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Brief Report

Social inequities in the distribution of COVID-19: An intra-categorical analysis of people with disabilities in the U.S

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A B S T R A C T

Background: While recent reports suggest that people with disabilities (PwDs) are likely to be adversely impacted by COVID-19 and face multiple challenges, previous research has not examined if COVID-19 burdens are unequally distributed with respect to the disability characteristics of the U.S. population.
Objective: This article presents the first national scale study of the relationship between COVID-19 incidence and disability characteristics in the U.S. The objective is to determine whether COVID-19 incidence is significantly greater in counties containing higher percentages of socio-demographically disadvantaged PwDs, based on race, ethnicity, poverty status, age, and biological sex.
Methods: This study integrates county-level data on confirmed COVID-19 cases from the Johns Hopkins Center for Systems Science and Engineering database with multiple disability variables from the 2018 American Community Survey. Statistical analyses are based on bivariate correlations and multivariate generalized estimating equations that consider spatial clustering in the data.
Results: Greater COVID-19 incidence rate is significantly associated with: (1) higher percentages of PwDs who are Black, Asian, Hispanic, Native American, below poverty, under 18 years of age, and female; and (2) lower percentages of PwDs who are non-Hispanic White, above poverty, aged 65 or more years, and male, after controlling for spatial clustering.
Conclusions: Socio-demographically disadvantaged PwDs are significantly overrepresented in counties with higher COVID-19 incidence compared to other PwDs. These findings represent an important starting point for more detailed investigation of the disproportionate impacts of COVID-19 on PwDs and highlight the urgent need for COVID-19 data collection systems to incorporate disability information.

Introduction

People with disabilities (PwDs) represent a rapidly expanding and diverse group, with almost 25% of adult Americans reporting some type of disability.[1] Recent reports suggest that PwDs are likely to be adversely impacted by the COVID-19 pandemic and face multiple challenges.[2–6] The first barrier involves adopting recommended public health guidelines and practicing routine prevention measures (e.g., social distancing and washing hands) that do not consider the needs of PwDs, especially those relying on assistance with personal care. Second, equitable access to health care, a well-documented barrier for PwDs, has worsened during this pandemic.[7] Medical resource allocation, including ventilators, may also be discriminatory against patients with disabilities, and complaints have been filed in several states about these rationing policies.[5] Third, PwDs often have difficulty communicating symptoms of illness, resulting in delays in diagnosis and additional virus spread.[3] Finally, PwDs are more likely to have underlying health problems and reside in congregate settings than those without disabilities, thus increasing their infection risks.[5,8,9]

While recent studies have documented greater COVID-19 incidence and fatality rates in U.S. counties containing higher proportions of non-White and socioeconomically disadvantaged residents,[10–12] research on the socio-spatial distribution of COVID-19 burdens has paid limited attention to PwDs. To address this gap, this article presents the first national scale study of the relationship between confirmed COVID-19 cases and disability characteristics in the U.S. The specific objective is to determine whether COVID-19 incidence is significantly greater in counties containing higher percentages of socio-demographically disadvantaged PwDs, based on their race, ethnicity, poverty status, age, and biological sex.

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Methods

Data on COVID-19 incidence were retrieved from the Johns Hopkins University Center for Systems Science and Engineering database[13] on August 1, 2020, for all counties in the continental U.S. This repository provides the most comprehensive and latest county-level COVID-19 data reported by the Centers for Disease Control and Prevention and state health departments, updated daily. The total number of COVID-19 cases in the 3108 counties of the continental U.S. (which excludes Alaska, Hawaii, and Puerto Rico) was 4,483,338 on the date this information was downloaded. The COVID-19 incidence rate, estimated as the number of confirmed cases per 100,000 people in each county, was used as the dependent variable for this study. The spatial distribution of this variable is depicted in Fig. 1, where counties in the continental U.S. are classified into five quintiles based on the COVID-19 incidence rate. Summary statistics for this dependent variable are included in the first row of Table 1.

Data on disability characteristics were obtained from the 2018 American Community Survey (ACS) five-year estimates. The ACS defines PwDs as members of the civilian non-institutionalized population who reported having serious self-care, hearing, vision, independent living, ambulatory, and/or cognitive difficulties on the ACS form. The ACS disability estimates allow disaggregation of PwDs based on five socio-demographic categories (race, ethnicity, poverty status, age, and biological sex) that were used for this intra-categorical analysis. County percentages for each disability subgroup were calculated by dividing the number of PwDs in each subgroup by the total civilian non-institutionalized population relevant to the variable category. The names and descriptive statistics for these explanatory variables are provided in Table 1.

