

Published: December 31, 2022

Citation: Fos PJ, Honore, et al., 2022. Relationship of Social Vulnerability, COVID-19 Mortality, Life Expectancy, and Chronic Disease Prevalence: Policy Implications for Public Health and Social Sciences Funding, Medical Research Archives, [online] 10(12). <https://doi.org/10.18103/mra.v10i12.3403>

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DOI

<https://doi.org/10.18103/mra.v10i12.3403>

ISSN: 2375-1924

RESEARCH ARTICLE

Relationship of Social Vulnerability, COVID-19 Mortality, Life Expectancy, and Chronic Disease Prevalence: Policy Implications for Public Health and Social Sciences Funding

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ABSTRACT

Background: The Centers for Disease Control and Prevention and its affiliate the Agency for Toxic Substances & Disease Registry established an index to identify the social vulnerability for natural disasters and infectious disease outbreaks for communities in the United States. This index, potentially, may be useful in evaluating the impact of social vulnerability on health.

Aim: The objective of the study is to identify the relationship of the Social Vulnerability index with COVID-19, chronic diseases, and life expectancy.

Methods: Social Vulnerability Index values were obtained for counties in Georgia, Louisiana (parishes), Michigan, and Mississippi. Current data on COVID-19, diabetes and obesity prevalence, premature age-adjusted death rates, and life expectancy were obtained from the County Health Ranking and Roadmaps. Pearson's correlation coefficients were calculated for the relationship of social vulnerability and health outcomes. The relationship of funding for public health and social services interventions that target the social determinants of health as a

mechanism for reducing community vulnerabilities was also examined. **Results:** Correlations were determined between social vulnerability and several health outcomes, both infectious and chronic diseases. Life expectancy was correlated with social vulnerability, overall and by race. Study findings found a positive correlation between social vulnerability and COVID-19 infections and mortality, premature age-adjusted mortality, and the prevalence of diabetes and obesity. There is a negative correlation between social vulnerability and life expectancy. Additionally, life expectancy was greater in non-Hispanic Whites compared to non-Hispanic Blacks.

Conclusion: The study results can be used to guide policies directed to improvements in the social determinants of health that target reductions in community vulnerabilities. Social vulnerability of communities can be reduced with adequate resource allocations in public health and social services to mitigate untoward health outcomes associated with natural disasters and disease outbreaks.

Keywords: social vulnerability, COVID-19, life expectancy, social sciences funding

Introduction

The COVID-19 pandemic is in its third year with no end in sight. As of October 19, more than 621 million cases have been confirmed, with 6.5 million global deaths. The COVID-19 pandemic continues to progress across the world. As of the 26th of September, more than 611 million cases have been confirmed, and 6.5 million deaths. Most confirmed cases have occurred in Europe and the Americas. According to the United Nations Research Roadmap for the COVID-19 Recovery, COVID-19 has uncovered inequity and frailty that has affected the entire globe. COVID-19 put the world on hold, with lockdowns and travel restrictions causing an economic decline, social change, fear, and isolation in individuals.¹

The Centers for Disease Control and Prevention's (CDC) Agency for Toxic Substances & Disease Registry (ATSDR) established guidelines in response to the effect of natural disasters and disease outbreaks. These guidelines are called the Social Vulnerability Index (SVI). Social vulnerability refers to the potential negative effects on communities caused by external stresses on human health. These stresses include both natural or human-caused disasters, and disease outbreaks. If social vulnerability can be mitigated, then it is expected to result in a decrease in human suffering and economic loss.²

The SVI consists of 15 variables from the United States Census. The index is designed to assist local officials identify communities in need of assistance before, during, and after natural disasters and disease outbreaks. The SVI is expressed as interactive maps which, according to the CDC, can be used to: a) estimate the needed supplies, such as food, water, and medications; b) help in determining the adequate emergency personnel required; c) identify areas where emergency shelters needed to be located; d) plan the best way to evacuate people, including people with special needs, without transportation, the elderly, and people who English is a second language.

