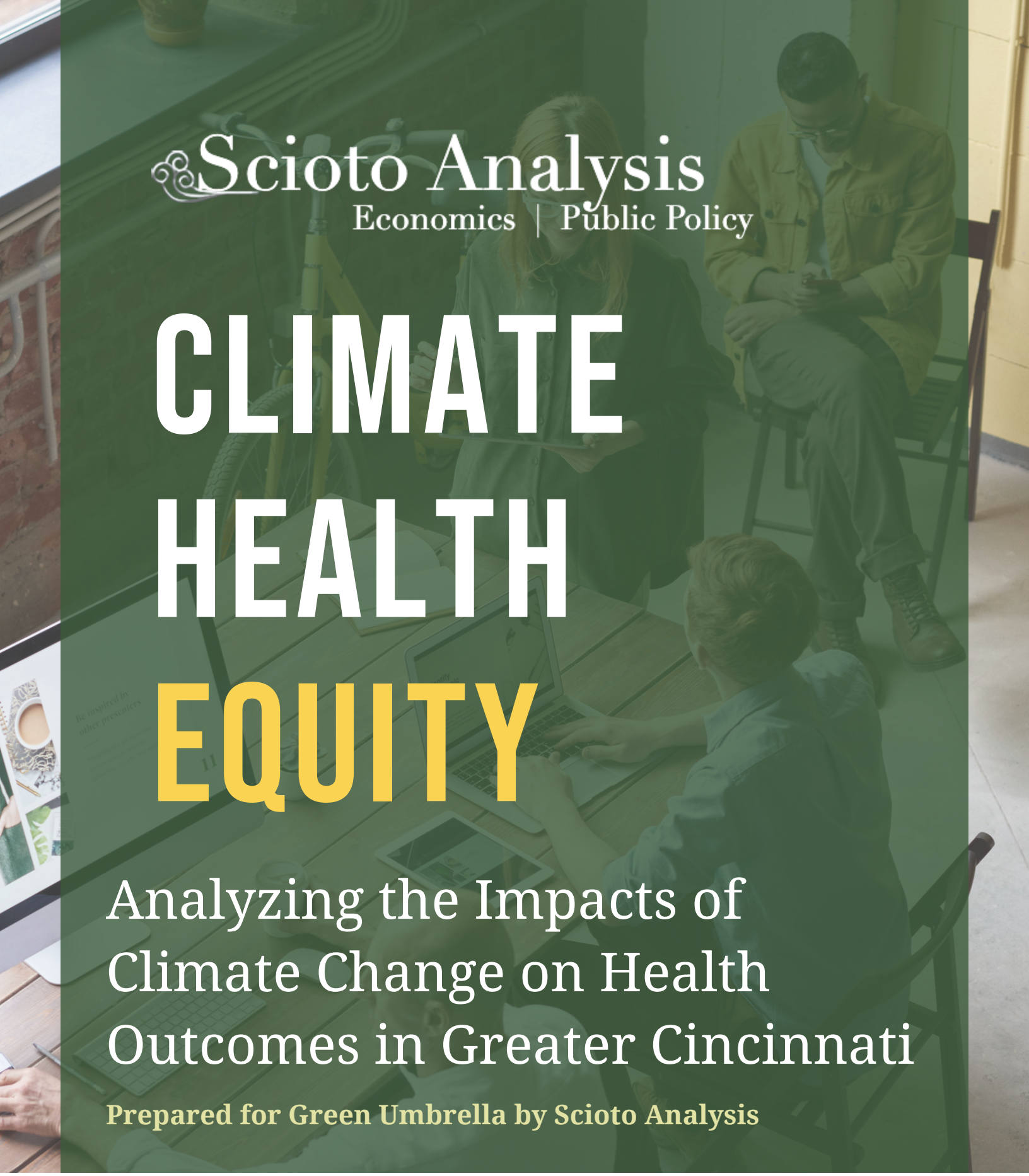


Scioto Analysis
Economics | Public Policy

CLIMATE HEALTH EQUITY

Analyzing the Impacts of Climate Change on Health Outcomes in Greater Cincinnati

Prepared for Green Umbrella by Scioto Analysis

Green Umbrella
REGIONAL CLIMATE COLLABORATIVE

INTRODUCTION

Green Umbrella thanks the Data for Equity Funding Collaborative – a partnership between bi3, HealthPath, and Interact for Health. Not only did their funding make this report possible, the collaborative provided incredible training opportunities over the past year to develop our team's capacity on health equity, and equitable data and evaluation.

Local decision makers across the Cincinnati metropolitan area are working hard to make it a more healthy, prosperous, equitable, resilient, and low-carbon region as the twin shifts of climate change and transformation of the energy sector will change the region.

It is increasingly clear that climate has a significant impact on public health. Higher average temperatures can lead to more heat waves which can increase the risk of heat stroke for elderly and vulnerable populations. Increased precipitation can lead to more high-precipitation days, which can harm water quality and create breeding grounds for mosquitoes. This can lead to more cases of water-borne illness and set the stage for outbreaks of West Nile Virus. Increased risk of high winds and tornadoes can threaten lives directly.