Bivariate Pearson product-moment correlations were first used to measure statistical associations between COVID-19 incidence rate and each disability variable. Generalized estimating equations (GEEs) were then used for a multivariate analysis of disability subgroups within each socio-demographic category. GEEs extend the generalized linear model to accommodate clustered data,[14] in addition to relaxing several assumptions of traditional regression (i.e., normality).

For estimating a GEE, clusters of observations must be defined based on the assumption that observations within a cluster are correlated, while observations from different clusters are independent.[15] A combination of two different approaches were utilized to define county clusters for this study. The state in which a county is located was first used to account for potential correlation in counties within the same state, because of similar COVID-19 response and testing policies, socio-cultural systems, and healthcare system characteristics[16–18] that imply similarities in counties within a given state and differences between states. Since the use of states as the only clustering variable potentially ignores intra-state and regional geographic variations in COVID-19 outcomes, a second approach based on identifying significant clusters of COVID-19 cases was incorporated. Specifically, SatScan[19] software was used to implement a spatial scan statistic based on the Poisson model, determine spatial clusters, and estimate relative risk (RR) for COVID-19 incidence rates at the county level. A similar methodology was recently employed by Desjardins et al.[20] to detect space-time clusters of COVID-19 cases in the continental U.S. The RR is defined as the estimated risk at a given location divided by the risk outside of the location (or, everywhere else). If a county has a RR of 3.0, for example, then the population within that county are three times more likely to be exposed to COVID-19. All U.S. counties were classified into six groups based on the estimated RR values (<1.0, 1.00–1.99, 2.00–2.99, 3.00–3.99, 4.00–4.99, and 5.0 or more). The use of both states ($n = 49$) and RR groups ($n = 6$) for the GEE cluster definition resulted in a total of 102 clusters, with the number of counties per cluster ranging from 1 to 245.

GEEs also require the specification of an intra-cluster dependency correlation matrix.[15] The 'exchangeable' correlation matrix was selected for the results reported here, since this specification yielded the best statistical fit based on the QIC (quasi-likelihood under the independence) model criterion. For each GEE, the normal, gamma, and inverse Gaussian distributions with logarithmic and identity link functions were explored. The gamma distribution with logarithmic link function was chosen for all GEEs since this model specification provided the lowest QIC value.

Since PwDs were disaggregated separately based on five socio-demographic characteristics (i.e., race, ethnicity, poverty status, age, and biological sex), five different GEE models were utilized. Each GEE included all disability subgroups relevant to that socio-demographic category. Finally, potential multicollinearity among the variables was also examined based on variance inflation factor,

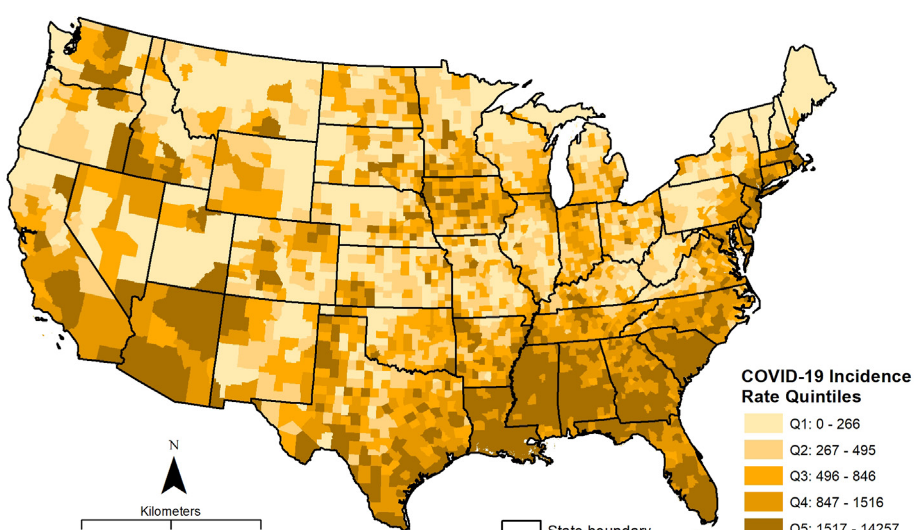

Fig. 1. County level distribution of COVID-19 incidence rate (cases per 100,000 people) in the continental USA, August 1, 2020.

Table 1
Summary statistics for variables analyzed and bivariate correlations with county COVID-19 incidence rate.