The SVI consists of four themes: socioeconomics, household composition and density, minority and language, and housing and transportation. The socioeconomic status theme is composed of four variables: percent of the population living below poverty, unemployment rate of those over age 16 years, per capita income, and percent of the population over 25 years of age without a high school diploma. The household composition and density theme consists of: percent of persons 65 years of age and older, percent of persons under the age of 17 years, percent of the population with a disability, and percent of single

parent households with children under the age of 18 years. The minority and language theme has two variables, the percent of the population that is non-Hispanic White and percent of persons over the age 5 years who do not speak English well. The housing and transportation theme consists of five variables: percent of housing structures in the community with 10 or more units, percent of mobile homes, percent of occupied housing units with more people than rooms, percent of households with no vehicles available, and percent of persons in institutionalized group homes. The sum of the four themes provides the overall SVI value, which is calculated for every census tract.

Variables used to populate the SVI themes are closely aligned and influenced by the social determinants of health. Evidence on the social determinants of health is supported with global research dating back at least to the 1970s.³ An often cited example is the association between mortality rates and education.⁴ In Health People 2030, the social determinants of health are defined as the conditions in the environments where people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks.⁵ The World Health Organization provides additional detail by simply explaining that the social determinants of health are the non-medical factors that influence health outcomes.⁶

The social determinants of health are drivers of social vulnerability. Research has shown that counties in the United States with high SVI values experienced high numbers of COVID-19 cases and deaths.⁷ In fact, the COVID-19 pandemic highlighted the effect of the social determinants of health on morbidity and mortality. A retrospective study was conducted to determine if social vulnerability was associated with COVID-19 infection in pregnant women. The study investigated women receiving COVID-19 testing and the SVI values for their communities. Study findings showed more women from communities with high SVI values tested positive for COVID-19. Statistical analysis found that the odds of COVID-19 positivity was twice higher for women living in communities with high SVI values. COVID-19 positivity was associated with values of SVI variables in higher percentages of women living in poverty, crowded households, more minorities, and limited English proficiency.⁸

Given previous research showing the relationship between social vulnerability and COVID-19, is this trend seen with COVID-19 vaccination coverage? A study was conducted to evaluate COVID-19 vaccination coverage and social vulnerability from December 14, 2020 -

March 1, 2021.⁹ Vaccine coverage was defined as receiving at least one dose of COVID-19 vaccine during December 14, 2020 – March 1, 2021. SVI values were classified as low, moderate, and high social vulnerability. Study findings, nationwide, indicated vaccination coverage was lowest in counties with high SVI values. The SVI variables which contributed to lower vaccination coverage were percent of population 65 years and older, percent of housing structures with 10 or more units, and percent of households with no available vehicles.

A recent study evaluated the temporal trends of COVID-19 morbidity and mortality of and social vulnerability.¹⁰ At the beginning of the pandemic, according to the study findings, counties with high SVI values had fewer cases than those with low social vulnerability. This was suggested to be due to local policy discussions. As the pandemic progressed over time those counties with higher SVI values had higher COVID-19 incidence. The relative risks showed the greatest disparity for the minority and language theme. Additionally, counties with high SVI values had higher mortality rates several months into the pandemic. Interesting, later in the pandemic the most vulnerable counties had lower mortality rates.

Rural communities have been identified as populations in need of special attention by public health agencies during the COVID-19 pandemic.¹¹ It is known that the majority of American Indians and Alaska Natives live in rural communities. A study of the effects of COVID-19 in American Indians and Alaska Natives evaluated its impact. Study findings illustrated that the risk of COVID-19 infection and complications was high in American Indian and Alaska Native communities. Examination of SVI variables showed high percentages of social vulnerability across all four themes.¹²

Social vulnerability has been linked with chronic diseases. Cardiovascular disease continues to be the top cause of death in the United States, and accounts for most premature deaths, which is defined as death before the age of 65 years, in the United States.¹³ There are significant disparities in cardiovascular mortality in American counties. A cross-sectional study investigated the effect of social vulnerability and cardiovascular disease mortality.¹⁴ The study categorized SVI into four quartiles, from lowest to highest, for counties in the United States. Overall, age-adjusted cardiovascular disease mortality rates increased from the lowest SVI quartile to the highest. Women living in communities with high SVI values had double the risk of premature death from cardiovascular disease. Non-Hispanic Blacks in high social vulnerability communities had the highest

cardiovascular mortality, compared to all other races or ethnic groups.