We also know that health impacts are not experienced the same by all members of society. In 2021, more than 200 medical journals warned that climate change is the greatest threat to public health.[1] According to Trust for America's Health, Kentucky, Indiana, and Ohio are some of the most vulnerable and least prepared states for the health effects of climate change.[2] Using Ohio as an example, according to the Health Policy Institute of Ohio's Health Value Dashboard, Black Ohioans are 40% more likely to be exposed to air pollution and 20% more likely to die of heart disease as white Ohioans.[3] Hispanic/Latino Ohioans are 20% more likely to be exposed to air pollution than white non-Hispanic Ohioans. Both low-income Ohioans and LGBTQ+ Ohioans are over twice as likely to experience adult depression as the general population.

To analyze the impact of climate change on health outcomes in the Cincinnati metropolitan area, Green Umbrella partnered with Scioto Analysis, a public policy and

economic analysis practice. Scioto Analysis is a small firm based in Columbus, Ohio that specializes in the study of energy and environment, equity, and tax and budget issues at the state and local level. Scioto Analysis is well known for its previous work on studies of environmental issues in the Midwest and Northeast, including "The Bill is Coming Due: Calculating the Financial Cost of Climate Change to Ohio's Local Governments," "Roadmap for Energy Storage in Northern Appalachia," "Policy Options for Reducing Carbon Emissions: a Social Cost Analysis," and "Water Quality in Ohio: a Cost-Benefit Analysis."[4, 5, 6, 7]

In this 16-county analysis, Scioto Analysis projected health impacts of six major disease categories, all leading estimated health impacts associated with climate change. The six health impacts are shown in Table 1, along with the climate change driver associated with the increased health risk and major data sources used to project impacts.

Climate impacts were measured using temperature and precipitation projections for 2050 from the data sources in Figure 1. Health outcomes were then adjusted based on the social determinants of health using current day demographic data such as race, ethnicity, education, etc.

Health Impact	Climate Driver	Data Source
Heat related illness	Increased temperature	NOAA / CDC (2023 / 2014)
Respiratory illness	Lower air quality	NOAA / Council on Environmental Quality (2023)
Vector borne disease	Better habitats for vectors (ticks / mosquitoes)	Ohio Dept. of Health / EPA (2022)
Water borne illness	Increased precipitation	NOAA / FEMA (2023)
Increased mortality	More extreme weather events	FEMA (2023)
Mental health	Various	Qualitative

Figure 1: health impacts included in health equity analysis

Health Equity and Climate Change

Health equity as a research topic, especially in the context of climate change, is not universally well defined across the globe. The main reason for this lack of consensus is that depending on the context, certain equity definitions are more or less useful. For example, health equity in the United Kingdom is often concerned with differences in socioeconomic status while the CDC's Office of Minority Health specifically focuses on racial differences in health outcomes.[8]

Some definitions of health equity avoid explicitly mentioning specific contexts and instead offer more general definitions. One example comes from the World Health Organization: "equity in health is operationally defined as minimizing avoidable disparities in health and its determinants – including but not limited to health care – between groups of people who have different levels of underlying social advantage."[9]

The Ohio Department of Health defines health equity as "striving for equal opportunity for health. This requires that health policy and programs prioritize the needs of those furthest behind in health outcomes."[10]Additionally, they reference the American Public Health Association's social determinants of health and equity and emphasize that in a world with complete health equity, none of these social determinants of health would have any impact on health outcomes:[11]

In 2019, Douglas Dover and Ana Paula Belon developed a Health Equity Measurement Framework to better understand the connections between the social determinants of health and health outcomes.[12] This framework, which we leveraged for this report, is particularly useful due to the specificity with which it outlines its connections.

The second component to consider is how climate change will affect health outcomes. Changes to local climates such as increased temperatures, increased precipitation, and more frequent extreme weather events all have the potential to directly worsen health outcomes.[13]

The connection between climate change and health equity is that we should expect groups who are exposed to the same changes in climate to have different health outcomes due to their social determinants of health. These effects are compounded by the fact that individuals who have greater social advantages have better access to climate adaptations

that could mitigate some of the negative health impacts.

Current State of Health Equity in Greater Cincinnati

This analysis covered the 16 county Cincinnati metropolitan area, which is home to 2.26 million people. Counties include: Boone Co. Kentucky, Bracken Co. Kentucky, Brown Co. Ohio, Butler Co. Ohio, Campbell Co. Kentucky, Clermont Co. Ohio, Dearborn Co. Indiana, Franklin Co. Indiana, Gallatin Co. Kentucky, Grant Co. Kentucky, Hamilton Co. Ohio, Kenton Co. Kentucky, Ohio Co. Indiana, Pendleton Co. Kentucky, Union Co. Indiana, and Warren Co. Ohio.