	Min	Max	Mean	SD	Pearson's r
COVID-19 incidence rate (confirmed cases per 100,000 people)	0.00	14,257	967	1004	
Percent[1] with a disability	3.83	33.71	15.95	4.40	−0.056**
Race:					
Percent w/disability: White alone	0.85	33.26	13.55	4.63	−0.326**
Percent w/disability: Black alone	0.00	20.70	1.48	2.66	0.456**
Percent w/disability: Native American	0.00	13.74	0.28	0.94	0.020
Percent w/disability: Asian alone	0.00	3.45	0.09	0.18	0.097**
Percent w/disability: Other race	0.00	15.24	0.55	0.65	0.028
Ethnicity:					
Percent w/disability: Non-Hispanic White	0.10	33.16	12.84	4.81	−0.355**
Percent w/disability: Hispanic	0.00	25.26	0.99	2.15	0.119**
Percent w/disability: Non-Hispanic non-White	0.00	20.93	2.13	2.75	0.439**
Poverty status:					
Percent w/disability: Below poverty level	0.00	14.97	3.57	1.85	0.108**
Percent w/disability: Above poverty level	0.00	27.30	12.48	3.06	−0.146**
Age:					
Percent w/disability: Age 5−17 years	0.00	5.08	1.03	0.48	0.083**
Percent w/disability: Age 18−34 years	0.00	5.59	1.56	0.67	0.066*
Percent w/disability: Age 35−64 years	1.01	18.36	6.35	2.30	−0.005
Percent w/disability: Age 65−74 years	0.00	12.73	3.09	1.16	−0.089**
Percent w/disability: Age 75 years or more	0.00	11.13	3.87	1.19	−0.181**
Biological Sex:					
Percent w/disability: Male	1.30	18.19	8.06	2.37	−0.131**
Percent w/disability: Female	1.91	19.94	7.90	2.26	0.028

[1]Disabilty percentages are based on the civilian noninstitutionalized population.
**$p < 0.01$; *$p < 0.05$; $n = 3108$ counties.

tolerance, and condition index criteria; inferences from the GEEs are not affected by multicollinearity. All independent variables were standardized before inclusion in the GEE and their statistical significance was estimated using two-tailed *p*-values from the Wald chi-square test.

Results

Bivariate correlation analysis results are summarized in the rightmost column of Table 1. A relatively weak ($r = 0.056$) but significantly negative correlation is observed between COVID-19 incidence and the overall disability percentage in the county. COVID-19 incidence is also negatively and significantly correlated with the percentages of PwDs who are White alone, non-Hispanic White, and above poverty, as well as those who are older (65 years or more) and male. However, the percentages of PwDs who are Black alone, Asian alone, Hispanic, non-Hispanic non-White, below poverty, and aged 5−34 years all indicate a positive and significant correlation with COVID-19 incidence.

Results from the multivariate GEEs, shown in Table 2, are consistent with the bivariate correlations. In the *Race* model, a significant and positive coefficient is observed only for the percentage of White PwDs, while all other racial (i.e., non-White) subgroups yield significantly negative coefficients. The *Ethnicity* model shows significantly positive associations for the percentages of Hispanic and non-Hispanic non-White PwDs, but a negative association with non-Hispanic White percentage. The percentage of PwDs below poverty level indicates a significantly positive effect in the *Poverty status* model, but a significantly negative relationship is observed for the percentage of those above poverty. In the *Age* model, the percentage of PwDs aged 5−17 years are significantly and positively related to COVID-19 incidence, while those aged 65−74 and 75 years or more reveal a significantly negative association. Finally, the *Biological sex* model indicates a significant and positive relationship with COVID-19 incidence for the percentage of female PwDs, but a negative relationship for the percentage of male PwDs.

Discussion

Although the overall disability percentage is negatively associated with confirmed COVID-19 cases, intra-categorical analysis reveals that socio-demographically disadvantaged PwDs are significantly overrepresented in counties with higher COVID-19 incidence, after controlling for spatial clustering. Specifically, PwDs who are Black, Asian, Hispanic, Native American, below poverty, aged 5−17 years, and female are significantly more likely to reside in counties with higher COVID-19 incidence compared to their counterpart socio-demographic subgroups. However, PwDs who are White alone, non-Hispanic White, above poverty, aged 65 years or more, and male are significantly less likely to reside in counties with higher COVID-19 incidence compared to their counterpart subgroups. This suggests that PwDs are experiencing a 'multiple jeopardy' based on the convergence of their disability, racial/ethnic minority, and poverty status,[21] that is potentially amplified by higher COVID-19 prevalence in their counties. For those under 18 years, the results align with a recent study that found higher concentrations of COVID-19 cases for younger patients with intellectual and developmental disabilities.[22] The significantly higher proportion of female PwDs in counties with greater COVID-19 is also a major concern, since women with disabilities have been documented to face more discrimination and difficulties in attaining access to education, employment, housing, and healthcare, as well as higher risks of gender-based violence and sexual abuse.[23,24] The findings imply that socio-demographically disadvantaged PwDs residing in areas of higher COVID-19 exposure are likely to suffer increased infection risks and various additional burdens that require further attention within public health research and intervention efforts.

