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COVID-19 Deaths and Minority Health Social Vulnerability, in the U.S., January 1, 2020 through June 24, 2023

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Abstract

Background: Health disparities, leading to worse health outcomes such as elevated COVID-19 mortality rates, are rooted in social and structural factors. These disparities notably impact individuals from lower socioeconomic backgrounds and more socially vulnerable areas. We analyzed the relationship between COVID-19 deaths and social vulnerability using the Minority Health Social Vulnerability Index (MHSVI).

Methods: COVID-19 death data in the U.S. was obtained from the Centers for Disease Control and Prevention (CDC) National Center for Health Statistics, where COVID-19 deaths were defined using the ICD-10 code U07.1. MHSVI composite scores were calculated for 3089 U.S. counties and categorized into social vulnerability quartiles, where values ranged from 0 (lowest vulnerability) to 1 (highest vulnerability). Negative binomial regression was employed to determine death rate ratios for each quartile within each theme. Finally, a multivariate negative

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Conflict of Interest The authors declare no competing interests.

Code Availability The code is available for use.

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binomial regression including all MHSVI sub-themes, excluding the overall index ranking, was used to assess the association between each theme and COVID-19 death rates independently.

Results: There were 1,134,272 COVID-19 deaths from January 1, 2020 through June 24, 2023. Adjusted rate ratios for COVID-19 deaths in the overall index ranking were 1.06 (95% *CI* 0.99–1.13), 1.14 (95% *CI* 1.06–1.22), and 1.41 (95% *CI* 1.31–1.52) for the second, third and fourth quartiles, respectively. Sub-themes of socioeconomic status (SES), household characteristics (HC), racial and ethnic minority status (REMS), housing type and transportation (HTT), and medical vulnerability (MV) revealed increasing death rates in higher vulnerability quartiles. The healthcare infrastructure and access (HIA) theme had decreasing death rate ratios of 0.74 (95% *CI* 0.71–0.78), 0.59 (95% *CI* 0.56–0.62), and 0.42 (95% *CI* 0.39–0.44) for the second, third, and fourth quartiles, respectively. Finally, the multivariate analysis showed that the HC, HTT, HIA, and MV themes were associated with COVID-19 deaths ($P < 0.05$).

Conclusion: Counties that were identified as more socially vulnerable experienced higher death rates from COVID-19. These areas may need additional public health and social support during future pandemics.

Keywords

COVID-19; Health disparities; Social determinants of health; Social vulnerability

Introduction

Health disparities, leading to worse health outcomes such as elevated COVID-19 death rates, are rooted in social and structural factors. These disparities notably impact individuals from lower socioeconomic backgrounds and more socially vulnerable areas [1, 2]. Social vulnerability is defined as “the degree to which a community exhibits certain social conditions, including high poverty, low percentage of vehicle access, or crowded households, that may affect that community’s ability to prevent human suffering and financial loss in the event of a disaster” [3]. During the COVID-19 pandemic, racial and ethnic minorities were disproportionately impacted by COVID-19, experiencing higher rates of infection, hospitalization, and death compared to White people in the United States (U.S.) [4–9]. This can be attributed to preexisting health disparities such as limited access to healthcare [10] and a higher prevalence of underlying health conditions (e.g. heart disease, chronic kidney disease, chronic obstructive pulmonary disease, diabetes, and obesity) [11, 12]. Additionally, research from the first 2 years of the COVID-19 pandemic found that people who had no vehicle access [13, 14], limited English proficiency [14, 15], and certain living conditions, such as crowded households [14, 15], were at increased risk for COVID-19. Studies have also shown that people who lived in socially vulnerable areas had lower COVID-19 vaccination uptake [16–18], and treatments dispensed in 2022 [19]. When the COVID-19 pandemic began, researchers quickly focused on understanding the various factors that contributed to the disparities in infection and death rates. Early studies primarily emphasized social vulnerability but often did not include a comprehensive analysis of medical vulnerability and healthcare infrastructure [13–16, 20]. This study expands the analysis by exploring the lasting effects of social vulnerability on COVID-19 outcomes throughout the later phases of the pandemic using a health equity perspective. Even though

the COVID-19 public health emergency has ended, the SARS-CoV-2 virus continues to circulate. Examining the relationship between death and social vulnerability can inform initiatives aimed at reducing health disparities, including efforts related to vaccination and treatment.

The CDC/ATSDR Social Vulnerability Index (SVI) was developed as a place-based index, database and mapping tool to assist public health officials with identifying and quantifying socially vulnerable communities [3]. Public health officials and community leaders have used SVI data to prepare communities to respond to emergencies, especially during the COVID-19 pandemic. The CDC/ATSDR SVI ranks each county on 16 social factors and groups them into four related themes: socioeconomic status, household characteristics, racial and ethnic minority status, and housing type and transportation (Fig. 1). In 2021, the U.S. Department of Health and Human Services (HHS) Office of Minority Health partnered with the CDC/ATSDR to develop the Minority Health Social Vulnerability Index (MHSVI). The Minority Health Social Vulnerability Index (MHSVI) builds upon the CDC/ATSDR SVI by incorporating two additional variables, medical vulnerability, and healthcare infrastructure. By considering these aspects, the MHSVI provides a more comprehensive assessment of social vulnerability, especially for minority populations [21]. The purpose of this study is to analyze the relationship between COVID-19 deaths and social vulnerability using the MHSVI.

Methods

COVID-19 Deaths

The primary outcome observed was COVID-19 deaths between January 1, 2020 and June 24, 2023 in the U.S. County-level data on COVID-19 deaths in the U.S. were obtained from the CDC National Center for Health Statistics, which sources its data from the National Vital Statistics System [22]. COVID-19-associated deaths were deaths for which COVID-19 was recorded as a contributing factor to the death on the death certificate using the ICD-10 code U07.1. These include deaths confirmed through laboratory testing for COVID-19, as well as those clinically confirmed, which includes cases where COVID-19 was presumed or considered a probable cause of death [23].

Minority Health Social Vulnerability Index

County-level social vulnerability data were obtained from the HHS Office of Minority Health website [24]. The 2023 MHSVI is an index of 36 social indicators, categorized into one of six themes: (1) socioeconomic status (SES), (2) household characteristics (HC), (3) racial and ethnic minority status (REMS), (4) housing type and transportation (HTT), (5) healthcare infrastructure and access (HIA), and (6) medical vulnerability (MV). To create the MHSVI ranking, computed or derived percentage estimates of 36 social indicator variables detailed in Fig. 1 are obtained from the Census Bureau. Each county's percentile rank among all counties was calculated for all 36 variables, each of the six themes, and its overall rank position. Within each thematic group, the variable percentiles were summed, and these sums were ranked again to obtain each county's MHSVI by theme. Summing these summed scores across all themes generated an overall summary ranking,

which was then ranked to establish the final MHSVI ranking for each county. MHSVI percentile ranking values ranged from 0 (lowest vulnerability) to 1 (highest vulnerability) and were divided into 4 groups (e.g., 0–0.25, 0.2501–0.50, 0.5001–0.75, and 0.7501–1.00) representing differing levels of vulnerability. Additional notes for recreating the index are detailed in the SVI documentation [3]. COVID-19 death data and social vulnerability data were combined by matching county FIPS (Federal Information Processing System) codes, such that each county had an MHSVI composite score associated with their reported COVID-19 deaths. To avoid risk in compromising protected health information, data for counties that reported less than 10 deaths were suppressed and treated as missing ($n = 342$), resulting in an undercount of reported COVID-19 deaths in the data and some states having more counties with missing data than others. In total, there were 3089 counties tracked in this dataset. Approximately 1.6% of counties ($n = 48$) were missing data for the medical vulnerability theme and overall index ranking. Counties with missing data for the medical vulnerability score and overall index score were removed from the analysis specific to the medical vulnerability theme and the overall index score, as well as bivariate maps in accordance with how missing data for the original SVI were handled.