Life expectancy is an indicator of the health of a population. Life expectancy has decreased in the United States over the past several years.¹⁵ Disparities exist in life expectancy in socially vulnerable populations.¹⁶ Previous research has shown a positive correlation between SVI values and preventable chronic diseases.¹⁷ Research which examined the relationship of social vulnerability and life expectancy show that counties with high SVI values have relatively low life expectancy. Alternately, counties with low SVI values have relatively high life expectancy. Further results indicated significant disparities exists in highly socially vulnerable counties.¹⁸

During the height of the pandemic, direct medical costs due to COVID-19 infection were determined to equal \$1,772 per day of hospitalization. The average length of stay was 6 days, for a total cost of \$11, 267 for each hospitalization. The length of stay in intensive care units was 5 days, on average, per day cost of \$2,902 or a total of \$13,443. If a patient is mechanically ventilated the total hospital costs were \$47,454 with an average 16 day length of stay. Mechanical ventilation in the intensive care unit was associated with an average length of stay of 11 days, and a total cost of \$41,510.¹⁹

In a study which forecasted costs of the COVID-19 pandemic, simulations revealed that one case could be associated with a median direct medical cost of \$3,045. It was also estimated if 20% of the United States population became infected, the result would be 11.2 million hospitalizations and \$163.4 billion total direct medical cost. If the pandemic infected 80% of the population 44.6 million hospitalization would result and an expected total cost of direct medical care of \$654 billion.²⁰

Many studies have documented that funding for public health services or the infrastructure to deliver those services has been under-funded for decades. When considering the total amount the United States spends on financing of the health care system, public health funding has been continually decreasing. The public health system is the first line of defense for disease prevention and health promotion and especially against infectious disease pandemics. Strengthening the infrastructure and providing adequate funding is an important requirement for addressing epidemics and pandemics. It is also important for targeting interventions to SVI variables that drive negative consequences. The same is true of targeted social services funding. In a July 2022 report by the Center for Budget and

Policy Priorities, it documented that the United States federal budget financed various public services at the following levels: education 3%, transportation 2%, natural resources and agriculture 1%, and law enforcement 1% while health care was financed at 25%.²¹ Current US social services funding from public and private sources is documented at 19.7% of GDP, similar when compared to Organization for Economic Cooperation and Development (OECD countries).²²⁻²³ Appropriate planning of use of finances is of equal importance.²⁴

This paper describes the evaluation of the correlation between social vulnerability and health outcomes in several counties/parishes in four states in the United States. The CDC's Social Vulnerability Index was used to measure social vulnerability. This study evaluated data from these areas focused on COVID-19 infections and deaths, associated life expectancy, premature death, and recognized-COVID-19 comorbidities diabetes and obesity. Policy implications for public health were identified.

Methods

County-level COVID-19 infection and mortality rates were acquired from the Louisiana Department of Health, the Mississippi State Department of Health, the Georgia Department of Health and the Michigan Department of Health. The study counties and parishes were selected to continue the research of the authors. When the COVID-19 pandemic began in early 2020 the study's counties and parishes were hotspots of infection and mortality. The authors have studied these counties and parishes over the past three years. Selection bias may be a concern, but the authors assume this challenge to continue their line of research.²⁵⁻³⁰ A common characteristics of the study areas was the demographics of the population, given that mortality rate from COVID-19 is the disproportionate among minorities.

The CDC's SVI was used to measure social vulnerability. SVI values overall, and four each of the four themes were acquired from the SVI website. The SVI values for the counties and parishes were examined for the study areas. The parishes in Louisiana were Orleans, Jefferson, St. Tammany, St. Bernard, St. James, St. Charles, St. John the Baptist, Iberville, East Baton Rouge, and West Baton Rouge. The counties in Mississippi were Hinds and Harrison. The counties in Georgia were DeKalb, Dougherty, and Fulton. The counties in Michigan in this study were Macomb, Oakland, and Wayne. Additionally, the SVI values for the four themes for each county/parish were obtained. SVI values ranges from 0 to 1, with values close to 0

considered to be at low vulnerability and values close to 1 having high vulnerability.

Another data source was 2022 County Health Rankings.³¹ County health rankings' variables were: life expectancy (measured as deaths of persons younger than 75 years), premature age-adjusted death (measured as the number of deaths among people under age 75 years per 100,000 population, age-adjusted), prevalence of diabetes (percentage of adults aged 20 years and older with diagnosed diabetes, age-adjusted), and prevalence of obesity (measured as the percentage of the adult population, age 18 years and older, with a reported body mass index greater than or equal to 30 kg/m², age-adjusted).