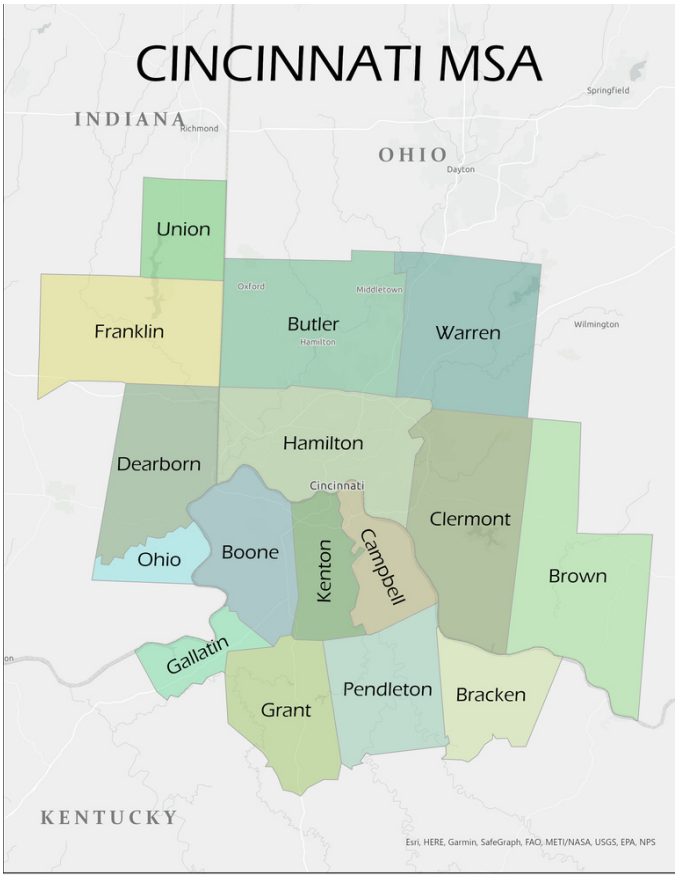


Figure 2: the 16 county Greater Cincinnati Metropolitan Statistical Area

Generally we understand this region is whiter and less diverse compared to national demographics, with communities of color being more concentrated in urban and suburban counties (though they are likely undercounted, especially Hispanic and Indigenous populations).

Health inequality is a persistent problem in the Cincinnati metropolitan area today. Just over 24% of the region's residents live in a census tract designated as “disadvantaged” by the Federal Council on Environmental Equity’s Climate and Economic Justice screening tool, meaning it meets the criteria for being burdened by at least one climate stressor in addition to having some socioeconomic disadvantage.[14]

Communities have historically had extreme differences in health outcomes. According to Interact for Health, life expectancy can vary by ~26 years between census tracts in the region, with West Newport, Kentucky having the shortest lifespan and Indian Hill, Ohio having the longest lifespan. Even at the neighborhood level disparities are stark. For example, according to the city of Cincinnati's Cincy Insight life expectancy report from 2015, people born in the Linwood neighborhood had a life expectancy of about 67 years, while their neighbors from Mt. Lookout had a life expectancy of 86 years.[15] Differences in life expectancy vary by race in the city as well. Black men born in Cincinnati have a life expectancy of only 67 years compared to 73 years for white men.[16]

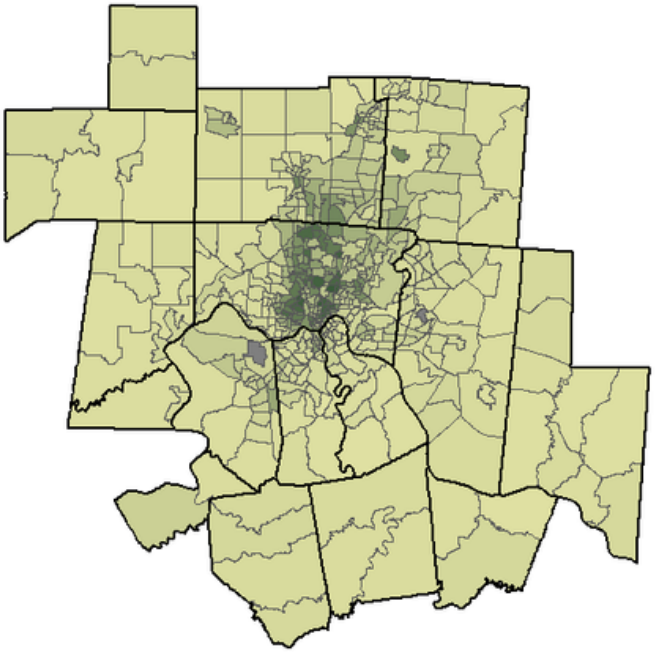


Figure 3: percent of people of color by Census tract across 16 counties in Greater Cincinnati, ranging from 0% (light green) to 75% (dark green).