Statistical Analysis

Descriptive statistics were calculated, including the mean, standard deviation, and range for the 36 social indicators, categorized in each of the six themes. The total number of deaths, death rates, median death rates, and interquartile range (*IQR*) per 100,000 persons were calculated. We used negative binomial regression models to assess the relationship between social vulnerability and COVID-19 deaths. Negative binomial regression was selected over Poisson regression because it was the most suitable for modeling count data, COVID-19 deaths for all counties in each quartile, with dispersion. Assumptions such as observations of independence and a linear relationship between the log of expected counts and variables were validated through thorough model diagnostics to ensure the decision to use negative binomial regression was well-founded. First, a negative binomial regression was used to model the count of COVID-19 deaths for each vulnerability quartile within each MHSVI subtheme and the overall index ranking. Following a similar methodology to Islam et al., the model used U.S. states as a fixed effect to control for state-level differences. The natural logarithm of the county population was incorporated in the model as an offset term to calculate the outcome of interest as a death rate and to adjust for population size [20]. MHSVI quartiles with rate ratios > 1 had greater death rates in comparison to the lowest vulnerability quartile, whereas those with rate ratios < 1 had lower death rates compared to the lowest vulnerability quartile.

Second, a multivariate negative binomial regression including all six MHSVI sub-themes, excluding the overall index ranking, was used to assess the association between each theme and COVID-19 death rates independently. The model incorporated the natural logarithm of the county population as an offset term and included U.S. state as a fixed effect to account for confounding. As a percentile rank, the original MHSVI ranged from 0 to 1, where counties with higher percentile rank are more vulnerable relative to other counties. The index was rescaled to range from 0 to 10 by multiplying the original percentile rank by 10 to enable better clarity of interpretation of the rate ratio. Each unit in the rescaled

index is equivalent to a decile on the original index scale [15]. All analyses and maps were performed and created using R (R version 4.2.2).

Results

Among all counties, the mean percentage of the population living below the poverty line was 24.5% (range 3.7–71%) within the SES theme and the mean percentage of persons ages 65 and older was 19.2% (range 3–57.8%) within the HC theme. Within the REMS theme, on average, about 24.2% (range 0–98.9%), the sum of the average each racial and ethnic minority group, of the population identified as a racial or ethnic minority across all U.S. counties (Table 1).

Table 2 shows COVID-19 deaths, death rates, and rate ratios by quartile, with the first quartile being the least vulnerable and the fourth quartile being the most vulnerable. Among 3089 U.S. counties, the cumulative number of COVID-19 deaths between January 1, 2020 through June 24, 2023 was 1,134,272. For the overall index ranking, the adjusted rate ratio of COVID-19 deaths in the second, third, and fourth quartiles were 1.06 (95% *CI* 0.99–1.13), 1.14 (95% *CI* 1.06–1.22), and 1.41 (95% *CI* 1.31–1.52) higher, respectively, compared to the death rate for counties in the least vulnerable quartile (Fig. 2). For the SES theme, the adjusted COVID-19 death rate ratios for counties in the second, third, and most vulnerable quartiles were 1.14 (95% *CI* 1.06–1.21), 1.29 (95% *CI* 1.20–1.38), and 1.39 (95% *CI* 1.28–1.50) higher, respectively, compared to the death rate for counties in the least vulnerable quartile (Fig. 3). For the HC theme, the adjusted COVID-19 death rates for counties in the second, third, and most vulnerable quartile were 1.14 (95% *CI* 1.07–1.21), 1.32 (95% *CI* 1.24–1.41), and 1.47 (95% *CI* 1.37–1.57) higher respectively, compared to the death rate for counties in the least vulnerable quartile (Fig. 4). The REMS theme had adjusted rates of 1.10 (95% *CI* 1.03–1.17), 1.26 (95% *CI* 1.18–1.34), and 1.44 (95% *CI* 1.34–1.55) for the same quartiles (Fig. 5). The HTT theme had adjusted rates of 1.18 (95% *CI* 1.11–1.26), 1.36 (95% *CI* 1.28–1.45), and 1.55 (95% *CI* 1.46–1.66) (Fig. 6). In contrast, counties of high vulnerability generally had lower COVID-19 deaths compared to counties with low vulnerability for the HIA theme with adjusted rates of 0.74 (95% *CI* 0.71–0.78), 0.59 (95% *CI* 0.56–0.62), and 0.42 (95% *CI* 0.39–0.44) for the second, third, and most vulnerable quartiles, respectively (Fig. 7). For the MV theme, the adjusted COVID-19 death rate ratios for counties in the second, third, and most vulnerable quartiles were 1.12 (95% *CI* 1.05–1.19), 1.22 (95% *CI* 1.14–1.30), and 1.35 (95% *CI* 1.25–1.45) higher, respectively, compared to the death rate for counties in the least vulnerable quartile (Fig. 8).

Table 3 shows that the HTT, HIA, and MV themes were associated with COVID-19 death rates. For the HTT theme, one decile increase in percentile rank was associated with 1.02 times (95% *CI* 1.01–1.03) increase in death rates. Increasing percentile rank by one decile was associated with 1.04 times (95% *CI* 1.03–1.05) increase in death rates for the MV theme. There was an opposite trend for the HIA theme, where every decile increase in percentile rank was associated with 0.90 times (95% *CI* 0.89–0.90) decrease in COVID-19 death rates. Though the association between the HC theme and COVID-19 death rates was statistically significant, the confidence interval rounds to 1.0. Therefore, we did not consider this association practically significant for further discussion.

