

University of Tennessee at Chattanooga

UTC Scholar

Honors Theses

Student Research, Creative Works, and
Publications

12-2021

Examining an intersection of environmental justice and COVID-19 risk assessment: a review

Ashley Ellis

University of Tennessee at Chattanooga, ldr857@mocs.utc.edu

Follow this and additional works at: <https://scholar.utc.edu/honors-theses>



Part of the [Environmental Health Commons](#), and the [Epidemiology Commons](#)

Recommended Citation

Ellis, Ashley, "Examining an intersection of environmental justice and COVID-19 risk assessment: a review" (2021). *Honors Theses*.

This Theses is brought to you for free and open access by the Student Research, Creative Works, and Publications at UTC Scholar. It has been accepted for inclusion in Honors Theses by an authorized administrator of UTC Scholar. For more information, please contact scholar@utc.edu.

Examining an Intersection of Environmental Justice and COVID-19 Risk Assessment: A Review

Ashley Ellis

Departmental Honors Thesis

University of Tennessee at Chattanooga

Department of Biology, Geology and Environmental Sciences

Examination Date: November 9, 2021

Dr. Dawn Ford

Chief Epidemiologist

Assistant Professor, MPH Program

Thesis Director

Dr. Bradley Reynolds

Senior Lecturer

BGE Department

Department Examiner

Table of Contents

Abstract	4
List of Tables and Figures	5
Introduction	6
Theoretical Foundation	7
Rationale for utilizing disaster management SVI variables	9
Background	11
Methods	12
The need for intersectional studies in Environmental Justice	14
Determinants involved in COVID-19 Environmental Injustice	15
Minority Status	15
Socioeconomic status: income, poverty, employment and education variables	16
Gender Inequality	18
Underlying Health Conditions	19
Spatial Inequalities	20
Representation in Policy	21
A Case Study: Chattanooga	22
Transportation	23
Underlying Health Conditions	23
Social Vulnerability Index	25
Spatial Variables	26
Discussion/Conclusion	28
Limitations	29

Examining an Intersection of Environmental Justice and COVID-19 Risk Assessment: A Review

Recommendations 30

 Risk Assessment and Outreach 30

 Survey Methods 32

 GIS distribution maps 32

References 34

Abstract

This study views the risks associated with the novel coronavirus (COVID-19) as an environmental injustice issue due to the connection between existing environmental disparities and the disproportional negative impacts brought upon by the virus. The social and health determinants attributed to those environmental disparities have traditionally been evaluated as individual risk factors, an approach that fails to gauge the complexity of an environmental injustice issue. This study employs the emerging theory of intersectionality, a belief that phenomena cannot be linked to one principal cause but instead an interconnected web of influences, in order to synthesize the multitude of factors believed to create a heightened risk to COVID-19. The U.S. Census variables integrated into the Centers for Disease Control Social Vulnerability Index (CDC SVI) provides a familiar outline of determinants to consider for risk assessment by local authorities and outreach efforts. Additional influences are evaluated to further highlight the intersectional nature of the pandemic's consequences that also serve as unique identifiers when mainstream data is unavailable. The scientific literature, case studies and COVID-related data reviewed here have revealed new insights on long-standing environmental issues and reinforced the need for comprehensive risk assessments.

List of Tables and Figures

Table 1. 15 U.S. census social vulnerability variables	10
Figure 1. Simulation results for exposed, infected and hospitalized residents of Hamilton County, Tennessee. Group I indicates individuals without underlying health conditions. Group II indicates individuals with underlying health conditions	24
Figure 2. 2018 CDC Social Vulnerability Index of Hamilton County, Tennessee	26
Figure 3. Hamilton County, Tennessee Current COVID-19 Assessment Sites Map. Key to the right of map.	27
Figure 4. The three stages of conventional risk analysis	31

Introduction

The environmental justice movement is an ever-growing social justice movement advocating for communities that disparately suffer environmental risks. This movement and the concept of environmental justice gained its traction during the early 1980s from community action against a hazardous waste site being placed in a predominantly poor, black community (McGurty, 1997).

The historical environmental justice movement achieved important regulations and reform among environmentalist groups, however the modern movement still seeks justice for environmental consequences continuing to be overburdened onto vulnerable communities. The EPA's official definition of environmental justice describes it as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (Institute of Medicine, 1999).

There is still evidence that this has not been achieved, with mounting pressure on how to approach these long-standing issues. An emerging concept that aids in the understanding of a multilayered issue such as environmental justice is that of intersectionality, especially intersectional environmentalism. Intersectionality is an idea that acknowledges the depth to certain phenomena and assumes that causes of certain issues overlap in a complex manner. The conception of intersectionality for the purpose of this review makes the assertion that there are multiple determinants to privilege and discrimination. Originating from the literature of early feminist scholars, intersectionality was first used to dismantle the societal perception of "women" and "femininity" (McCall, 2005). In the case of environmental injustice, an intersectional approach considers a range and overlap of determinants to environmental risk such

Examining an Intersection of Environmental Justice and COVID-19 Risk Assessment: A Review
as race/ethnicity, class, spatial variables, education and other factors that have historically been considered individually.

Theoretical Foundation

The early environmentalist movement was largely influenced by literature that exposed certain practices to having negative effects on the environment. The acknowledgement that humans and other life was at risk from practices that didn't directly target them is an example of how intersectionality found its way into environmental matters. For instance, Rachel Carson's *Silent Spring* shed light on the interconnectedness of the environment and how the use of pesticides affected much more than just pests (DiChiro, 2006). Her work pushed for environmental protections and brought more attention to the importance of looking at environmental issues as multilayered.

Early studies assessing community vulnerability from multiple factors are often linked to natural disasters. Some of these studies have recognized the "combination" of factors in an early indication of intersectional significance. One study by Morrow (1999) discovered that many factors leading to increased vulnerability of Hurricane Andrew existed in combinations. For instance, the resources available to a household during a crisis was influenced by its "ratio of healthy, productive adults to dependents", a ratio heavily influenced by gender, socioeconomics, cultural norms, and other demographics (Morrow, 1999). The obvious advantages of knowing where and who requires the most immediate aid can be translated into other situations, such as environmental hazards or a health crisis like the COVID-19 pandemic. This study and others have since assisted local governments in administering relief in adverse conditions.

A deeper vulnerability assessment was eventually conducted through the Centers for Disease Control and Prevention (CDC) for the Journal of Homeland Security and Emergency Management, creating the Social Vulnerability Index widely used today for disaster management. This assessment defined the calculation of risk as:

$$\text{Risk} = \text{Hazard} * (\text{Vulnerability} - \text{Resources})$$

Recognizing that resources are not equally distributed among people, the Social Vulnerability Index is now one of the most widely used set of variables that consider an intersectional relationship among risk factors. The index integrates 15 factors across 4 domains, classified as 1) socioeconomic status, 2) household composition and disability, 3) minority status and language and 4) housing and transportation (Flanagan et al., 2011). Although originally created around the need for aid during natural disasters, notably hurricanes, this index can be applied to other relevant crises--in this case, a global pandemic.