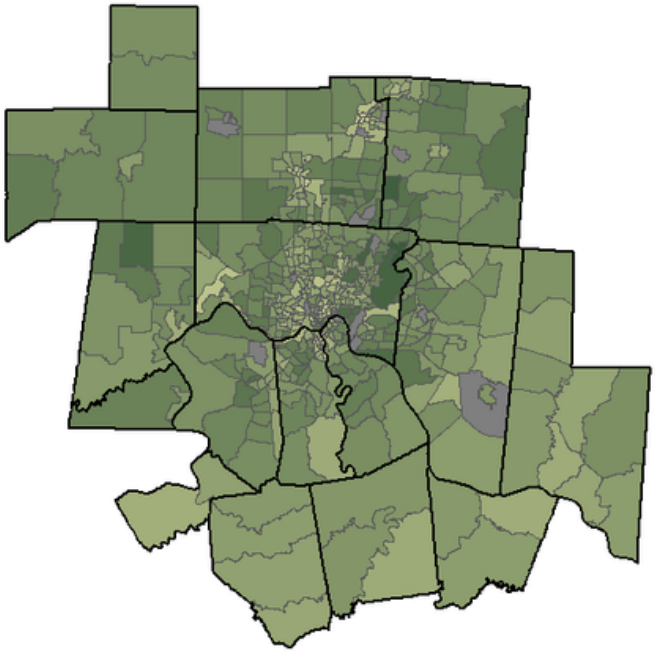


Figure 4: average life expectancy by Census tract across 16 counties in Greater Cincinnati, ranging in years from late 60's (light green) to early 80's years (dark green).

Other forms of health disparity exist in the region as well. Just over 13% of the metro area's population has some form of disability according to data from the American Community Survey.[17] People with disabilities often have a much harder time finding doctors able to provide basic preventive care, instead needing to rely on harder-to-find specialists.[18]

Outcomes are even worse for individuals of color with disabilities. One study from 1997 found that among white people with Down syndrome, the median age of death was 50 years old compared to only 25 years old for Black people with Down syndrome.[19]

Another major social determinant of health is access to healthcare. People can have limited access because of socioeconomic reasons or because of physical reasons such as living in a rural community far from a hospital.

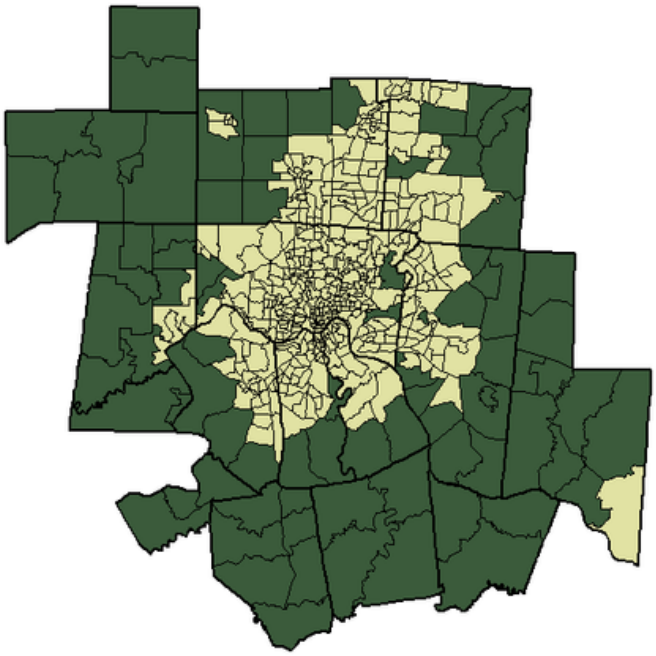


Figure 5: urban or rural Census tracts designation

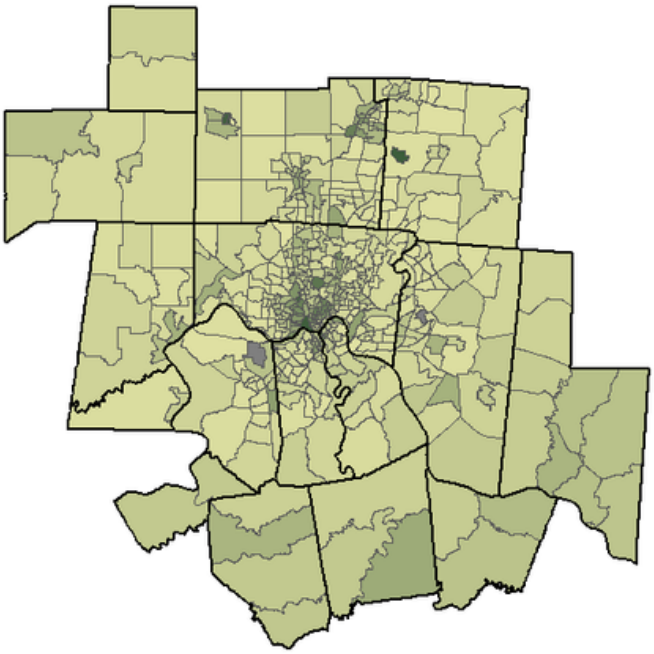


Figure 6: percent of population in poverty by Census tract across 16 counties in Greater Cincinnati, ranging from 0% (light green) to 60% (dark green).

In the Cincinnati metropolitan area, 11.7% of the population live below the federal poverty line.[20]This is lower than the overall poverty rates for Ohio, Indiana, and Kentucky.[21] This lack of resources often leads to worse health outcomes for these people.

As our climate continues to change, we are likely to see health outcomes become worse, as well as less equitable. In the following sections, we explore some of the potential health outcomes that climate change is likely to impact and how these changes will influence the future health equity of the Cincinnati metropolitan area.