Discussion

This study contributes significant new insights into the associations between social vulnerability and COVID-19 death rates across the U.S. We explored the association between U.S. COVID-19 deaths and various themes of social vulnerability as described by the MHSVI. Counties of high vulnerability generally had higher COVID-19 death rates compared to counties with low vulnerability for socioeconomic status, household characteristics, racial and ethnic minority status, housing type and transportation, and medical vulnerability indicators. The association between higher COVID-19 death rates and greater socioeconomic vulnerability in communities is confirmed by several studies [14, 15]. However, one study found temporal trend differences in COVID-19 outcomes with more vulnerable counties having lower death rates in October 2020 [25]. These findings contribute to the body of research, enhancing our understanding of how SES factors influence disparities in COVID-19 outcomes and highlighting the significant impact of structural inequities during the pandemic. The relationships between the SES factors, which include poverty, housing cost burden, no high school diploma and no health insurance, and COVID-19 deaths potentially reflect the multidimensional barriers, such as access to resources and healthcare, that potentiate disease risks and consequences in disproportionately affected populations [26]. However, when adjusting for the other five themes in the same model, we observed that the SES theme was no longer associated with COVID-19 deaths. We hypothesize the association went away because the SES theme is likely correlated with other themes such that the association was better captured in other themes or other themes have particularly unique relationships with death rates such that significance between the SES theme and death rates is lost.

During the pandemic, urban areas experienced a decline in deaths early in the pandemic, while rural areas witnessed higher rates of death and infection subsequently [27, 28]. We found that counties with a higher concentration of racial and ethnic minorities experienced higher COVID-19 deaths when compared to least vulnerable counties. We attribute this association to higher proportions of racial and ethnic minorities living in more metro and urban counties, which tend to have higher populations overall compared to rural areas [29]. These geographic differences present unique challenges and opportunities for public health professionals, as such public health professionals should consider the specific needs and circumstances of each community to enhance equitable health outcomes. The association between the REMS theme and COVID-19 deaths was no longer statistically significant when all themes were included in the model likely due to other themes better capturing the association when adjusting for all other themes.

Counties with higher social vulnerability, particularly in terms of the HC theme, experienced higher COVID-19 death rates compared to those less vulnerable. The HC theme includes several demographic factors that influence a community's susceptibility to severe outcomes from COVID-19. Among these factors are age, disability status, household composition, and language proficiency. Older adults, specifically those over 65 years of age, are particularly at increased risk of severe COVID-19 outcomes due to age-related health vulnerabilities and pre-existing conditions [30]. In contrast, children under 17 years of age, who are part of this theme, typically experience milder symptoms or remain asymptomatic [31],

though their inclusion highlights their role in community transmission dynamics. Individuals with disabilities face increased risk because of potential pre-existing health conditions and barriers to accessing healthcare [32]. Single-parent households may encounter additional stressors and challenges in accessing healthcare, which can impact their ability to manage health risks effectively. Furthermore, individuals with limited English proficiency often face language barriers that can hinder access to crucial health information and services, delaying medical care and complicating understanding of public health guidelines [14, 15, 33]. Effective communication strategies must address language barriers by providing health information in multiple languages and culturally relevant formats. This can improve understanding and adherence with public health guidelines. Public health strategies should prioritize disproportionately affected groups, particularly older adults, individuals with disabilities, single-parent households, and those with limited English proficiency. Tailored interventions can help mitigate severe outcomes and improve access to care.

After adjusting for all themes simultaneously, counties with high vulnerability in the HTT, MV, and HIA themes were associated with COVID-19 deaths. HTT indicators of the MHSVI include factors such as crowding, vehicle unavailability, and living in group quarters, indicating the degree of potential vulnerability or resilience of a community with respect to, housing and transportation resources. COVID-19 death rates increased progressively with each higher vulnerability quartile compared to counties in the least vulnerable quartile, highlighting a clear association between increased housing and transportation vulnerability and higher death rates on community health outcomes during the pandemic. Studies have shown that living conditions, such as overcrowding, are crucial factors in determining COVID-19 death risks, as such factors create challenging environments for quarantine and/or isolation within a household [34, 35]. Additionally, households with no vehicle access also faced increased risks [13, 14], suggesting that reliance on public transportation could potentially increase COVID-19 transmission risk, particularly in urban areas [36, 37].

There was also an association between COVID-19 deaths and the MV theme where counties with higher rates of cardiovascular disease, chronic respiratory diseases, obesity, diabetes, and/or the highest percentage of individuals with no internet access experienced increased rates of COVID-deaths. Other studies have confirmed the correlation between COVID-19 deaths, comorbidities, and community-level access to the internet [32, 38–40]. For the HIA theme, which encompasses factors such as the availability of medical facilities, more vulnerable counties had less risk of death compared to counties in the least vulnerable quartile. Vulnerable counties may have benefitted from targeted vaccine programs, potentially contributing to their lower death rates [41]. However, despite these targeted vaccination efforts, studies have demonstrated low vaccine uptake in high socially vulnerable counties, indicating that other factors may also influence these outcomes [16–18]. This discrepancy underscores the need for further investigation to identify the specific interventions that were most effective and to understand how these findings can be applied to future public health strategies. Investments in healthcare infrastructure and targeted interventions in under-resourced communities are vital for enhancing health outcomes, but additional research is necessary to refine these approaches and enhance their impact.

Geographic variations in social vulnerability and COVID-19 deaths revealed several notable trends. For the overall social vulnerability index ranking, counties with high overall social vulnerability and low death rates tended to be in the West whereas counties with high overall social vulnerability and high death rates tended to be in the Southeast (Fig. 2). For the SES theme, counties with low social vulnerability and high death rates were in the Midwest and Northeast while counties with high death rates and high social vulnerability were in the South and West U.S. regions (Fig. 3). For the HC theme, counties with higher social vulnerability and low death rates were in the western region of the country (Fig. 4). For the REMS themes, counties with high social vulnerability and low death rates were largely in the western region and Mid-Atlantic coastal area of the country. Counties with low social vulnerability and high death rates were clustered in the Midwest and some areas in the Southeast (Fig. 5). For the HTT theme, counties with high social vulnerability and low death rates were in the West (Fig. 6). For the HIA theme, there were many regions throughout the country with counties of low social vulnerability and high death rates (Fig. 7). For the MV theme, counties with high death rates and high social vulnerability tended to be in the Southeast region (Fig. 8). These patterns underscore the complex interplay between regional factors and social vulnerability in influencing COVID-19 death rates across different U.S. regions.

Limitations

Our study had several limitations. First, the unit of observation was at the county level and inferences regarding COVID-19 death rates cannot be made at the individual level. Second, vaccination coverage was not included as a potential factor that may influence COVID-19 death rates within counties, especially for the household characteristics and racial and ethnic minority status themes. A recent study highlights the relationship between COVID-19 vaccination coverage and social vulnerability [18]. Third, the MHSVI and its social factors are cross-sectional, thus analyses cannot account for changes over time. Fourth, COVID-19 death data processed by NCHS are counted based on the state or jurisdiction where the death occurred, which is not necessarily where the decedent resided. Additionally, the classification of COVID-19 deaths varied by state or jurisdiction surveillance system. As a result, the dataset likely does not capture every single death that was caused by COVID-19 in this time period. The generalizability and interpretation of results should be done with caution considering these limitations.

Conclusion

In conclusion, counties with higher social vulnerability experienced greater COVID-19 death rates. This highlights the need for targeted interventions and comprehensive strategies to reduce health disparities and enhance resilience in disproportionately affected populations during public health crises.