Olofsson et al. (2016) describes intersectional risk theory, an idea that views risk as “entangled with the norms and structures of power which, in turn, affects how inequality is and can be done”. Intersectional risk theory provides a framework on how to rethink individual factors of inequality and how they intersect with vulnerability. Intersectional risk theory applied to environmental phenomena acknowledges that personal practices and responses to environmental risks are constructed from norms rooted in “power relations”, such as gender, race or class (Olofsson et al., 2016). Intersectionality has become an increasingly important framework due to the large span of disparities highlighted by the COVID-19 pandemic.

Rationale for utilizing disaster management SVI variables

The concept of social vulnerability was only recently introduced into disaster management plans during the 1970s after connections were found between certain social factors and community resilience (Juntunen, 2005). Further considerations are needed as future policies and plans are made to aid those most vulnerable, especially in an era of rapid social changes brought upon by the nature of COVID-19. Although different from other major disasters, the same social obstacles have been acknowledged in assessing risks involved with the pandemic. In March of 2020, Former President Donald Trump declared COVID-19 a nationwide emergency. Following this state of emergency, all 50 states along with the District of Columbia and 5 U.S. territories were approved for major disaster declarations in order to mitigate the impacts of the COVID-19 pandemic (Stafford Act; 42 U.S.C. §§5121 et seq.).

The 15 variables of social vulnerability are in line with those considered in previous intersectional studies and may provide a guideline for the social determinants of health that are seen to increase the risks associated with COVID-19 (**Table 1**).

Examining an Intersection of Environmental Justice and COVID-19 Risk Assessment: A Review

Variable	2000 Census Table Variable(s)	Additional Description	Domain
Percent individuals below poverty	P88	Individuals below poverty="under .50" + ".50 to .74" + ".75 to .99." Percent of persons below federally defined poverty line, a threshold that varies by the size and age composition of the household. Denominator is total population where poverty status is checked.	Socioeconomic Status
Percent civilian unemployed	P43	Based on total population 16+. Civilian persons unemployed divided by total civilian population. Unemployed persons actively seeking work.	↓
Per capita Income in 1999	P82	The mean income computed for every person in the census tract.	
Percent persons with no high school diploma	P37	Percent of persons 25 years of age and older, with less than a 12 th grade education (including individuals with 12 grades but no diploma).	
Percent persons 65 years of age or older	P8		Household Composition/Disability
Percent persons 17 years of age or younger	P8		↓
Percent persons more than 5 years old with a disability	P42	Percent of civilian population not in an institution who are 5 years of age and older with a disability.	
Percent male or female householder, no spouse present, with children under 18	P10	"Other family: male householder, no wife present, with own children under 18 years" + "Other family: female householder, no husband present, with own children under 18 years"	↓
Percent minority	P6 & P7	Total of the following: "black or African American alone" + "American Indian and Alaska Native alone" + "Asian alone" + "Native Hawaiian and other Pacific Islander alone" + "some other race alone" + "two or more races" + "Hispanic or Latino – white alone."	
Percent persons 5 years of age or older who speak English less than "well"	P19	For all age groups and all languages—the total of persons who speak English "not well" or "not at all."	
Percent multi-unit structure	H30	Percent housing units with 10 or more units in structure.	Housing/Transportation
Percent mobile homes	H30	Percent housing units that are mobile homes.	↓
Crowding	H49	At household level, more people than rooms. Percent total occupied housing units (i.e., households) with more than one person per room.	
No vehicle available	H44	Percent households with no vehicle available.	
Percent of persons in group quarters	P9	Percent of persons who are in institutionalized group quarters (e.g., correctional institutions, nursing homes) and non-institutionalized group quarters (e.g., college dormitories, military quarters).	↓

Table 1: 15 U.S. census social vulnerability variables

(Source: Flanagan, BE, Gregory EW, Hallisey EJ, Heitgerd JL and Lewis B (2011). A social vulnerability index for disaster management. Journal of Homeland Security and Emergency Management, 8(1): 1–22.)

Background

December of 2019 marked the beginning of a global spread of the novel coronavirus (COVID-19) that has since claimed millions of lives (WHO, 2021). The COVID-19 pandemic has shown that existing environmental injustices may have caused the consequences of the virus to be particularly severe for those considered vulnerable. The CDC has identified 15 determinants that translate to a Social Vulnerability Index (SVI). These determinants include socioeconomic status, minority status and language, and household composition and disability. Furthermore, the CDC acknowledged that “many factors, such as poverty and healthcare access, are intertwined and have a significant influence on the people’s health and quality-of-life. Racial and ethnic minority populations are disproportionately represented among essential workers and industries, which might be contributing to COVID-19 racial and ethnic health disparities” (CDC, 2021). SVI is traditionally used as a guide for disaster management, however this review utilizes several of the 15 social vulnerability variables for the risk assessment of COVID-19. Defining some of these factors is only the beginning of understanding the impact of COVID-19 to those who face a heightened risk from the virus. These indicators not only reflect the roots of an environmental intersectional study but have also already been linked to COVID-19 risks.

Analyzing the full risk of the COVID-19 illness to vulnerable communities requires an intersectional approach--one that can assess the complex nature of the problem. A recent case study in New York City showed how spatial and social distributions translated into immediate

Examining an Intersection of Environmental Justice and COVID-19 Risk Assessment: A Review and disproportionate impacts of COVID-19, finding that the prevailing influences were race and class (McPhearson et al., 2020). The study emphasized associated indicators that influence the uneven spatial patterns of COVID-19 risks and severity, including language, isolation, rent burden, unemployment, lack of health insurance, just to name a few.

The way in which humans interact with their environment is imperative to understand to assess the risk of the ecological threat of a virus. The unique human experience associated with their own environment involves intersectional determinants related to human health and therefore their risk to illness. The aim of this review is to outline some of the intersections involved but rarely considered in a crisis such as the COVID-19 pandemic. Each section of this review elaborates on important determinants to environmental justice and its relevance to COVID-19 risks. A broad review of relevant factors will provide overarching connections while utilizing specified data over the Chattanooga-Hamilton County area whenever possible will serve as a base model for how intersectionality can be studied on a local level.

Methods

The design of this study is in the form of a qualitative review from official or peer-reviewed sources on the determinants of health that ultimately make up the intersectional connections involved with heightened risks associated with COVID-19. The main guideline used for selecting relevant criteria was Social Vulnerability Index variables as defined by the CDC. The utilization of this index as a criteria guideline serves as a familiar set of variables employed by local officials to identify areas in need of support before, during, or after a crisis (Flanagan et al., 2011). Examples of recognizable determinants include race/minority status and socioeconomic status. Other factors were selected, many of which had close connection to other

social determinants but are not well-represented in existing literature. The purpose of incorporating underrepresented factors in this review was to emphasize the interconnectedness between related focuses of study. Moreover, it was to support the assertion that seemingly minor circumstances are still worthy of consideration in risk assessments because of the interwoven nature of all health determinants. These factors include transportation, spatial environment, and representation in policy. Research criteria for this particular review excluded factors that may be relevant but are generally too highly variable or abstract to be considered as a “determinant” to health risk, such as health habits, social behaviors, religion, and political affiliation. This review also excluded age, which although influential, is not a target of environmental injustice and is considered a given to increased health risk over time.