Correlations between the SVI index values and life expectancy, premature age-adjusted mortality, diabetes prevalence, and prevalence of obesity were calculated. Correlations between SVI values and chronic disease prevalence were calculated because of the strong association of chronic diseases and COVID-19 infection and death. Specifically, diabetes and obesity prevalence were among the top four co-morbidities associated with COVID-19 mortality.²⁵ Pearson's correlation coefficients were determined using IBM SPSS Statistics for Windows Version 27.0.

To evaluate whether there exist any disparity in life expectancy between non-Hispanic Blacks and Whites, the absolute difference in years of life expectancy was determined. It has been shown that non-Hispanic Blacks have lower life expectancy from birth than non-Hispanic Whites, especially among non-Hispanic Black males.³² Differences in life expectancy would indicate the impact of health disparities over time.³³

Results

SVI values, as well as theme SVI values, are presented in Table 1. The overall SVI values ranged from 0.9513 in Dougherty County, Georgia to 0.1140 in Oakland County, Michigan. Dougherty County has high social vulnerability and Oakland County's social vulnerability is low. The average overall SVI value was 0.6696. The Socioeconomic theme values averaged 0.5977, with the highest theme value in Dougherty County, Georgia and lowest value, 0.034 in Oakland County, Michigan, as was seen in the overall SVI values. The Household Composition and Density theme values were like the Socioeconomics values with the highest in Dougherty County, Georgia and lowest in Oakland County, Michigan, with an average of 0.4889. The Minority and Language theme values averaged 0.7702, with values ranging from 0.9688 in DeKalb County, Georgia to 0.4893 in St. James Parish, Louisiana. The highest Housing and

Transportation theme value was in West Baton Rouge Parish, Louisiana (0.9424) and the lowest in Oakland County, Michigan (0.1840).

Table 1: Social Vulnerability Index

County/Parish	SV Value	Theme 1 Socioeconomics SVI Value	Theme 2 Household Composition and Density SVI Value	Theme 3 Minority and Language SVI Value	Theme 4 Housing and Transportation SVI Value
Louisiana					
Orleans	0.7449 ⁺	0.6997 ⁺	0.1761 [#]	0.8797 [*]	0.7771 [*]
Jefferson	0.6121 ⁺	0.5054 ⁺	0.3992 [^]	0.9296 [*]	0.4610 [^]
Iberville	0.8860 [*]	0.7987 ⁺	0.7240 ⁺	0.5791 ⁺	0.9564 [*]
St. Bernard	0.7713 [*]	0.8908 [*]	0.7625 [*]	0.8071 [*]	0.1888 [#]
St. James	0.6299 ⁺	0.6589 ⁺	0.5355 ⁺	0.4893 [^]	0.6027 ⁺
St. Charles	0.3529 [^]	0.3220 [^]	0.4877 [^]	0.6584 ⁺	0.2436 [#]
St. John the Baptist	0.7468 ⁺	0.7022 ⁺	0.6692 ⁺	0.8042 [*]	0.4916 [^]
East Baton Rouge	0.6653 ⁺	0.4841 [^]	0.3537 [^]	0.8727 [*]	0.7593 [*]
West Baton Rouge	0.7611 [*]	0.5561 ⁺	0.6835 ⁺	0.5489 ⁺	0.9424 [*]
Mississippi					
Hinds	0.8742 [*]	0.8182 [*]	0.5603 ⁺	0.7746 [*]	0.8720 [*]
Harrison	0.8838 [*]	0.7764 [*]	0.7714 [*]	0.7781 [*]	0.8637 [*]
Georgia					
Dekalb	0.6611 ⁺	0.4889 [^]	0.2230 [^]	0.9688 [*]	0.7208 ⁺
Dougherty	0.9513 [*]	0.9427 [*]	0.8271 [*]	0.7076 ⁺	0.9204 [*]
Fulton	0.5268 ⁺	0.3245 [^]	0.1124 [#]	0.8968 [*]	0.8259 [*]
Michigan					
Macomb	0.3296 [^]	0.3166 [^]	0.1961 [^]	0.7386 ⁺	0.3130 [^]
Oakland	0.1140 [#]	0.0834 [#]	0.0455 [#]	0.7593 ⁺	0.1840 [#]
Wayne	0.8723 [*]	0.7936 ⁺	0.7845 ⁺	0.9019 [*]	0.6587 ⁺

Note: 1 = highest social vulnerability; 0 = lowest social vulnerability

*high social vulnerability

+moderate to high social vulnerability

^low to moderate social vulnerability

#low social vulnerability

Source: Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry

Within-state review shows some interesting findings. In Louisiana, Iberville Parish has the highest overall SVI value (0.8860), followed by St. Bernard Parish (0.7713), indicating high vulnerability. West Baton Rouge Parish also has high vulnerability (0.7611), while St. John the Baptist (0.7468) and Orleans Parishes (0.7449), has moderate to high vulnerability. Jefferson and East Baton Rouge Parish have moderate to high social vulnerability, St. Tammany Parish has a low to moderate SVI value, as does St. Charles Parish.