Data Availability

The data is available.

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Theme	2023 Minority Health Social Vulnerability Index
THEME 1: SOCIOECONOMIC STATUS	Below 150% Poverty
	Unemployed
	Housing Cost Burden
	No High School Diploma
	No Health Insurance
THEME 2: HOUSEHOLD CHARACTERISTICS	≥65 Years
	≤17 Years
	Civilian with a Disability
	Single-Parent Households
	Spanish Speakers
	Chinese Speakers
	Vietnamese Speakers
THEME 3: RACIAL & ETHNIC MINORITY STATUS	Korean Speakers
	Russian Speakers
	Other Languages
	Hispanic or Latino
	Black or African American
	Asian
	American Indian or Alaska Native
THEME 4: HOUSING TYPE & TRANSPORTATION	Native Hawaiian or Pacific Islander
	Some Other Race
	Two or More Races
	Multi-Unit Structures
	Mobile Homes
THEME 5: HEALTH CARE INFRASTRUCTURE & ACCESS	Crowding
	No Vehicle
	Group Quarters
	Hospitals
THEME 6: MEDICAL VULNERABILITY	Urgent Care Clinics
	Pharmacies
	Primary Care Physicians
	Cardiovascular Disease
	Chronic Respiratory Disease
	Obesity
	Diabetes
	Internet Access

Fig. 1.
2023 Minority Health Social Vulnerability Index

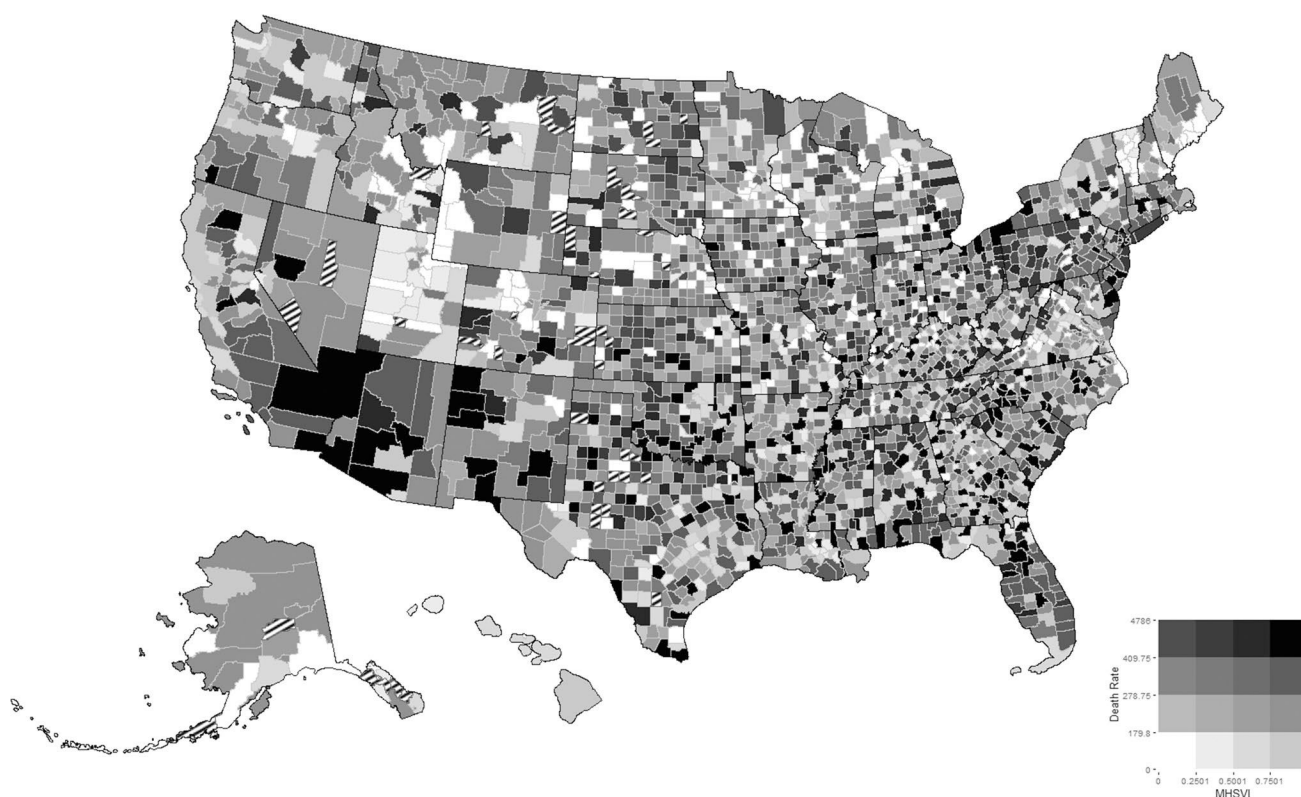


Fig. 2.
Overall Vulnerability Index and COVID-19 death rate per 100 k population, by county —
USA, Jan 2020–Jun 2023