The main method of this study involves the qualitative research and examination of multiple theories, historical evidence, specified case studies, and available data. These bodies were ultimately synthesized to foster a big-picture understanding of an intersectional study. The process involved reviewing official reports and scientific literature, with the intention to make sense of a complex theory. The final version of this review will be suited to inform outreach efforts and local policymakers. As for the examination of Hamilton County/Chattanooga datum, the Social Vulnerability Index informative map of Hamilton County, Tennessee was obtained by the CDC’s official website. Future studies should produce an extensive comparative map that includes factors and statistical analysis of their relevance.

Review searches were performed using the following databases: Google Scholar, Web of Science and ProQuest Central. All data provided for the current reported COVID-19 statistics was restricted to 2021 unless otherwise specified in order to provide an accurate representation of available COVID-19 data during the creation of this review.

The need for intersectional studies in Environmental Justice

The onset of environment-related issues such as the COVID-19 pandemic and global climate change has brought upon an increasing awareness of environmental justice. The application of intersectionality to environmental concerns stemmed from the environmental justice movement and has proven to be an important part of the ongoing struggle against these disparities. Early forms of environmental intersectionality specifically involved environmental racism. Research focused on the idea that race and socioeconomic class could dictate environmental matters helped discover evidence of the unfair siting of hazardous waste sites near underprivileged communities (Malin & Ryder, 2018).

Now that these preliminary connections have been established and accepted in research and policy, it could mean reversing or remediating other harmful environmental injustices. In the case of the Chattanooga-Hamilton County area, more accurate data pertaining to COVID-19 is required to conduct a full risk assessment. Utilizing existing maps is only a qualitative inference of the risk to vulnerable populations of the Chattanooga area. It is imperative that a more intersectional approach is applied to some of Chattanooga's environmental injustice issues. The factors that prevented communities from receiving full aid are in part due to the same determinants discussed throughout this review. Those same barriers likely apply to the current COVID-19 pandemic. This ultimately calls for a thorough intersectional examination of those barriers in order to address how to surpass them without depleting the already limited aid and funds allocated for these communities.

Determinants involved in COVID-19 Environmental Injustice

There are multiple determinants that are interconnected to impose a heightened risk to COVID-19 and potentially other illnesses or disasters. My focus is to discuss the determinants that have historically been considered as individual factors associated with environmental injustice instead of an intersectional, entangled web of potential risk factors.

Minority status

Race and Ethnicity is an immensely influential social determinant of health. This is something that may influence where you live, your wealth, what language you speak, where you work, what quality of care you receive by health professionals among other things.

Segregation is a historical tool for racial oppression in the United States. Minorities were prevented from accruing any wealth, property and representation in policies intact today. These stolen rights are reflected in modern environmental injustices. Historical zoning and gentrification ultimately forced low-income people of color (POC) in areas more likely to be of poor environmental quality. Environmental justice itself is rooted in environmental racism, the belief that communities with a high racial/ethnic minority population are exposed to disproportionate amounts of environmental hazards. Research following the early claims of environmental racism did find evidence of disproportionate appointing of toxic waste sites near low-income communities of color (Mohai et al., 2009). These zones continue to reflect this history and continue to see discrepancies in the ultimate care and resources appointed in comparison to low minority zones or neighborhoods.

Studies have shown us that in general, POC suffer from a poorer quality of care due to racism and discrimination observed in the U.S. healthcare system. The historical mistreatment of

POC has only heightened the risks associated with illnesses such as COVID-19 by generating distrust for health care professionals--a root cause for reluctance to seek help and delay of necessary care. A study that looked at risk for COVID-19 hospitalization and death found that POC were at a higher risk than white patients. The researchers used an analysis that controlled for age, sex, relevant underlying health conditions, and the 15 factors of social vulnerability. What they found was that there were still barriers to care that put POC at a higher risk, markedly delayed care and poorer quality of care within a biased healthcare system (Miller et al., 2020). The combination of other social vulnerabilities further complicates these barriers.

The 2018 National Healthcare Quality & Disparities Report discussed health disparities of POC (namely Black, Asian and Latino) compared to their white counterparts. For Black-Americans, their health disparities coincided with the previous study where healthcare professionals may have downgraded the severity of their ailments. The report found that Black-Americans experienced a lower likelihood of receiving timely fibrinolytic medication for heart attack compared to white patients. As for Asians and Hispanics, the report found that English proficiency was a significant disparity to quality of care despite the fact that access to language assistance is required by law (AHRQ, 2018). The reality that POC are more likely to test positive for COVID-19 yet less likely to receive adequate care from health professionals highlights the need for inclusive risk assessments.

Socioeconomic Status: Income, Employment and Education variables

Arguably one of the most influential factors in the determination of health and quality of life is one's socioeconomic status. It greatly influences the severity of almost every other social

determinant dictating environmental equality and can arguably override the lack of other privileges.

Our health is directly related to our environment--not just the air we breathe or water we drink but our structural environment as well. Marginalized groups make up the bulk of essential/frontline workers that risk contracting the virus in order to support the same communities that exploit them. Not only do these individuals risk contracting and spreading COVID-19, many of these jobs involve poor working conditions that worsen the risk of severe illness and death. One study centered around Chelsea, MA, found that the high levels of pollution increased the rate of COVID-19 infection 4-5 times that of the state rate with the majority being Latino and Black frontline workers (Cole et al., 2020). The nature of the pandemic has faced frontline workers with an impossible choice of either staying safe at home and risking their livelihood or risking illness in order to support themselves and their families. This risk is not as widely shared with higher income individuals. High income individuals have the privilege of having an expendable income after necessities and stable employment, so cessation of employment or an unexpected finance is not devastating. In addition to that, those with higher incomes were more likely to be able to work from home and online anyways, instead of simply losing their job (Papageorge et al., 2021). This blatant and large weight placed on low-income individuals only increases their risk of COVID-19 related consequences.

Income can also dictate the accessibility of good healthcare, nutrition, safe and adequate housing, transportation, education, childcare, etc. The CDC has stated that the wealth gap is associated with “less access to high-quality education. Without a high-quality education, people face greater challenges in getting jobs that offer options for minimizing exposure to COVID-19. People with limited job options likely have less flexibility to leave jobs that might put them at a

higher risk of exposure to the virus that causes COVID-19. They often cannot afford to miss work, even if they're sick, because they do not have enough money saved up for essential items like food and other important living needs" (CDC, 2021). The connections have started to be recognized; however, the affected individuals are still not easily identifiable in crisis management.

Gender Inequality

Gender is generally not considered in risk assessments since it may seem impractical to map out gender distribution in populations affected by many other factors, but it is still necessary to consider for community outreach. Gender can often assign unequal burdens when dealing with a health crisis like COVID-19. These inequalities are placed upon women by societal norms of nurturing roles. An article by Power (2020) explains the concept of a "care economy", the unpaid care work that traditionally falls on women. Women are often depended upon to raise children, care for ill family members, clean, cook, among other responsibilities. When these women become the sole provider of both care and income, the pressure can become unmanageable. With the onset of the pandemic, this "unpaid care work" has increased, in some cases along with other burdens associated with heightened risk. Hamel and Salganicoff (2020) surveyed parents in the United States under 18 years old and found that 57% of mothers experienced more stress because of the pandemic while 32% of fathers experienced it.