Heat-Related Illness

As the number of hot days each year is expected to increase, one of the most direct health impacts will be an increase in the incidence of heat related illness (HRI). HRI's include a spectrum of adverse health effects that can occur due to increased body temperature, such as heat exhaustion, rashes, cramps, and heat stroke.[22] Heat exhaustion occurs when a person experiences hyperthermia, a temperature >101*F, and dehydration due to excessive sweating. Heat stroke occurs when body temperatures exceed 104*F which leads to a life-threatening shutdown of essential organs. Those that are most at-risk for HRI include children under 5, those over 65, those with cardiovascular disease, chronic kidney disease, outdoor workers, pregnant women, and those without access to air conditioning.

We specifically model increases in heat exhaustion and heat stroke, though there is also evidence to suggest that increased temperatures can lead to other negative health outcomes. These additional outcomes include increases in heart disease, including heart attacks and heart failure, strokes, asthma exacerbations, and mental heath exacerbations, including suicides and homicide rates.[23, 24] For example, the risk of heart attacks increases by 2.8% for every 1*C increase (1.6% per every 1*F).[25] Mortality from stroke increases by 1.5% for every 1*C increase (0.83% per every 1*F).[26] Due to their less direct nature, we were not able to project the impacts of heat for these more common diseases.

The number of dangerously hot days are expected to increase dramatically by 2050. For example, in Hamilton county, compared to an observed average temperature of 64.2*F between 1961 and 1990, the average temperature in the 2050's is projected to be 70.5*F. There is a projected increase from an average of 18.3 days above 90*F to 72.9 days and from 0 days above 100*F to 11.6 days in the 2050's.

The effects of heat are amplified in the setting of urban heat islands. Urban heat islands are urban areas that experience hotter temperatures than surrounding areas predominantly due to less green space and reduced air circulation, which dissipate heat, and more infrastructure like roads or buildings, which absorb heat. Temperatures in urban heat islands can be almost 10*F hotter than surrounding areas.[27] These areas tend to have more low-income and Black residents.

From an equity perspective, HRI incidence rates can vary depending on a variety of physical and social factors. Past studies have shown that the burden of heat related illness

falls disproportionately on disadvantaged communities, particularly those of color.[28]

Historically, rates of hospitalizations for the Cincinnati metro area have been relatively low. Using data from the CDC, we estimate that the average baseline rate for HRI hospitalizations across the metro is 2.17 hospitalizations per 100,000 people.[29]

Using projections about the number of days above 90 degrees fahrenheit from the National Oceanic and Atmospheric Administration (NOAA) accessed via the climate explorer tool, we built a generalized additive model to predict the increased incidence of HRI.[30] We then used research about how social determinants of health influence HRI incidence to adjust our results by local equity conditions.[31]

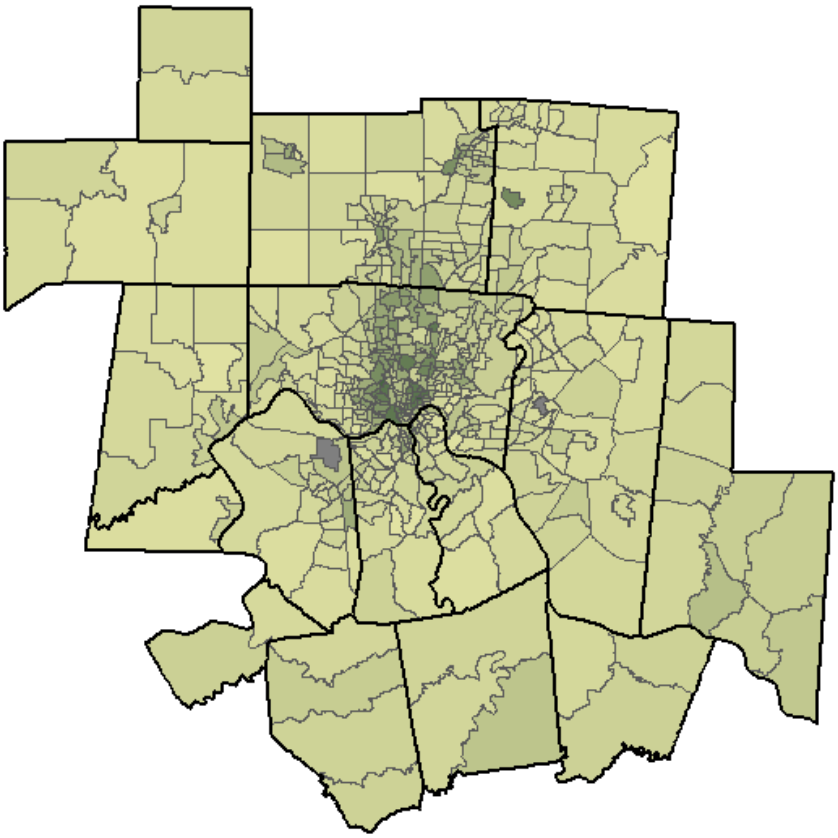


Figure 7: number of new heat related illness hospitalizations per year by Census tract across 16 counties in Greater Cincinnati, ranging from 0.5 (light green) to 0.9 (dark green) hospitalizations per 100,000.