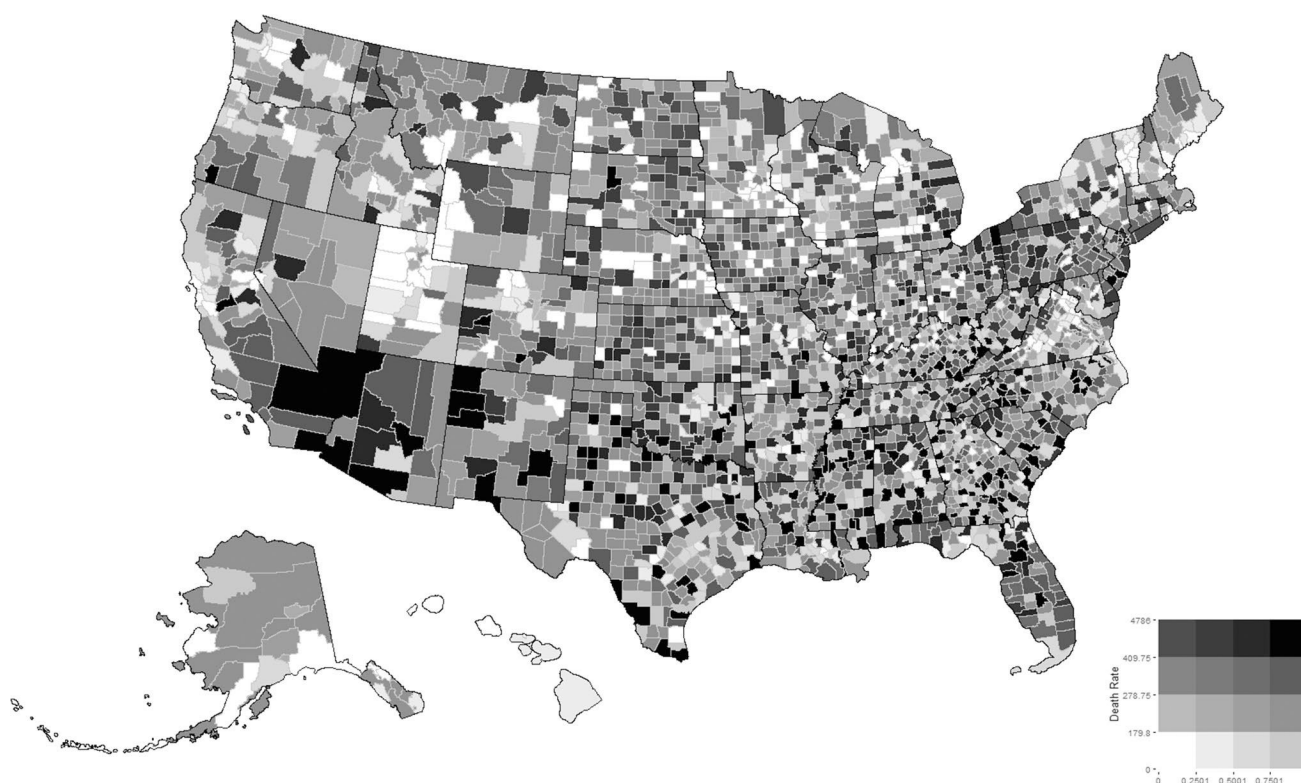


Fig. 3. Socioeconomic status vulnerability and COVID-19 death rate per 100 k population, by county — USA, Jan 2020–Jun 2023

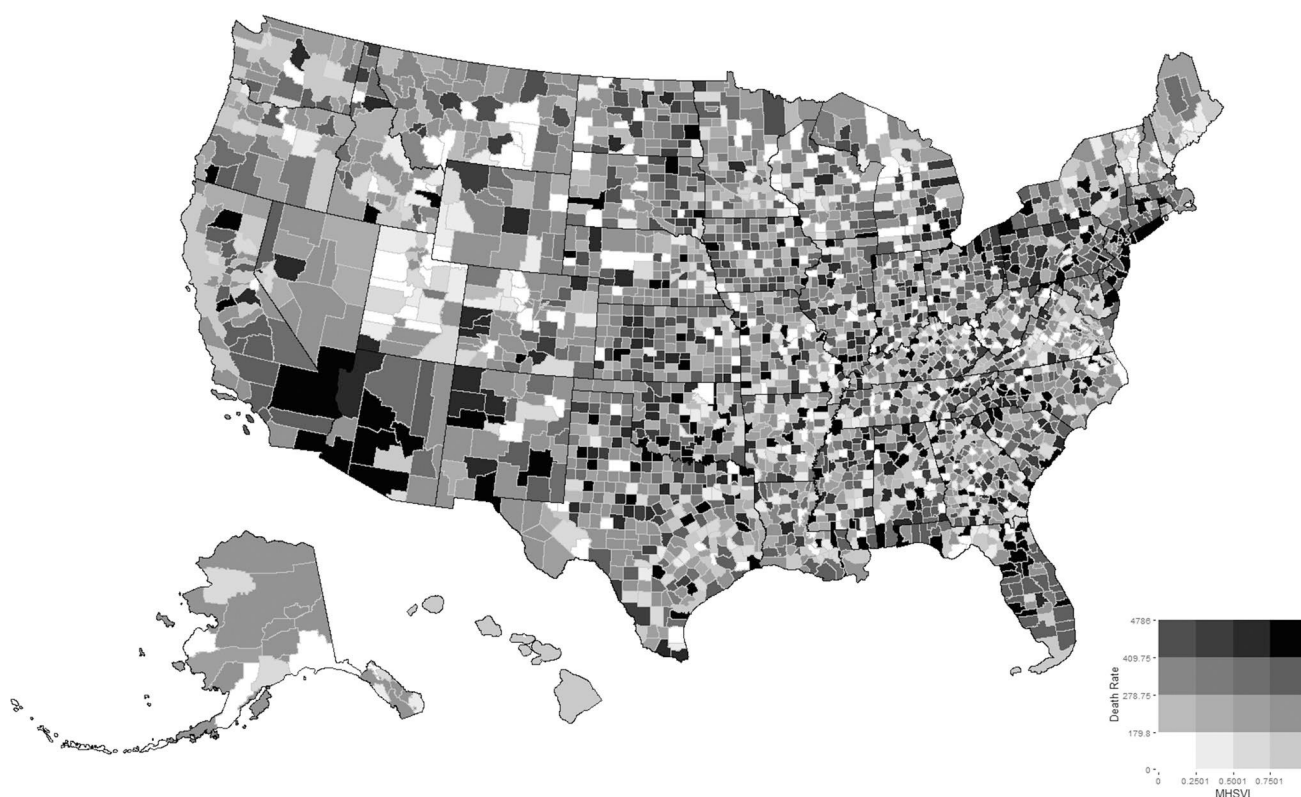


Fig. 4.
Household characteristics vulnerability and COVID-19 death rate per 100 k population, by county — USA, Jan 2020–Jun 2023