Seeing such a large percentage of women facing care-related hardships, it's also important to consider the type of essential working roles that women often hold such as nurses. It is a given that the COVID-19 outbreak has put an immense amount of pressure on healthcare workers. Datum from the 2017 U.S. Census shows us that women make up approximately 76%

Examining an Intersection of Environmental Justice and COVID-19 Risk Assessment: A Review of all health care occupations (Day & Christnacht, 2021). A woman holding any high-demanding frontline job while upholding her care work responsibilities can be forced into a vulnerable position with the added pressures of the pandemic. It's also important to note that unpaid care work may actually be positively influenced by the pandemic for families that have enough resources or opportunity to work from home.

Underlying Health Conditions

The CDC has found that those with underlying health conditions such as cardiovascular diseases, diabetes, and chronic lung diseases, were 6 times more likely to be hospitalized and 12 times more likely to die from COVID-19 (Yang & Wang, 2021). Additionally, the CDC reported that approximately 94% who died of COVID-19 in the United States as of 2020 had at least one underlying medical condition (Chow et al., 2020). Although these conditions can affect anyone regardless of privilege or background, there is evidence that suggests that those experiencing disparities along with underlying conditions are overrepresented in COVID hospitalizations and deaths.

According to Hsu et al. (2020), datum from patients treated at Boston Medical Center between March 1st to May 18th, 2020 showed that the overall COVID-related hospitalization rates were highest among Hispanic patients while the number of deaths were highest among black patients. A higher portion of black patients were also reported to have at least one underlying condition compared to others (Hsu et al., 2020). Although this datum is limited, related research has recognized that the risk of hospitalization and death from diseases are more severe for individuals experiencing disparities. A related study by Quinn and Kumar (2014) stated that “psychological stress has been shown to be higher among low-income people and may result in

impaired immune function, hence greater susceptibility to disease”. The knowledge that persons facing inequalities are more likely to have existing health conditions equates to a higher risk to COVID-19.

Structural Inequalities: Housing, Transportation and other spatial variables

Housing, transportation, and other spatial variables are often downplayed in their involvement of heightened risk to diseases. Household composition can be influenced by everything: minority status and cultural influences, income, age, gender, education, etc.

Transportation and other spatial variables are directly related to many essential human resources.

According to Flanagan et al. (2011), housing quality is tied to personal wealth, and those in poverty are more likely to live in poorly constructed homes that can add to environmental hazards. As outlined by the SVI index, any household with dependent children under the age of 18, elderly over the age of 65, single-parent households, and those with disabilities were likely to require financial assistance and other aid during disasters (Flanagan et al., 2011). Lastly, in many cultures, especially cultures of developing countries, large families living in one home is a common occurrence.

Associated with almost every other determinant, transportation has a forceful impact on exposure to COVID-19. Those who rely on public transportation are at a higher risk to contract the virus and do not always have transportation to testing, vaccinations, etc. Other spatial variables need to be considered in risk assessments such as proximity to hospitals, testing or vaccination centers, and general resources. Spatial variables go much deeper than low-income or minority neighborhoods represented in health statistics. Some research has gone into the facilitation and preservation of vulnerable communities based on the strategic placement of their

structural environment. Datum shows that affluent neighborhoods are strategically placed near parks, high quality food stores, prestigious schools and security while poor neighborhoods were disregarded and exploited--those positive spatial variables replaced with low quality stores and schools, liquor/tobacco sellers, pollution, violence and inferior law enforcement (Bernard et al., 2007). Perpetuating the oppressive nature of current community structures creates more vulnerable communities yet little consideration in risk assessment. Identifying any overlap of a recognized social disparity with something overlooked, such an excess of liquor stores and smoke shops, could lead outreach efforts to reasonably consider that area as high-risk to COVID-19. This would be especially useful in a community where consistent demographic or health data is not available.

Representation in policy

One of the most basic ways that vulnerable communities are being forgotten in policies is through inadequate funding. Although the purpose of many social policies sound promising, the poor prioritization of allocated funds to carry out the mission of many policies ultimately contributes to existing disparities. The delivery of public health services, for example, has been especially difficult for communities facing the risks of COVID-19.

A paper by DeSalvo et al. (2021) found that the Preventative Health and Health Services block grant decreased its funding 35% from 1995 to 2012. The paper also found that funding for the Public Health Emergency Preparedness program declined by \$265 million between 2002 and 2020 (DeSalvo et al., 2021). Denying people public health resources will not hurt the privileged, only increase the barriers experienced by vulnerable persons.

Furthermore, environmental policies that protect human health are often changing or halting their progress depending on the current government administration. According to Outka & Warner (2019), former President Trump and his administration have been documented taking multiple actions to systematically undercut regulatory protections that involved exposing communities to higher environmental burdens. Many claim that the administration showcased a rejection of climate science and Environmental justice-related protests to certain policy enactment, for example the issuing of an executive memorandum that allowed the Secretary of the Army to ensure permit approvals for the completion of the Dakota Access Pipeline, despite immense protest and evidence of environmental injustice (Outka & Warner, 2019). When those in power knowingly create health risks to those suffering from inequalities, it highlights the superficial promises of representation and environmental safety for all.

Case Study: Chattanooga/Hamilton County, TN.

The Chattanooga/Hamilton County area serves as a promising model for an intersectional environmental study. The need for increased access to COVID relief resources has already been established in Chattanooga. In a public health COVID-19 impact assessment, DeSalvo et al. (2021) stated that the Hamilton County Health Department depended on predominantly Black churches to establish accessible testing sites to their communities. By conducting an intersectional review of what factors are most relevant in risk assessment of the Chattanooga area, it will be much easier for local entities to improve their aid efforts. There are already some evaluations of the determinants that affect residents of Chattanooga and Hamilton County, including transportation and underlying health conditions, along with the factors integrated in the Social Vulnerability Index provided by the CDC.

Transportation

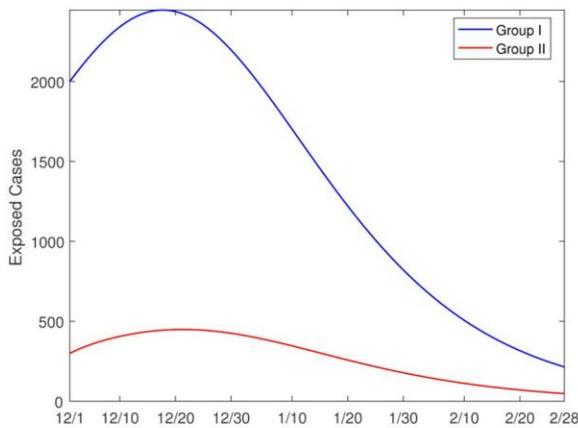
One study that tracked the ridership and operation changes of the public transit systems in response to COVID-19 and considered disparities of low-income and marginalized people who often depend on public transportation. The datum uncovered for Chattanooga was shown to have limited their weekly fixed-line bus trips from 781 to 373 in response to COVID-19 regulations with a rapid decline in ridership (suggesting that people were actually utilizing public transportation prior to the limitations) (Wilbur et al., 2020). Once the transit trips rose and stabilized, ridership in low-income areas in the city also increased. The overall purpose of this study was to show that not only is access to transportation a necessary component of life, regardless of a deadly global pandemic, but also that the lack of transportation due to COVID-19 potentially creates further disparities. For someone who can only rely on public transportation for work, school, or medical attention, a reduced bus schedule could have drastic effects on their livelihood. This is something that may need to be addressed in future plans for increasing access to COVID resources.