While this study represents an important starting point for documenting the unequal impacts of COVID-19 on PwDs, it is important to consider three limitations. First, disability data from the ACS is limited to six types of difficulties, does not allow identification of prevalent health conditions (e.g., cancer or paralysis), and excludes factors that potentially contribute to disability such as

Table 2
Generalized estimating equations (GEE) for predicting county COVID-19 incidence rate: Standardized model coefficients and significance.

	Beta	Std Error	Lower 95% CI	Upper 95% CI	Wald Chi Square
Race:					
Percent w/disability: White alone	−0.203	0.020	−0.242	−0.164	102.958**
Percent w/disability: Black alone	0.111	0.016	0.079	0.143	46.214**
Percent w/disability: Native American	0.051	0.009	0.033	0.069	31.438**
Percent w/disability: Asian alone	0.080	0.018	0.046	0.115	21.060**
Percent w/disability: Other race	0.077	0.017	0.044	0.110	21.030**
Intercept	7.160	0.083	6.997	7.322	7465.214**
Ethnicity:					
Percent w/disability: Non-Hispanic White	−0.237	0.022	−0.280	−0.194	116.954**
Percent w/disability: Hispanic	0.119	0.031	0.058	0.180	14.708**
Percent w/disability: Non-Hispanic non-White	0.118	0.0161	0.086	0.149	53.248**
Intercept	7.186	0.083	7.023	7.348	7525.648**
Poverty status:					
Percent w/disability: Below poverty level	0.148	0.022	0.105	0.190	46.913**
Percent w/disability: Above poverty level	−0.267	0.023	−0.312	−0.222	134.297**
Intercept	7.183	0.072	7.043	7.324	10066.93**
Age:					
Percent w/disability: Age 5−17 years	0.047	0.016	0.016	0.078	8.732**
Percent w/disability: Age 18−34 years	0.038	0.022	−0.005	0.081	3.008
Percent w/disability: Age 35−64 years	−0.026	0.023	−0.071	0.019	1.300
Percent w/disability: Age 65−74 years	−0.089	0.021	−0.131	−0.047	17.597**
Percent w/disability: Age 75 years or more	−0.108	0.020	−0.148	−0.069	29.479**
Intercept	7.242	0.076	7.093	7.391	9093.179**
Biological Sex:					
Percent w/disability: Male	−0.298	0.0280	−0.353	−0.243	113.460**
Percent w/disability: Female	0.153	0.0286	0.097	0.209	28.577**
Intercept	7.223	0.072	7.081	7.365	9963.672**

Note: All GEEs are based on a gamma distribution with log link function and an exchangeable correlation matrix.
QIC (quasi-likelihood under the independence model criterion) = 2582.53 (*Race* model), 2586.55 (*Ethnicity* model), 2801.46 (*Poverty status* model), 2978.737 (*Age* model), and 2892.35 (*Biological Sex* model).
**$p < 0.01$; *$p < 0.05$; CI = confidence interval; $n = 3059$ counties (cases>0).

discrimination and lack of reasonable accommodations.[25] Second, statistical analyses are restricted to county-level associations since COVID-19-related disability information for smaller geographic units or individual cases are currently unavailable. Third, while this county level GEE analysis utilizes states and significance of COVID-19 risks to define spatial clusters, data on additional factors that influence COVID-19 variability such as testing protocols, access, and availability should be incorporated in future work. Despite these limitations, the findings emphasize the need for COVID-19 data collection and surveillance systems to incorporate disability identifiers, in addition to existing indicators of age, race/ethnicity, and gender. To understand and address the needs of PwDs affected by this pandemic, more detailed information is urgently needed on rates of infections, hospitalizations, outcomes, and fatalities, disaggregated by types of difficulty experienced by PwDs as well as their demographic and socioeconomic characteristics.

Conclusions

This study examined the disproportionate effects of COVID-19 on PwDs by analyzing county-level associations between COVID-19 incidence rate and disability characteristics in the continental U.S. Results revealed that PwDs who are racial/ethnic minority, below poverty, aged 5−17 years, and female are significantly overrepresented in counties with higher COVID-19 incidence, while PDWs who are White, above poverty, and aged 65 or more years are significantly underrepresented. These intra-categorical inequalities highlight the need for additional data and analysis to document the adverse impacts of this pandemic on physically and socially vulnerable PwDs, as well as formulate appropriate intervention strategies.

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Disclaimer

Any opinions, findings, and conclusions or recommendations expressed in this article are those of the author and do not necessarily reflect the views of NSF.

Conflict of interest

The author has no conflicts of interest or disclosures to report.

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