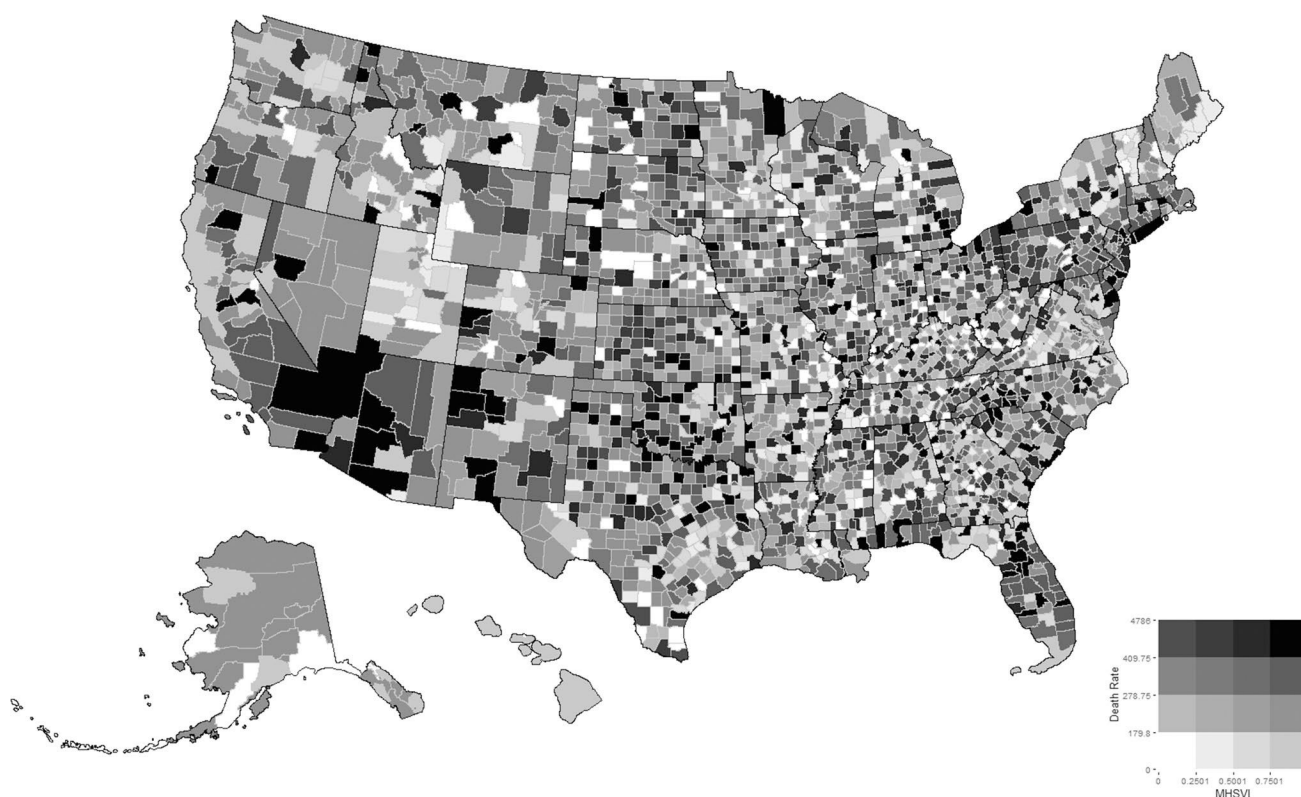


Fig. 5.
Racial and ethnic minority status vulnerability and COVID-19 death rate per 100 k
population, by county — USA, Jan 2020–Jun 2023

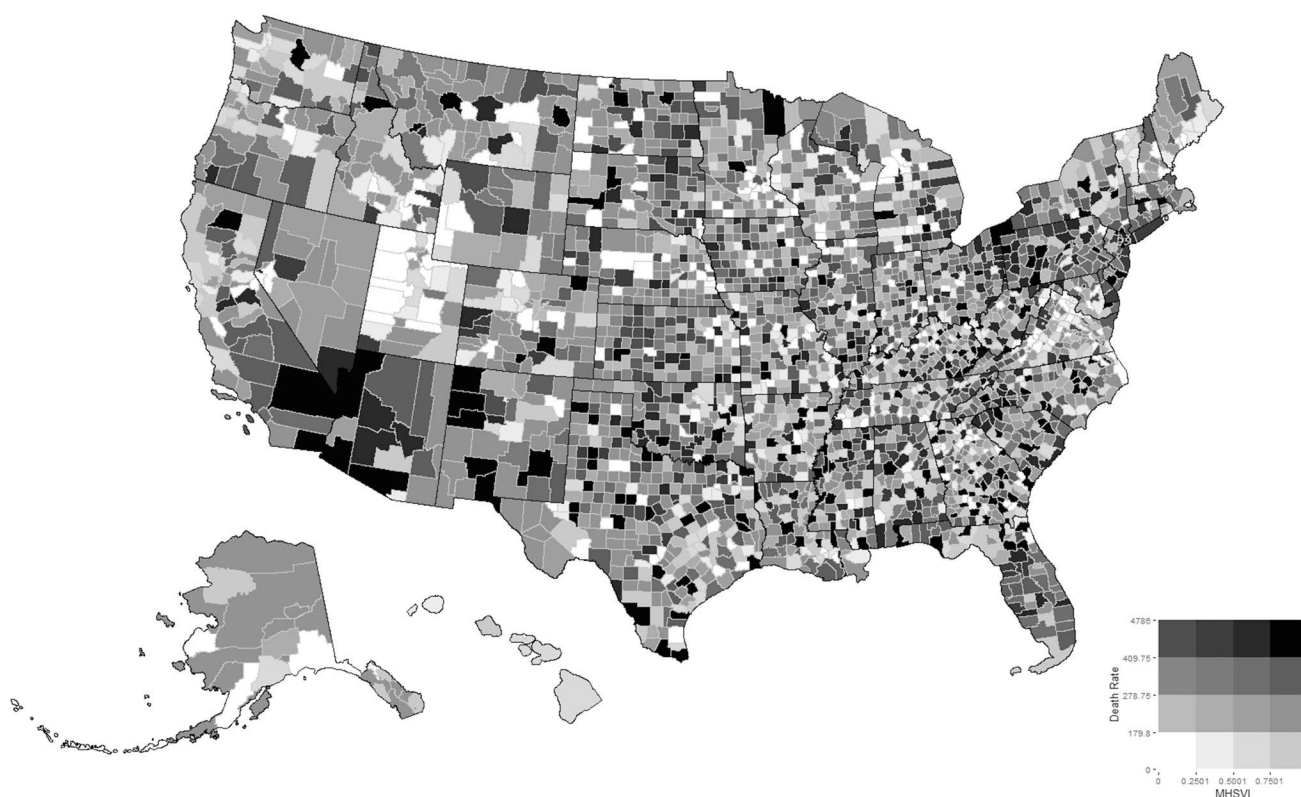


Fig. 6.
Housing type and transportation vulnerability and COVID-19 death rate per 100 k
population, by county — USA, Jan 2020–Jun 2023