Underlying Health Conditions

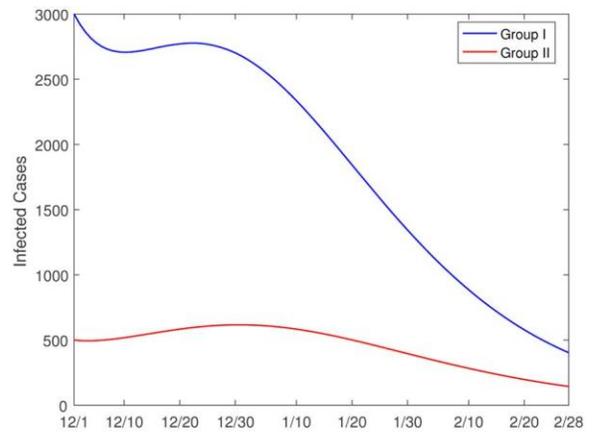
A modeling investigation of underlying health conditions relevant to COVID-19 risk was conducted for Hamilton County, TN (**Figure 1**). Researchers discovered that a significant portion of Hamilton County residents were at high risk to COVID-19 due to underlying health conditions such as chronic heart disease, chronic obstructive pulmonary disease, diabetes and other condition recognized by the CDC to increase the likelihood of hospitalization when contracting the COVID-19 virus (Yang & Wang, 2021). Their datum suggested that the

Examining an Intersection of Environmental Justice and COVID-19 Risk Assessment: A Review

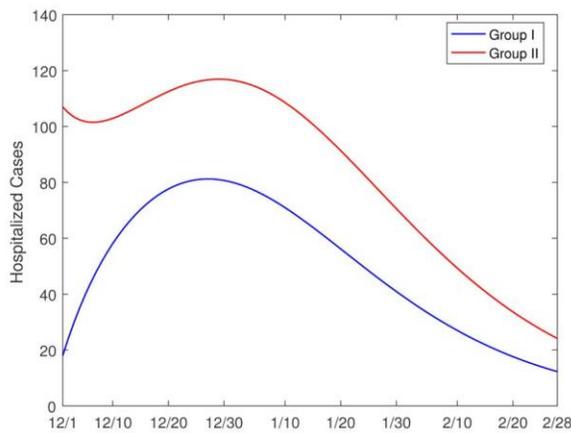
population group with underlying health conditions were associated with higher amounts of COVID-related hospitalization and death. The reported datum from this study is from December 1, 2020 to February 28, 2021. This report made the observation that individuals with underlying conditions were generally more cautious of contracting the virus, this is reflected in the lower rate of exposed and infected individuals compared to those without underlying health conditions. When evaluating how relief resources are advocated, identifying residents with underlying health conditions may be important.



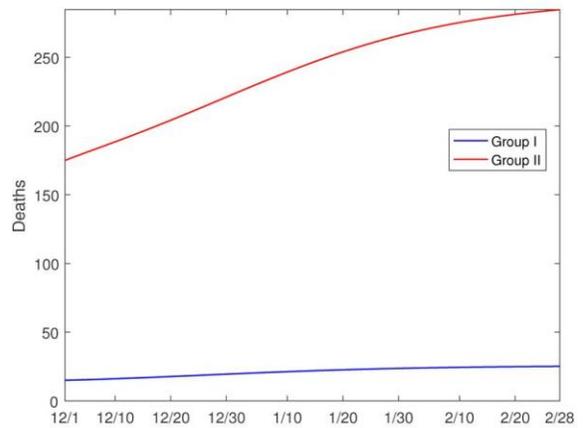
(a) Number of exposed individuals



(b) Number of infected individuals



(c) Number of hospitalized individuals



(d) Number of disease-induced deaths

Figure 1: Simulation results for exposed, infected and hospitalized residents of Hamilton County, Tennessee. Group I indicates individuals without underlying health conditions. Group II indicates individuals with underlying health conditions.

Source: Yang, C., & Wang, J. (2021). COVID-19 and underlying health conditions: A modeling investigation. *Mathematical biosciences and engineering : MBE*, 18(4), 3790–3812. <https://doi.org/10.3934/mbe.2021191>

Social Vulnerability Index

Since the Social Vulnerability Index was created to assist in identifying vulnerable populations, it will be useful to incorporate data into an intersectional study. Comparing the factors that assess social vulnerability with other related factors like spatial variables, real-time data such as COVID cases and other relevant factors may be able to help the most vulnerable people in a city. Maps of the 2018 SVI provided by the CDC shows the overall distribution of vulnerability as well as distributions of the four themes considered in the index (**Figure 2**).