Review of the two counties in Mississippi shows high vulnerability in both. Harrison County has an SVI value of 0.8838 and Hinds County's value is 0.8742. Two counties in Georgia have high vulnerability, Dekalb and Dougherty. In fact, Dougherty has the highest social vulnerability value of all the counties/parishes in the study. Fulton County has moderate to high vulnerability. The only county in Michigan with high vulnerability is Wayne, which includes the city of Detroit.

The theme SVI values are variable. The Socioeconomics theme values which indicate high vulnerability are seen in Dougherty, Wayne, Hinds,

Harrison counties, as well as Iberville and St. Bernard Parishes. Moderate to high social vulnerability values are seen in Orleans, Jefferson, St. James, St. John the Baptist, and West Baton Rouge Parishes. The remaining counties/parishes in the study have moderate to low vulnerability values.

The Household Composition and Density theme shows four counties/parishes at high vulnerability. These are Dougherty, Wayne, Harrison counties, and St. Bernard Parish. Four parishes and one county have moderate to high vulnerability values: Orleans, St. James, St. John the Baptist, West Baton Rouge, and Hinds. The Minority and Language theme values indicate high vulnerability in ten of the seventeen study areas. Louisiana parishes include Orleans, Jefferson, St. Bernard, St. John the Baptist, and East Baton Rouge. Both counties in Mississippi have high vulnerability values. Dekalb and Dougherty Counties have high vulnerability, as does Wayne County, Michigan.

Social vulnerability values for the Housing and Transportation theme ranged from 0.9564 to 0.1840. The highest vulnerability value is in

Iberville Parish and the lowest is in Oakland County, Michigan. High vulnerability is seen in Dougherty and Fulton Counties in Georgia; Hinds and Harrison Counties in Mississippi; Orleans, Iberville, East and West Baton Rouge Parishes in Louisiana. Wayne and Dekalb Counties, and St. James Parish have moderate to high vulnerability values.

Table 2 illustrates data on COVID-19 infection rate, COVID-19 death rate, COVID-19 case-fatality rate, life expectancy, premature age-adjusted mortality, diabetes, and obesity prevalence. The highest COVID-19 infection rate, which is the cumulative incidence, is in Oakland County (50,599 cases per 100,000 population). Other high rates are in Iberville Parish, Macomb County, Hinds County and Harrison County. COVID-19 mortality rate is greatest in Dougherty County (522.27 deaths per 100,000 population), Iberville Parish (516.37 deaths per 100,000 population),

and Macomb County (473.54 deaths per 100,000 population). The COVID-19 case-fatality rate was greatest in Dougherty (3.00%) and Wayne (2.42%) Counties. Overall life expectancy was highest in Oakland and Dekalb Counties (79.9 years), and lowest in Dougherty County (72.8 years). Premature age-adjusted mortality rate, including deaths due to COVID-19, is highest in Dougherty County (600 deaths per 100,000 population), followed closely by Hinds County (570 deaths per 100,000). The highest diabetes prevalence is in Dougherty County where 16% of adults over 20 years of age have diagnosed diabetes. Hinds County's diabetes prevalence rate is 15%, the second highest. Iberville Parish has the highest obesity prevalence of 43% (adults over 18 years of age). St. James Parish, St. John the Baptist Parish, Hinds County, Harrison County, and Wayne County have obesity prevalence 40% or higher.