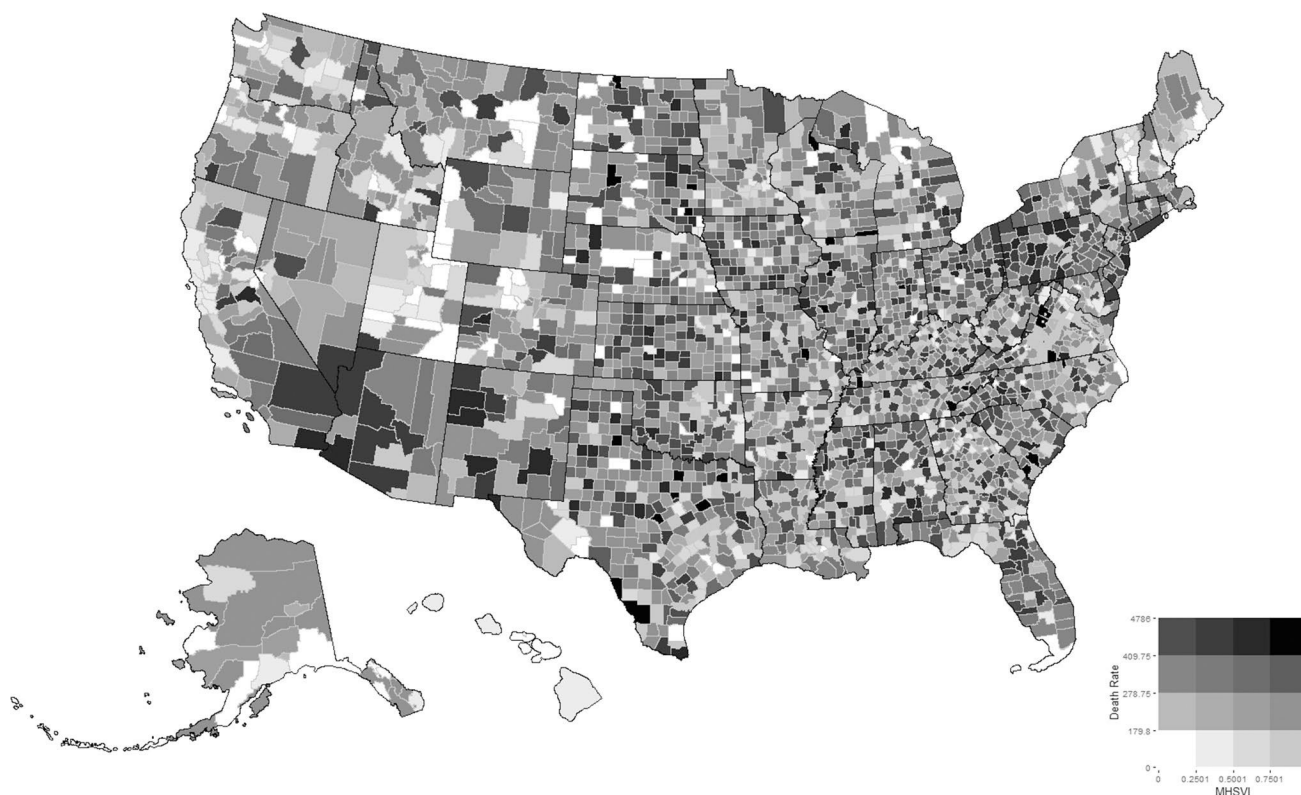


Fig. 7.
Health care and infrastructure and access vulnerability and COVID-19 death rate per 100 k
population, by county — USA, Jan 2020–Jun 2023

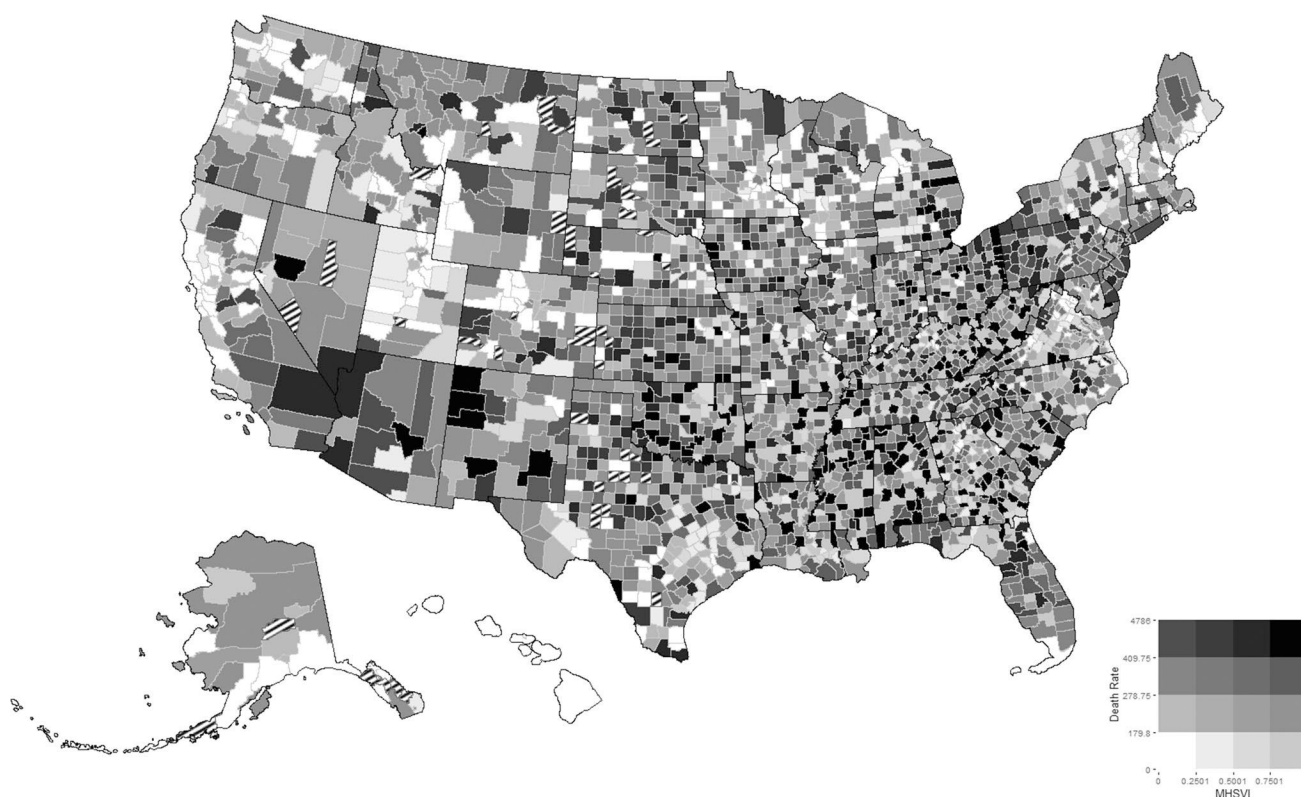


Fig. 8.
Medical vulnerability and COVID-19 death rate per 100 k population, by county — USA,
Jan 2020–Jun 2023

Descriptive statistics for the USA by county-level Minority Health Social Vulnerability Index sub-theme and sub-factors as of June 24, 2023

Table 1

Variable	Mean (SD)	Range
Total population (county)	105,790.3 (334,858.1)	653–10,040,682
Population density (residents/mi ²)	276.9 (1803.9)	0–71,363.3
Theme 1: socioeconomic status		
Percentage living below poverty line	24.5% (8.4)	3.7–71%
Percentage of unemployment	5.2% (2.5)	0–30.4%
Percentage of housing units with housing cost-burden	22.4% (5.1)	5.2–49.4%
Percentage with no high school diploma	12.4% (5.9)	1.5–51.5%
Percentage without health insurance	9.5% (5)	1–42.6%
Theme 2: household characteristics		
Percentage of persons aged 65 years and older	19.2% (4.7)	3–57.8%
Percentage of persons aged 17 years and younger	22.1% (3.5)	5.2–42.7%
Percentage with a disability	16% (4.4)	4.3–38.7%
Percentage of single parent household	5.9% (2.3)	0–22.7%
Percentage of Spanish speakers who speak English "less than well"	2.4% (4)	0–45.5%
Percentage of Chinese speakers who speak English "less than well"	0.1% (0.4)	0–10.9%
Percentage of Vietnamese speakers who speak English "less than well"	0.1% (0.2)	0–4.2%
Percentage of Korean speakers who speak English "less than well"	0% (0.1)	0–3.1%
Percentage of Russian speakers who speak English "less than well"	0.1% (0.2)	0–4%
Percentage of other language speakers who speak English "less than well"	0.7% (1.1)	0–18%
Theme 3: racial and ethnic minority status		
Percentage of American Indian/Alaska Native, not Hispanic or Latino	1.7% (7)	0–85.9%
Percentage of Asian, not Hispanic or Latino	1.4% (2.8)	0–41.7%
Percentage of African American or Black, not Hispanic or Latino	9% (14.4)	0–87.8%
Percentage of Native Hawaiian/Pacific Islander, not Hispanic or Latino	0.1% (0.4)	0–11%
Percentage of Hispanic or Latino/a	9.6% (13.9)	0–98.9%
Percentage of Two or more races, not Hispanic or Latino	2.3% (1.7)	0–23.1%
Percentage of Some Other Race Alone, not Hispanic or Latino	0.2% (0.2)	0–3.2%
Theme 4: housing type and transportation		