We found that on average, HRI incidence increased by 0.51 cases per 100,000 people across the Cincinnati metropolitan area, a roughly 23% increase. In order to estimate the incidence rates that each equity group will be exposed to, we first calculate the adjusted incidence rate for each census tract in the metropolitan area. We then take the weighted

average of these incidence rates for each equity group and determine which groups will have above average increases. The populations that are going to be exposed to above average risk are people with disabilities, Hispanic residents, people who live in urban areas, people with low levels of education, people who rent their homes, Indigenous people, people in poverty, Native Hawaiian/Pacific islanders, and Black residents.

Interestingly, our model projects that elderly residents will observe an increase in HRI incidence of only 0.47 cases per 100,000. This is because in our data, the elderly population is correlated with other factors that reduce the risk of HRI hospitalization. Most notably, the elderly population in Greater Cincinnati is less likely to experience poverty.

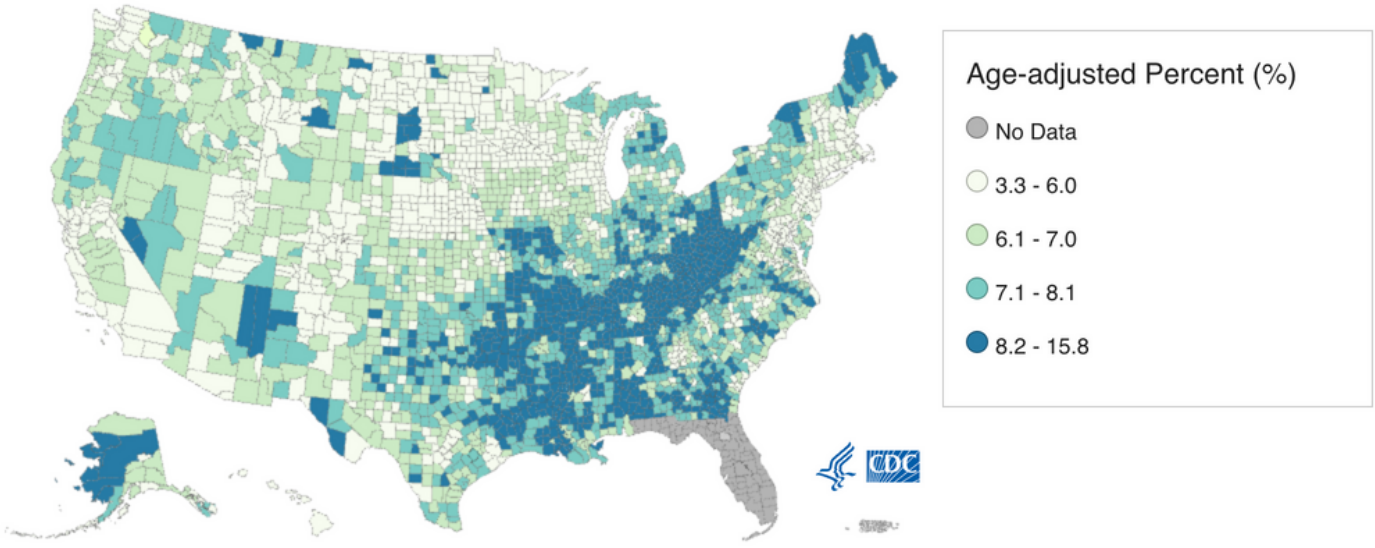
Furthermore, based on a projected increase of 3*F between the 2020's and 2050's in Hamilton county, there is a projected 4.5% increased risk for heart attacks and 2.5% increased risk of strokes. In 2019, there were 174.1 per 100,000 deaths from heart disease and 49.3 per 100,000 deaths from stroke in Cincinnati. This corresponds to 7.8 and 1.2 excess deaths per 100,000 from heart attacks and strokes due to heat in 2050.

Respiratory Illness

As climate change worsens, individuals who have a history of respiratory illness will be subject to more negative health outcomes. This is because climate change happens in conjunction with things like increased levels of air pollution that make it harder to breathe.

Cincinnati is the 12th worst city in the US for year round particulate pollution, making it the worst city for air quality East of the Mississippi.[32] In a population of 2.3 million people in the greater Cincinnati area, there are 37,000 cases of pediatric asthma, 183,00 cases of adult asthma, and 155,000 cases of COPD on average per year.

Additionally, there is evidence that links increased temperatures to increased exposure to ozone.[33] Short-term exposure to high levels of ozone has been linked to increased rates of hospitalizations for people with chronic obstructive pulmonary disease (COPD). COPD that becomes severe enough to warrant a hospitalization can sometimes be life threatening.[34] Figure 8 shows the CDC's estimated rates of COPD incidence across the country.[35]



Data sources: The model-based estimates were generated using data from BRFSS 2021 and ACS 2017-2021, and 2021 Census county population estimates.

Figure 8: the Cincinnati metro area has a relatively high incidence of COPD compared to the nation.