Table 2: COVID-19, Life Expectancy, Premature Mortality, Diabetes, Obesity

County/ Parish	COVID-19 Infection Rate*	COVID-19 Death Rate*	COVID-19 Case Fatality Rate (%)	Life Expectancy (Years)	Premature Age-adjusted Mortality*	Diabetes Prevalence(%)	Obesity Prevalence(%)
Louisiana							
Orleans	27,743.8	307.98	1.11	75.9	490	13	33
Jefferson	30,365.5	319.58	1.05	76.7	430	11	36
Iberville	35,823.0	516.37	1.44	74.6	540	13	43
St. Bernard	29,746.0	257.58	0.87	74.8	520	13	39
St. James	34,348.1	379.90	1.11	76.2	440	13	40
St. Charles	30,480.9	284.99	0.93	76.4	390	10	35
St. John the Baptist	29,124.1	439.49	1.51	73.8	510	13	41
East Baton Rouge	28,067.1	306.89	1.09	75.1	480	12	36
West Baton Rouge	29,918.7	334.63	1.12	77.1	450	11	37
Mississippi							
Hinds	27,374.1	366.00	1.32	73.7	570	15	42
Harrison	29,265.6	327.13	1.12	74.6	510	12	40
Georgia							
Dekalb	19,594.7	204.75	1.04	79.9	340	12	33
Dougherty	17,426.2	522.77	3.00	72.8	600	16	39
Fulton	20,014.2	202.15	1.01	79.0	340	11	29
Michigan							
Macomb	30,425.5	473.54	1.56	77.4	380	10	36
Oakland	50,559.0	319.76	0.63	79.9	290	9	31
Wayne	17,815.5	467.26	2.62	74.3	530	12	40

Source: County Health Ranking
Louisiana Department of Health
Mississippi State Department of Health
Georgia Department of Health
Michigan Department of Health

*Per 100,000

Note: COVID-19 data as of October 15, 2022

Table 3 shows the disparity in life expectancy between non-Hispanic Whites and non-Hispanic Blacks. In each study county/parish, life expectancy is higher in non-Hispanic Whites than non-Hispanic Blacks. The greatest difference is in Fulton County where the life expectancy of non-

Hispanic Whites is 7.9 years higher than in non-Hispanic Blacks. The difference in Wayne County is 6.8 years, 6.7 years difference in St. James Parish, and 6.6 years difference in Orleans and West Baton Rouge Parishes. The least difference in life expectancy (approximately 2 years) is in

Dougherty County, Harrison County, and St. John the Baptist Parish.

Table 3: Life Expectancy in Years, by Race

County/Parish	Life Expectancy	Life Expectancy, NH-Blacks	Life Expectancy, NH-Whites	Difference NH-Whites, NH-Blacks (years)
Louisiana				
Orleans	75.9	73.2	79.8	6.6
Jefferson	76.7	72.6	77.0	4.4
Iberville	74.6	72.9	75.8	2.9
St. Bernard	74.8	71.5	74.1	2.6
St. James	76.2	72.9	79.6	6.7
St. Charles	76.4	72.8	77.0	4.2
St. John the Baptist	73.8	72.3	74.4	2.1
East Baton Rouge	75.1	71.8	77.5	5.7
West Baton Rouge	77.1	73.0	79.6	6.6
Mississippi				
Hinds	73.7	72.7	76.4	3.7
Harrison	74.6	72.6	74.8	2.2
Georgia				
Dekalb	79.9	77.8	82.4	4.6
Dougherty	72.8	72.0	73.9	1.9
Fulton	79.0	74.6	82.5	7.9
Michigan				
Macomb	77.4	72.1	77.9	5.8
Oakland	79.9	75.8	80.2	4.4
Wayne	74.3	70.2	77.0	6.8

Source: County Health Rankings and Roadmaps

Table 4 shows Pearson's correlations between SVI values and health outcomes. SVI values were significantly negatively correlated with life expectancy, and life expectancy among non-Hispanic Whites (p-values of <.01 and <.05). This indicates that as social vulnerability increased, life expectancy decreased. SVI values were significantly positively correlated with COVID-19 infection rate, COVID-19 case-fatality rate,

premature age-adjusted mortality rate, and diabetes and obesity prevalence (p-values of <.01 and <.05). As social vulnerability increased, these outcomes also increased. Correlations of SVI values and life expectancy among non-Hispanic Blacks and COVID-19 mortality rate were not statistically significant.