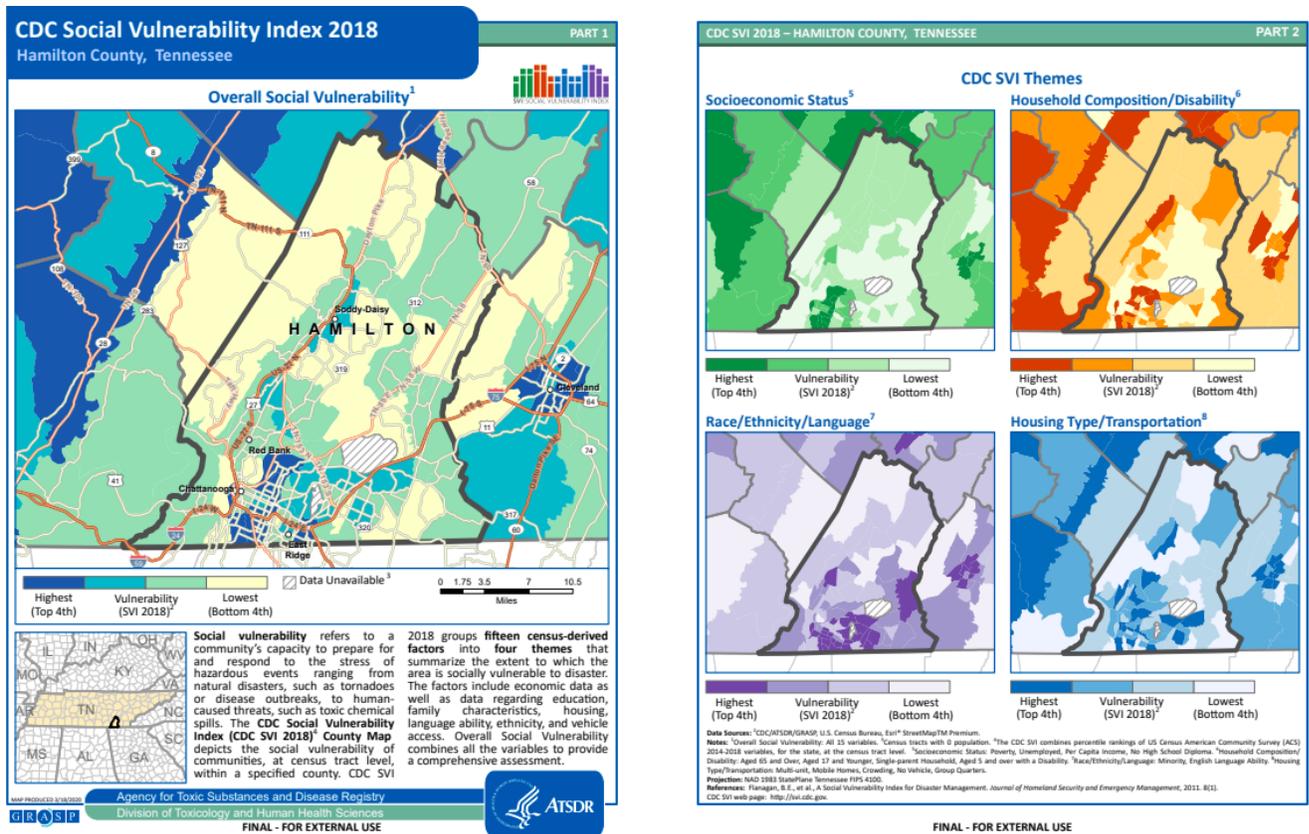


FIGURE 2: 2018 CDC Social Vulnerability Index of Hamilton County, Tennessee
(Source: Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program. CDC/ATSDR Social Vulnerability Index [2018] Database [Hamilton County, Tennessee, U.S.]

Spatial Variables: Map of Assessment Sites

The Hamilton County Department of Health has already begun to strategically place its COVID-19 assessment sites. When compared to the county’s SVI map produced by the CDC, the areas of high Race/Ethnicity/Language vulnerability are in close proximity to COVID-19 assessment sites that provide Spanish-language services (**Figure 4**). This is a great model for other cities to follow, especially with the restriction of available funding toward community aid. It is imperative that funding and resources are allocated efficiently to actually benefit people at

risk. The use of a distribution map is also helpful for future studies that may incorporate the spatial variables discussed in this review, such as charting what areas of Hamilton County show the highest rate of public transportation use and allocating resources in close proximity to meet residents in their own communities. Furthermore, any indication of poor environments could be evaluated for accessible sites since data may suggest that those populations will have higher likelihood to severe illness and death.

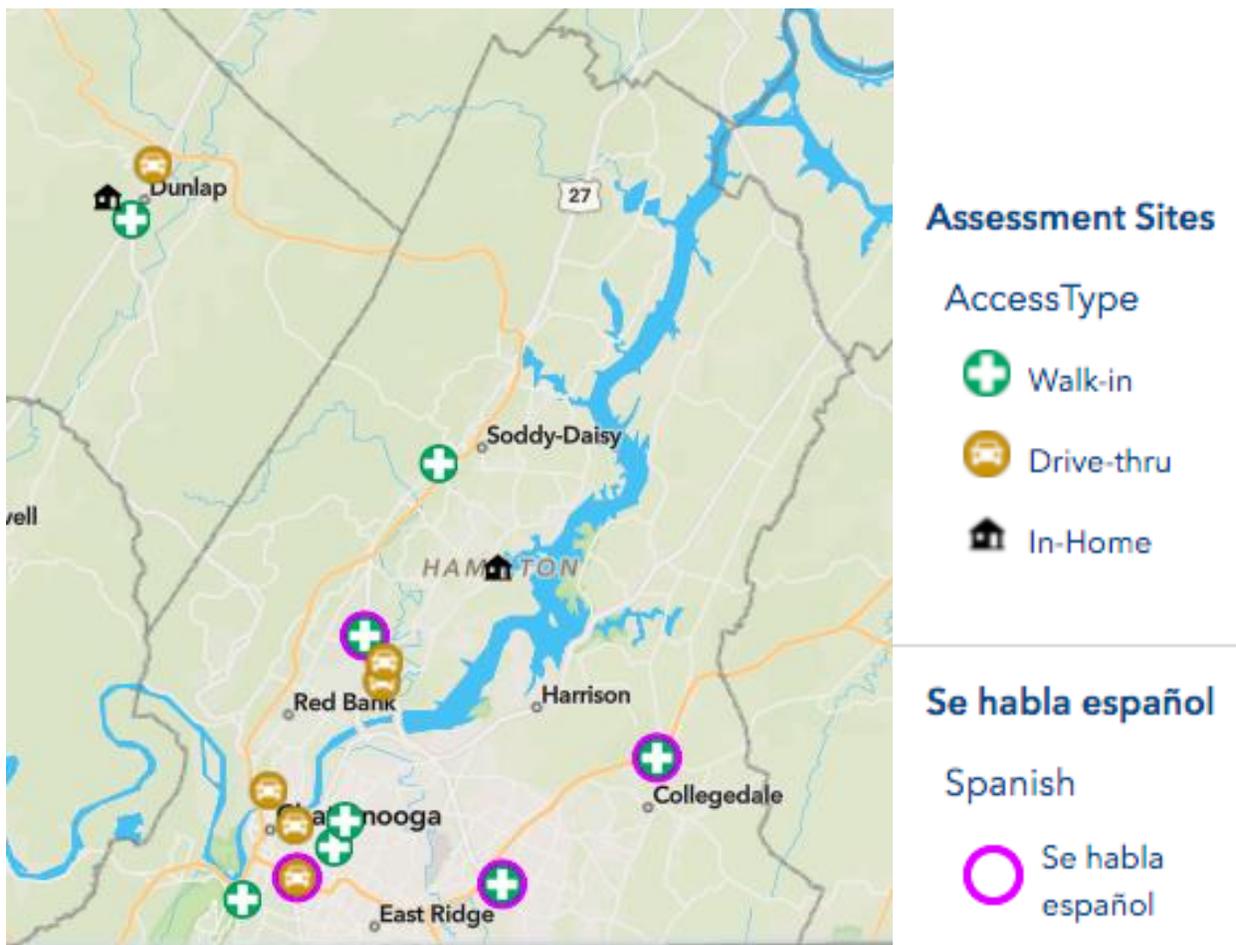


Figure 3: Hamilton County, Tennessee Current COVID-19 Assessment Sites Map. Key to the right of map.

(Source: Tennessee Department of Health. (2021) Assessment Sites Map.

<https://experience.arcgis.com/experience/885e479b688b4750837ba1d291b85aed>)

Discussion/Conclusion

Once there is a thorough examination of the different factors that create a high risk to a crisis like COVID-19, it is much easier to see the interconnectedness of these issues. Each determinant can be made more severe by another, making it more and more difficult to overcome certain disparities. Several connections between risk factors are obvious, but some may not even be considered until it has taken its toll.