This means that the region is particularly susceptible to the adverse effects of increased temperatures on COPD hospitalizations. One of the biggest risk factors for COPD is a history of smoking.[36]

Using projections about increased temperatures from NOAA, we predict that on average COPD hospitalizations will increase by 0.83% across the region.[37] From an equity perspective, we expect this number to be higher for people with disabilities, people with low levels of education, Native Hawaiian/Pacific islanders, people in poverty, people who rent instead of own their homes, people who live in urban areas, and Black residents.

Although the effects of increased ozone exposure associated with rising temperatures are relatively small, there are other risk factors that can worsen outcomes for people with respiratory illnesses.

Vector-Borne Disease

Vector-borne disease refers to infections that are transmitted to humans and other

animals by bloodsucking parasites such as mosquitoes and ticks.[38] Examples of vector borne diseases in the United States include things like West Nile Virus, and lyme disease. There were 67 cases of lyme disease in Ohio in 2013 which increased to 590 in 2021.[39] In the last 10 years, there have been no reported cases of locally acquired malaria or dengue fever.

As the global climate changes, the places suitable for vector habitation are becoming broader. Generally speaking, vectors thrive in warmer habitats with lots of precipitation.[40] It can get too hot for vectors to survive, and extreme rain events can wash away the eggs of vectors reducing their population, but overall the changes associated with climate change suggest that the prevalence of vector borne disease will increase.

However, there is some debate about whether or not climate change is a significant enough factor to accurately predict future incidence rates by itself. For example, past incidence rates of vector borne diseases have been heavily influenced by public health interventions, biasing predictions based on climate factors alone.

In fact, when we look at data from the CDC for lyme disease cases in the Cincinnati metropolitan area, we find that historically case counts have been negatively correlated with temperature and precipitation.[41]

Still the risk of exposure to new vectors remains a potential threat. One study found that between 2070 and 2099, the Midwest region of the United States will become a suitable habitat for mosquitoes carrying dengue fever and malaria.[42] This study also found that less densely populated areas are more at risk.

From an equity perspective, rural communities tend to experience greater incidence of lyme disease.[43] However, it is still an important consideration for people living in urban areas, especially those who work outdoors.

Among people who are bitten by ticks and contract lyme disease, there is evidence to suggest that people with less access to healthcare or who have worse socioeconomic status are more susceptible to severe illness.[44]

The most significant vector-borne disease risk exacerbated by climate change is the risk of proliferation of newer, more severe diseases such as West Nile Virus or malaria. If past trends of health equity continue when this happens, then we should expect those with less access to healthcare resources to bear the brunt of the health costs of new diseases in Greater Cincinnati.

Water-Borne Disease

According to the CDC, one of the health impacts the Midwest is expected to experience is an increase in waterborne illness due to increased precipitation and temperature.[45] There is fairly significant risk for this in the Cincinnati metropolitan area, given that FEMA's national risk index reports that almost 67% of all census tracts in the region have some risk of riverine flooding.[46] Among those people most at risk for riverine flooding events are people living in rural communities and elderly residents of the region.

However, a meta-analysis of the climate drivers of diarrheagenic E. coli found that ambient temperature is often a better indicator of future incidence change.[47] Researchers found that a 1 degree celsius increase in ambient temperature was associated with an 8% increase in the incidence of diarrheagenic E. coli.

Assuming this trend holds in the Cincinnati metropolitan area, we expect disease incidence to rise by as much as 24%. Based on different exposure to rising temperatures, Black residents of the region, people in poverty, urban residents, people who rent their homes, and native Hawaiian/Pacific islanders will all be exposed to above average rates of diarrheagenic E. coli.

Diarrheal diseases are most deadly for children under five years old.[48] Increased incidence of waterborne illness is going to most severely affect families with young children. Of extreme importance will be those families who don't have adequate access to healthcare.

Additionally, the effects of waterborne illness will be more strongly felt in places where the water treatment infrastructure is insufficient. Fortunately, in the Cincinnati metropolitan area, only 1% of residents live in census tracts designated as disadvantaged in their water/wastewater infrastructure by the federal Council on Environmental Quality.[49] This suggests Cincinnati could have some more resilience to these problems than other metropolitan areas.

However, this will be an important indicator to monitor going forward. Increased precipitation from climate change could increase the burden on water treatment systems. Ensuring the infrastructure in place is able to handle the changing climate will be critical to maintaining public health.

Extreme Weather Deaths

Extreme weather events are defined by the US Department of Agriculture's Climate Hubs as short-lived events such as heat waves, freezes, heavy downpours, tornadoes, tropical cyclones and floods. Adding in the factor of climate change, "climate-related extreme events either persist longer than weather events or emerge from the accumulation of weather or climate events that persist over a longer period of time (for example, drought resulting from long periods of below-normal precipitation)."[50]