Table 4: Correlations of SVI and Theme Values with Study Variables

	SVI	Theme 1 Socioeconomics	Theme 2 Household Composition and Density	Theme 3 Minority and Language	Theme 4 Housing and Transportation
Variable	Pearson's Coefficient (p-value)	Pearson's Coefficient (p-value)	Pearson's Coefficient (p-value)	Pearson's Coefficient (p-value)	Pearson's Coefficient (p-value)
Life Expectancy	-.743 (<.01)	-.834 (<.01)	-0.801 (<.01)	0.177 (NS)	-0.302 (NS)
Life Expectancy, NH Blacks	-.417 (NS)	-.523 (<.05)	-0.630 (<.01)	0.175 (NS)	-0.0003 (NS)
Life Expectancy, NH Whites	-.486 (<.05)	-0.644 (<.01)	-0.771 (<.001)	0.162 (NS)	0.161 (NS)
COVID-19 Infection Rate	.563 (<.05)	-0.439 (NS)	-0.264 (NS)	-0.416 (NS)	-0.464 (NS)
COVID-19 Mortality Rate	.326 (NS)	0.417 (NS)	0.502 (<.05)	-0.413 (NS)	0.185 (NS)
COVID-19 Case Fatality Rate	.518 (<.05)	0.534 (<.05)	0.521 (<.05)	-0.005 (NS)	0.346 (NS)
Premature Age-adjusted Mortality Rate	.872 (<.01)	0.927 (<.01)	0.806 (<.01)	-0.147 (NS)	0.464 (NS)
Diabetes Prevalence	.816 (<.01)	0.868 (<.01)	0.563 (<.05)	-0.070 (NS)	0.542 (<.05)
Obesity Prevalence	.675 (<.01)	0.767 (<.01)	0.845 (<.01)	-0.417 (NS)	0.250 (NS)

Socioeconomics theme's SVI values were significantly positively correlated with COVID-19 case-fatality rate, premature age-adjusted mortality rate, and diabetes and obesity prevalence (p-values of <.01 and <.05). Values that were significantly negatively correlated included life expectancy, life expectancy among non-Hispanic Blacks, and non-Hispanic Whites (p-values of <.01 and <.05). Correlations of SVI theme values and COVID-19 infection rate and COVID-19 mortality rate were not statistically significantly correlated.

Correlations with Household Composition and Disability theme values were similar to those with the Socioeconomics theme. Life expectancy ($r = -.081$), life expectancy among non-Hispanic Blacks ($r = -.630$), and life expectancy among non-Hispanic Whites ($r = -.771$) were significantly negatively correlated with theme SVI values. Again, this shows that as SVI theme values increase, life expectancy decreases. COVID-19 mortality rate ($r = .502$), COVID-19 case-fatality rate ($r = .521$), premature age-adjusted mortality rate ($r = .806$), diabetes prevalence ($r = .563$), and obesity prevalence ($r = .845$) are significantly positively correlated with theme values. COVID-19 infection rate and COVID-19 case-fatality rate are not statistically significantly correlations with Household Composition and Density theme SVI values.

There was no significant correlation between Minority and Language theme SVI values and study variables. A similar finding was seen Housing and Transportation theme SVI values and study variables, except for diabetes prevalence. Diabetes prevalence is positively correlated with theme SVI values ($r = .542$). This indicates that as the social vulnerability increases, the diabetes prevalence increases ($p < .05$).

Discussion

The Socioeconomics theme SVI values are positively correlated with COVID-19 case-fatality rate, premature age-adjusted mortality rate, diabetes prevalence, and obesity prevalence. This is not surprising because of the effect of socioeconomic characteristics on health and wellness. Increasing SVI Socioeconomic theme values, which indicate increasing vulnerability, are related to increasing values of untoward health outcomes. COVID-19 infection and mortality rate are not correlated with Socioeconomics theme SVI values. Again, this may be explained by the relatively long duration of the COVID-19 pandemic.

SVI values for the Household Composition and Density are positively related with all health outcomes values, except for COVID-19 mortality

rate. The Pearson's correlation coefficient is highest with premature age-adjusted mortality rate (0.806) and obesity prevalence (0.845). Overcrowded households are considered to detrimental to health and well-being across all racial and ethnic groups. Crowding has been directly associated with adverse health outcomes, in particular mental health problems and infectious disease.³⁴

The SVI theme values for Minority and Language and Housing and Transportation are not related with study health outcomes, except for diabetes prevalence. Diabetes prevalence is positively correlated with Housing and Transportation theme SVI values, with a Pearson's correlation coefficient of 0.542. This was seen when evaluating the relation between the SVI values of these themes and life expectancy among non-Hispanic Blacks and non-Hispanic Whites.