Minority status, socioeconomic status, education, gender, and plenty of other factors affect something as seemingly minor as school lunch. The inability to provide a child home lunch is something that is likely never even considered in a higher income household. However, for many low-income households, the shutdown of public schools can be detrimental in a multitude of ways. Studies have shown that malnutrition is associated with high susceptibility of disease due to the role it plays in a weakened immune system (Quinn & Kumar, 2014). Food security is a real concern for low-income families, with many other factors worsening this situation. Spatial inequalities could worsen this situation if those affected live in a polluted environment with little access to high-quality food and nutrition. An article by Dunn et al. (2020) points out that during school shutdowns, “children from low-income households, who are already at higher risk for poorer health and academic performance than children from high-income households, may be further disadvantaged by nutrition shortfalls”. Furthermore, minority households are more likely to receive income from frontline jobs and are not able to stay home to feed their children, let alone help them with remote learning if there is a language barrier in the home. Gender also plays a role as the burden of care falls upon mothers to stay home and care for their children, even if they are the sole income provider. The same article by Dunn et al. also

discusses how the increased financial burden of food security forces families to potentially forfeit other necessities such as medication, or even rent (Dunn et al., 2020). If any household members suffer from underlying health conditions due to existing inequalities, the inability to afford or access proper healthcare may create a deadly risk to COVID-19. This is just one situation showcasing issues that may be minimized to one cause, when in reality, these issues are extremely complex and unique to individual circumstances.

Careful consideration of these many factors has contributed to the assertion that they are heavily influenced by one another. Even with the intention to help people facing the highest risks, in order to reach a community, it is important to understand it. By failing to meet an incapable community where they need it, we are essentially wasting resources.

Limitations

The lack of intersectional studies in the environmental field was one limitation to this review. Since the concept of intersectionality is originally credited to feminist literature, the application of the theory to other fields is fairly new. There were many sources discussing feminism, ecofeminism and sociology but very little sources incorporating environmental injustice and/or COVID-19. The nature of the pandemic added to the limitations of this review. It was realized that contracting the virus has non-determinant influences such as social practices and even political/social beliefs. Furthermore, since we are still experiencing the COVID pandemic, there is no long-term data available at this time. The consistency of COVID-related data was also a limitation, as I hoped to keep data as recent and as accurate as possible, but the availability of peer-reviewed works is not always abundant on such a new subject.

Implications

The findings of this review imply that those who require assistance during crises are also the least likely to have access to it. In the environmental and public health crisis that is COVID-19, those with ample resources will not need as much aid during a pandemic. They will most likely have health care for necessary medical attention, transportation to testing or vaccination sites, access to technology for information and the overall higher ability to persevere any unexpected burdens. With that said, simply having resources available is not always enough. It is important for efforts to be made to cater to the populations that are most vulnerable due to their inability to outright seek out aid. The factors discussed in this review may assist in spreading awareness about available resources. For example, a high population of single-parent households may require additional services to compensate for the lack of time or money that families can sacrifice to seek out help during the pandemic or any other emergency. Furthermore, spatial variables showing an excessive demand for liquor stores and tobacco shops may benefit from a study looking into the rates of underlying health conditions for that population. If conclusions can be made that an area will be more at risk to death or severe illness from COVID-19, then local authorities can push for preventative measures or access to medical care in that area.

Recommendations

Risk Assessment and Outreach

Since the COVID-19 pandemic is an ongoing public health crisis, updated studies are recommended to stay consistent with the current needs of communities. Future studies should focus on distribution maps that incorporate determinants relevant to specific populations or cities and can be easily updated as new data is reported. Local authorities and organizations should take an intersectional approach when deciding how to embed appropriate resources and educational tools into communities. Depending on the community representation, these entities can gauge the most effective ways to provide resources such as involving local churches/schools or providing translations of educational information in high minority communities. If a community is found to have a high representation of single-parent households, entities can allocate resources to provide convenience for families that may have to prioritize other responsibilities before finding the time for medical attention or COVID testing and vaccinations.

Models for community risk assessment are available, with some catered specifically to measuring risk of exposure to illnesses. Coburn (2002) reviewed EPA's first community-based Cumulative Exposure Project and provided a model for risk analysis, emphasizing the need for management and communication to be considered post-assessment (**Figure 4**).

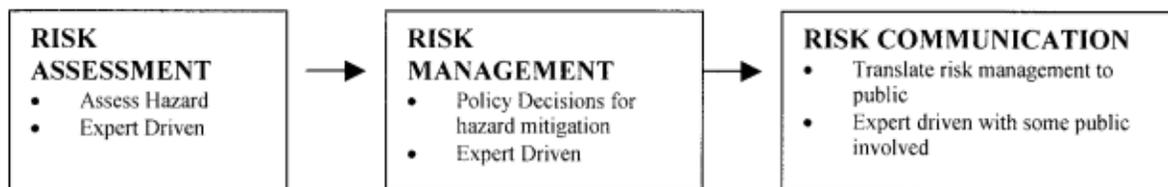


Figure 4: The three stages of conventional risk analysis

(Source: Corburn, J. (2002). Environmental Justice, Local Knowledge, and Risk: The Discourse of a Community - Based Cumulative Exposure Assessment. DOI: 10.1007/s00267-001-0013- 3)

Local governments can use base models for risk assessment and then consider the connected determinants that may increase health risks to COVID-19. What's more important is implicating the assessment into active management and community awareness so that resources are provided to the necessary populations.

Surveying Methods

Advocates for environmental justice often claim that some risk assessments do not embody the severity of environmental disparities. Wherever data is questionable or believed to not accurately represent a community, then surveying methods can be conducted to gather community-based responses. This not only provides a more personal approach to risk assessment but can serve to find out if assistance is needed directly from the source. Surveys could be conducted door to door following COVID-19 safety guidelines, by mail, phone, or online sources when feasible. Even something as simple as quantifying levels of community awareness regarding available COVID-19 resources or general knowledge of the virus could foster a productive response from local authorities and outreach programs.

GIS map distributions

The use of map distributions in risk assessment has obvious advantages. Similar to the existing SVI maps, a map that considers local data arranged by zip code or neighborhood would be useful in identifying vulnerable populations. Furthermore, studying the spatial variables

through mapping may aid in understanding why certain communities may be at risk. As discussed in the section over structural inequalities, communities suffering from disparities will more commonly be situated within low-quality environments. As shown in the Hamilton County case study, maps can be useful to strategically plan testing sites or vaccination centers. Specialized data and distributions will provide an efficient model for resource allocation and will make it easier for both local officials and the public to understand the risk assessment. Lastly, data that is transferred into mapping programs could be easily utilized in future studies.

References

Bernard, P., Charafeddine, R., Frohlich, K. L., Daniel, M., Kestens, Y., & Potvin, L. (2007).

Health inequalities and place: A theoretical conception of neighbourhood. *Social Science & Medicine*, 65(9), 1839–1852. <https://doi.org/10.1016/j.socscimed.2007.05.037>

Centers for Disease Control and Prevention. (2021). Health equity considerations and racial and ethnic minority groups. Centers for Disease Control and Prevention. <https://www.cdc.gov/coronavirus/2019-ncov/community/health-equity/race-ethnicity.html>.

Chow N, Fleming-Dutra K, Gierke R, Hall A, Hughes M, Pilishvili T, et al. ; CDC COVID-19 Response Team. Preliminary estimates of the prevalence of selected underlying health conditions among patients with coronavirus disease 2019 — United States, February 12–March 28, 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(13):382–6.

Corburn, J. (2002). Environmental Justice, Local Knowledge, and Risk: The Discourse of a Community - Based Cumulative Exposure Assessment. DOI: 10.1007/s00267-001-0013-3

Covid-19 disaster declarations. FEMA.gov. (n.d.).

