healthcare data collection, similar to other demographic information like age, gender identity, race, and ethnicity.[32]

Although five hospitals serving patients largely coming from a catchment population of the Baltimore/Washington, D.C. area were included, this cohort is limited to one academic hospital system with premier resources. Despite limited generalizability, our findings can still inform public health responses to COVID-19 and health inequities faced by people with disabilities. Future studies should consider other parts of the US and other healthcare settings.

Disability is distinct from disease but may be both a cause and a consequence of medical conditions.[33] Our primary analysis did not adjust for comorbid conditions or BMI, as these factors may result from disability and thus be mediators of the association between disability and COVID-19 outcomes.[26,27] However, these conditions are also risk factors for adverse COVID-19 outcomes.[29] Model estimates were attenuated when we adjusted for BMI and comorbidities in secondary models, but this result would be consistent with these factors being mediators or confounders. We cannot rule out residual confounding by comorbidities, and the true effect estimate is likely to be within the range of the hazard ratios estimated for the two different models (1.21–1.35).

Conclusions

Our results suggest an increased risk of severe COVID-19 among adults <65 years with disabilities requiring assistance. This study also highlights the urgent need to include a standardized set of disability questions within EHR to identify and address health inequities impacting people with disabilities.

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Conflicts of interest

Mr. Betz reported equity and entitlement to future royalties from miDiagnostics. Dr. Reed reported membership on the advisory board of Neosensory. Dr. Garibaldi reported consulting fees from Janssen Research and Development, LLC, Gilead Sciences Inc, and Atea Pharmaceuticals Inc, and is also a member of the FDA Pulmonary-Asthma Drug Advisory Committee. Dr. Swenor is an advisor to the Innovation and Value Initiative. No other disclosures were reported.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dhjo.2023.101441.

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