Study results follow what has been reported in the body of literature on the social determinants of health provides a wide variety of domains recognized as factors that influence community, individual, and population health. The relationship of social determinants of health and improved health outcomes is strongly documented.³⁵ Frequently cited social determinants of health categories that are a mix of public health and social services functions are housing, education, economic conditions, healthcare, neighborhood conditions, environmental exposures, transportation, employment, food security, and community safety. Given the intersection of the social determinants of health categories to those used by developers of the SVI, it is reasonable that an analysis that examines the community and individual consequences of the SVI during disasters and disease outbreaks should also look at the likelihood of the social determinants of health as drivers of the SVI. Insights into this influence could have major implications to guide funding policies for both public health and social services activities. In fact, evidence shows that jurisdictions with a high-social services to health spending ratio had better health outcomes in several measures such as asthma, type 2 diabetes, and adult obesity.²⁴

Social vulnerability has been associated with the impact of the COVID-19 pandemic. A study of the relationship between social vulnerability and COVID-19 infection was conducted among census tracts in Louisiana. The study, after adjusting for population density, found that all four SVI themes were significantly associated with COVID-19 incidence. The study also found a correlation between high levels of social vulnerability and higher COVID-19 infection⁷

Health disparities between non-Hispanic Whites and non-Hispanic Blacks are illustrated

when evaluating life expectancy. An inverse relationship is seen between SVI values and life expectancy of both non-Hispanic Whites and non-Hispanic Blacks (the correlated is negative, but not statistically significant in non-Hispanic Blacks). The average difference in life expectancy between non-Hispanic Whites and non-Hispanic Blacks in the 17 study counties/parishes is 4.7 years. The greatest disparity is seen in Dougherty County (7.9 years), Wayne County (6.8 years), and St. James Parish (6.7 years). Life expectancy was highest among non-Hispanic Whites in all study counties/parishes.

SVI theme values confirm the life expectancy disparity. Life expectancy and the Socioeconomics theme values are inversely related for non-Hispanic Whites and non-Hispanic Blacks. The same is seen in the Household Composition and Density theme. The correlation for non-Hispanic Whites is -0.771 ($p < .001$) and non-Hispanic Blacks is -0.630 ($p < .01$). Life expectancy among non-Hispanic Whites and non-Hispanic Blacks and SVI values for the themes Minority and Language and Housing and Transportation are not statistically significantly correlated. These finding follows previous research of racial differences in life expectancy. A twenty-year study of racial differences in Life expectancy showed disparities among racial groups. The study found that these disparities were nationwide and apparently ongoing.³⁶

Below we present the potential implications from policies that can target reducing the burden of poor health outcomes foster by individual and community vulnerabilities.

Policy implications are that systematically strengthening resource allocation policies at all levels of government for public health and social services interventions can be embraced as tools to lessen the burden of community vulnerabilities as measured with the SVI. Enhancing government funding through policies such as the Internal Revenue Service community-benefit requirements could be used to incentivize health care private sector funding for public health and social services. The benefit to government is reduced vulnerabilities and financial hardships on local communities and the federal government especially in times of natural disasters and other crisis. From a broader perspective, policies to strengthen funding policies would promote overall improvements in health

outcomes. A major benefit of policies for public health and social services that target social determinants of health would be to provide guidance that has been lacking, on implementation of actionable interventions that result in desired impacts. Exploring policies and piloting some community-based targeted approaches to funding rather than the more traditional disease-focused models could support local efforts to address factors that directly influence community vulnerabilities.

Conclusion

This study clearly shows the relationship of SVI values and health outcomes. SVI values are inversely related to life expectancy. As SVI values increase, life expectancy decreases. SVI values are directly related with COVID-19 infection rate, COVID-19 case-fatality rates, premature age-adjusted mortality rate, diabetes prevalence, and obesity prevalence. There appears to be no significant correlation between SVI values and COVID-19 mortality rate. This may be because of cumulative incidence of COVID-19, over time. The longer the pandemic is ongoing the greater chance for people, regardless of their geographic residence, will become infected and may subsequently die.

The Social Vulnerability Index values are correlated with COVID-19 effects on the population, as well as chronic diseases. Overall, attention to the Social Vulnerability Index would also guide policymakers in addressing health equity and reducing disparities. Similar to the social determinants of health, goals for improving equity are widespread, but lack of improvement continues to persist. Application of the Social Vulnerability Index as a tool for formulating policies to address health equity warrants serious consideration.

Source(s) of support: Research reported in this study was funded, in part, by the National Institute of Minority Health and Health Disparities of the National Institutes of Health under grant S21MD1007136.

Conflicting Interest (if present, give more details):
None

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