<https://www.fema.gov/disaster/coronavirus/disaster-declarations>.

Examining an Intersection of Environmental Justice and COVID-19 Risk Assessment: A Review

Covidtracking.com. (2020). Racial Data Dashboard. <https://covidtracking.com/race/dashboard>.

Day, J. C., & Christnacht, C. (2021, October 8). Women hold 76% of all health care jobs, gaining in higher-paying occupations. Census.gov. Retrieved November 1, 2021, from <https://www.census.gov/library/stories/2019/08/your-health-care-in-womens-hands.html>.

DeSalvo, K., B. Hughes, M. Bassett, G. Benjamin, M. Fraser, S. Galea, N. Garcia, and J. Howard. 2021. Public Health COVID-19 Impact Assessment: Lessons Learned and Compelling Needs. NAM Perspectives. Discussion Paper, National Academy of Medicine, Washington, DC. <https://doi.org/10.31478/202104c>

Flanagan, BE, Gregory EW, Hallisey EJ, Heitgerd JL and Lewis B (2011). A social vulnerability index for disaster management. *Journal of Homeland Security and Emergency Management*, 8(1): 1–22.

Helen V. S. Cole, Isabelle Anguelovski, Francesc Baró, Melissa García-Lamarca, Panagiota Kotsila, Carmen Pérez del Pulgar, Galia Shokry & Margarita Triguero-Mas (2020) The COVID-19 pandemic: power and privilege, gentrification, and urban environmental justice in the global north, *Cities & Health*, DOI: 10.1080/23748834.2020.1785176

Examining an Intersection of Environmental Justice and COVID-19 Risk Assessment: A Review

Hsu, H. E., M.D., Ashe, E. M., M.P.H., Silverstein, M., M.D., Hofman, M., M.S.I.S.,

Lange, S. J., M.P.H., Razzaghi, H., PhD., . . . Goodman, A. B., M.D. (2020).

Race/Ethnicity, underlying medical conditions, homelessness, and hospitalization status of adult patients with COVID-19 at an urban safety-net medical center - Boston, Massachusetts. Atlanta: U.S. Center for Disease Control.

Institute of Medicine (US) Committee on Environmental Justice. (1999). Toward

Environmental Justice: Research, Education, and Health Policy Needs. National Academies Press (US).

Jordan, R. E., Adab, P., & Cheng, K. K. (2020). Covid-19: Risk factors for severe

disease and death. *BMJ : British Medical Journal (Online)*, 368

doi:<http://dx.doi.org/10.1136/bmj.m1198>

Malin, S. A., & Ryder, S. S. (2018). Developing deeply intersectional environmental

justice scholarship. *Environmental Sociology.*, 4(1), 1–7.

<https://doi.org/10.1080/23251042.2018.1446711>

McCall, L. (2005). The Complexity of Intersectionality. *Signs : Journal of Women in*

Culture and Society., 30(3), 1771–1800. <https://doi.org/10.1086/426800>

McGurty, E. M. (1997). From nimby to civil rights: The origins of the Environmental

Justice Movement. *Environmental History*, 2(3), 301. <https://doi.org/10.2307/3985352>

Examining an Intersection of Environmental Justice and COVID-19 Risk Assessment: A Review

McPhearson, T., Grabowski, Z., Herreros-Cantis, P., Mustafa, A., Ortiz, L., Kennedy, C.,

Tomateo, C., Lopez, B., Olivotto, V., & Vantu, A. (2020). Pandemic injustice:

Spatial and social distributions of COVID-19 in the US epicenter. *Journal of*

Extreme Events, 07(04). <https://doi.org/10.1142/s234573762150007x>

Mohai, P., D. Pellow, and J. Timmons Roberts. 2009. "Environmental Justice." *Annual Review*

of Environment and Resources 34: 405–430. doi:10.1146/annurev-environ-082508-

094348.

Morrow, B.H. 1999. Identifying and Mapping Community Vulnerability. *Disasters*

23(1)1–18.

National Healthcare Quality and Disparities Report. (2018) Rockville, MD: Agency for

Healthcare Research and Quality; AHRQ Pub. No. 19-0070-EF.

<https://www.ahrq.gov/sites/default/files/wysiwyg/research/findings/nhqdr/2018qdr-final.pdf>.

Olofsson, A. (2016). An intersectional risk approach for environmental sociology.

Environmental Sociology., 2(4), 346–354.

<https://doi.org/10.1080/23251042.2016.1246086>

Examining an Intersection of Environmental Justice and COVID-19 Risk Assessment: A Review

Outka, U., & Warner, E. K. (2019). Reversing Course on Environmental Justice under the Trump Administration. *Utah Law Faculty Scholarship*. 172.

<https://dc.law.utah.edu/scholarship/172>

Papageorge, N. W., Zahn, M. V., Belot, M., van den Broek-Altenburg, E., Choi, S., Jamison, J. C., & Tripodi, E. (2021). Socio-demographic factors associated with self-protecting behavior during the COVID-19 pandemic. *Journal of Population Economics*, 34(2), 691–738.

<https://doi.org/10.1007/s00148-020-00818-x>

Power, K. (2020). The COVID-19 pandemic has increased the care burden of women and families. *Sustainability: Science, Practice, & Policy.*, 16(1), 67–73.

<https://doi.org/10.1080/15487733.2020.1776561>

Quinn, S. C., & Kumar, S. (2014). Health inequalities and infectious disease epidemics: a challenge for global health security. *Biosecurity and bioterrorism : biodefense strategy, practice, and science*, 12(5), 263–273. <https://doi.org/10.1089/bsp.2014.0032>

Ramírez IJ, Lee J. COVID-19 emergence and social and health determinants in Colorado: a rapid spatial analysis. *Int J Environ Res Public Health* 2020;17(11):3856.

Rubin-Miller, L., C. Alba, S. Artiga, and S. Sullivan. 2020. COVID-19 Racial Disparities in Testing, Infection, Hospitalization, and Death: Analysis of Epic Patient Data. Available at: <https://www.kff.org/report-section/covid-19-racial-disparities-in-testing-infection-hospitalization-and-death-analysis-of-epic-patient-data-issue-brief/>

Stafford Act; 42 U.S.C. §§5121 et seq.

Tennessee Department of Health. (2021) Assessment Sites Map.

<https://experience.arcgis.com/experience/885e479b688b4750837ba1d291b85aed>

Wilbur, M., Ayman, A., Ouyang, A., Poon, V., Kabir, R., Vadali, A., Pugliese, P.,

Freudberg, D., Laszka, A., & Dubey, A. (2020). Impact of COVID-19 on Public Transit Accessibility and Ridership. arXiv preprint arXiv:2008.02413

World Health Organization. (n.d.). The true death toll of COVID-19: Estimating global excess mortality. World Health Organization. Retrieved October 30, 2021, from <https://www.who.int/data/stories/the-true-death-toll-of-covid-19-estimating-global-excess-mortality>.

Yang, C., & Wang, J. (2021). COVID-19 and underlying health conditions: A modeling investigation. *Mathematical biosciences and engineering* : MBE, 18(4), 3790–3812. <https://doi.org/10.3934/mbe.2021191>