Variable	Mean (SD)	Range
Percentage of housing in structures with 10 or more units	4.8% (5.8)	0–89.6%
Percentage of mobile homes	12.6% (9.5)	0–56.9%
Percentage of occupied housing units with more people than rooms	2.3% (2.2)	0–36.4%
Percentage of households with no vehicle available	6.2% (4.2)	0–77.6%
Percentage of persons in institutionalized group quarters	3.5% (4.5)	0–45.5%
Theme 5: health care infrastructure and access		
Hospitals per 100,000	6.2 (9.1)	0–99.7
Urgent care clinics per 100,000	1.2 (2.8)	0–56.5
Pharmacies per 100,000	21.7 (11.1)	0–121.8
Primary care physicians per 100,000	52 (36.8)	0–572.1
Theme 6: medical vulnerability		
Percentage with no internet access	16.9% (7.6)	2.2–62.4%
Total cardiovascular disease death rate per 100,000 ^a	243.1 (59.1)	55.6–550.1
Total adults diagnosed with diabetes per 100,000 ^a	8642.4 (1697.6)	4100–16,400
Total adults with obesity per 100,000 ^a	27,963.1 (6,031.7)	11,000–48,600
Adults with chronic respiratory diseases per 100,000 ^a	64 (16.8)	14.3–160.9

^aForty-eight counties were excluded due to having missing information for the Minority Health Social Vulnerability Index. Three hundred forty-two counties with counts between 1 and 9 have been suppressed in accordance with NCHS confidentiality standards

^bThe table displays the mean and range for each sub-factor among counties

COVID-19 deaths, death rate, and rate ratios and Minority Health Social Vulnerability Index sub-theme by quartile in 3089 US counties as of June 24, 2023

Table 2

Theme	Minority Health Social Vulnerability Index			
	First quartile Least vulnerable	Second quartile	Third quartile	Fourth quartile Most vulnerable
Overall MHSVI^a				
Total deaths	57,407	160,319	224,640	691,869
Death rate per 100 k; median (IQR)	267 (170–390)	265(186–389)	261(169–393)	328 (200–462)
Adjusted rate ratio (95% CI)	1.0 (Ref)	1.06 (0.99–1.13)	1.14 (1.06–1.22)	1.41 (1.31–1.52)
P-value	-	0.907	< .001	< .001
Socioeconomic status				
Total deaths	183,873	253,060	324,409	372,919
Death rate per 100 k; median (IQR)	251 (161–365)	283(184–402)	288 (188–422)	297 (186–444)
Adjusted rate ratio (95% CI)	1.0 (Ref)	1.14 (1.06–1.21)	1.29 (1.2–1.38)	1.39 (1.28–1.5)
P-value	-	< .001	< .001	< .001
Household characteristics				
Total deaths	40,988	85,954	146,925	860,394
Death rate per 100 k; median (IQR)	236 (152–350)	259 (170–384)	288 (188–428)	326 (212–442)
Adjusted rate ratio (95% CI)	1.0 (Ref)	1.14 (1.07–1.21)	1.32 (1.24–1.41)	1.47 (1.37–1.57)
P-value	-	< .001	< .001	< .001
Racial and ethnic minority status				
Total deaths	46,892	75,100	220,197	792,072
Death rate per 100 k; median (IQR)	254 (180–375)	263 (164–400)	287(177–416)	314 (197–428)
Adjusted rate ratio (95% CI)	1.0 (Ref)	1.1 (1.03–1.17)	1.26 (1.18–1.34)	1.44 (1.34–1.55)
P-value	-	.004	< .001	< .001
Housing type and transportation				
Total deaths	96,989	186,021	392,891	458,360
Death rate per 100 k; median (IQR)	239 (148–348)	271(176–388)	291(188–428)	320(201–456)
Adjusted rate ratio (95% CI)	1.0 (Ref)	1.18 (1.11–1.26)	1.36 (1.28–1.45)	1.55 (1.46–1.66)
P-value	-	< .001	< .001	< .001

Theme	Minority Health Social Vulnerability Index			
	First quartile Least vulnerable	Second quartile	Third quartile	Fourth quartile Most vulnerable
Health care infrastructure and access				
Total deaths	524,479	440,670	130,842	38,270
Death rate per 100 k; median (<i>IQR</i>)	403 (273–553)	311 (205–410)	248(176–345)	174 (120–254)
Adjusted rate ratio (95% <i>CI</i>)	1.0 (Ref)	0.74 (0.71–0.78)	0.59 (0.56–0.62)	0.42 (0.39–0.44)
<i>P</i> -value	-	< .001	< .001	< .001
Medical vulnerability ^a				
Total deaths	426,059	261,853	252,235	194,088
Death rate per 100 k; median (<i>IQR</i>)	237(156–355)	288(188–402)	290(187–413)	309 (188–475)
Adjusted rate ratio (95% <i>CI</i>)	1.0 (Ref)	1.12 (1.05–1.19)	1.22 (1.14–1.3)	1.35 (1.25–1.45)
<i>P</i> -value	-	< .001	< .001	< .001

^aForty-eight counties were excluded due to having missing information for the Minority Health Social Vulnerability Index. Three hundred forty-two counties with counts between 1 and 9 have been suppressed in accordance with NCHS confidentiality standards

^bEach model included one theme, a population offset term, and a fixed effect. The rate ratios were adjusted for each US state as a fixed effect to address potential confounding at the state level while incorporating the natural logarithm of the county population as an offset term in the model

Table 3

Association between Minority Health Social Vulnerability Index Themes and COVID-19 Mortality in 3089 US counties as of June 24, 2023

Theme	<i>aRR</i> (95% confidence interval) ^b	<i>P</i> -value
Socioeconomic status	1.01 (1.00–1.02)	0.118
Household characteristics	1.01 (1.00–1.02)	.008
Racial and ethnic minority status	1.00 (0.99–1.01)	.404
Housing type and transportation	1.02 (1.01–1.03)	< .001
Health care infrastructure and access	0.90 (0.89–0.90)	< .001
Medical vulnerability ^a	1.04 (1.03–1.05)	< .001

^aForty-eight counties were excluded due to having missing information for the Minority Health Social Vulnerability Index. Three hundred forty-two counties with counts between 1 and 9 have been suppressed in accordance with NCHS confidentiality standards

^bThe model included all six themes, an offset term, and a fixed effect. The mortality rate ratios were adjusted for each US state as a fixed effect to address potential confounding at the state level while incorporating the natural logarithm of the county population as an offset term in the model
aRR adjusted rate ratio