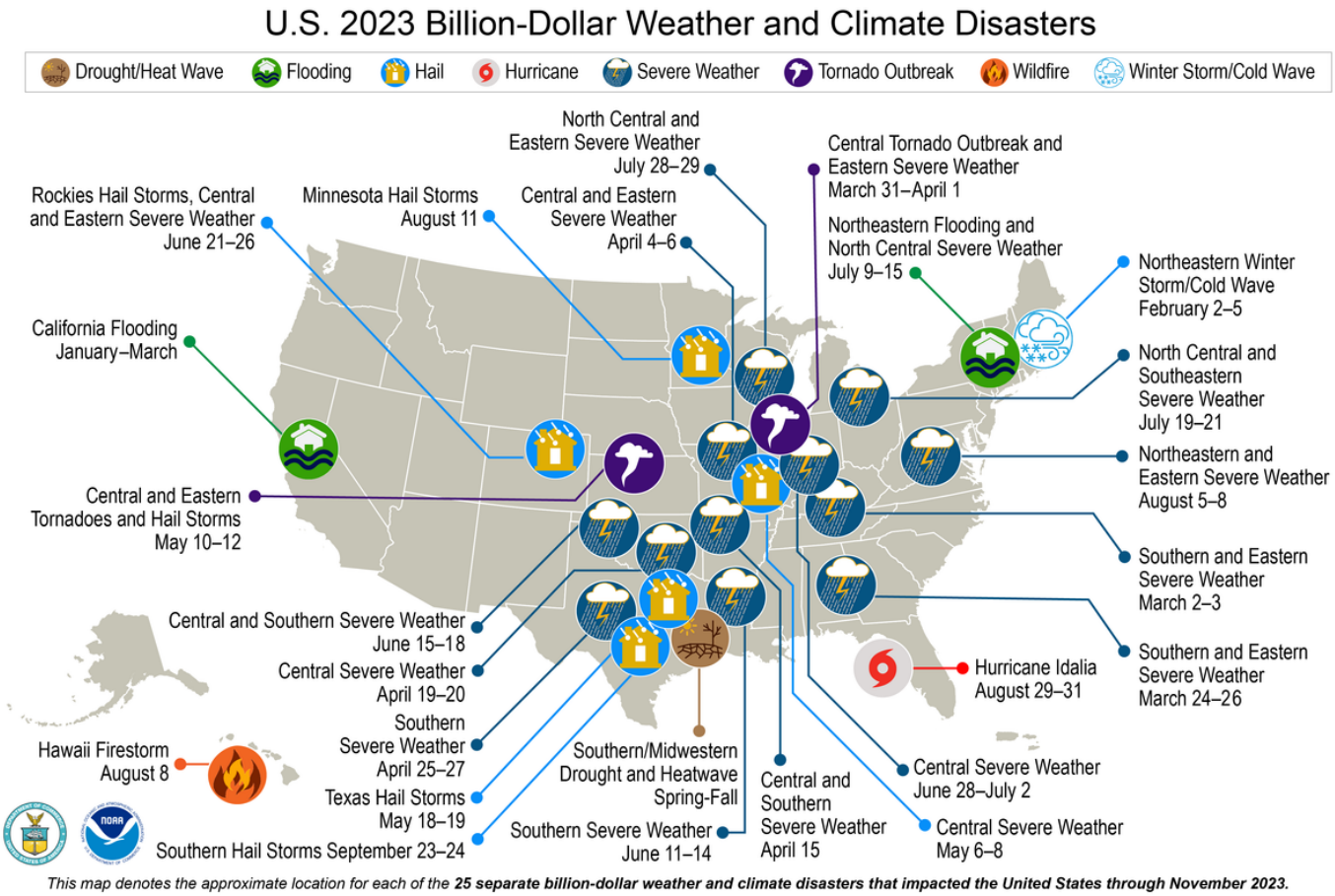


Figure 9: map denoting approximate location for 25 separate billion-dollar weather and climate disasters that impacted the US through November 2023.

As of November 2023, there have been 25 separate billion-dollar weather and climate disaster events. These events include: nineteen severe storm events (tornado outbreaks, high wind, hailstorms), two flood events, one tropical cyclone, one wildfire event, one winter storm/cold wave and one drought/heat wave. As shown in Figure 9 from the National Oceanic and Atmospheric Administration, these events are heavily concentrated in Central and Midwestern states. Importantly, 2023's historic pace of events exceeds the prior annual record number of inflation-adjusted billion-dollar disaster events (i.e., 22 events in 2020). Furthermore, the total cost from the 25 events in 2023 exceeds $81.0 billion; the total cost 2017-2023 exceeds $1 trillion while the costs for 373 events from 1980-2023 exceeds $2.655 trillion (inflation-adjusted to 2023 dollars).[51]

Our health equity analysis of extreme weather events uses the Federal Emergency Management Agency's (FEMA) national risk index.[52] This index takes into account both social and environmental factors to calculate a risk score at the census tract level.

Of particular interest is the population expected annualized loss (PEAL). What the PEAL represents is the annual monetized value of the human risk associated with extreme weather events. We can think of this as how much money we'd have to pay each year to counteract the added risk that comes with more severe weather events.

Using FEMA's estimate for the value of statistical life of $11.6 million, we can represent the PEAL as the cost of expected annual deaths that result from extreme weather events. In 2050, FEMA calculates the PEAL for the Cincinnati metropolitan area to be about $87 million. This is the equivalent of an additional 7.5 deaths annually due to extreme events. In the metro area, the most severe extreme event is tornadoes, which FEMA projects to cause an average of 3 additional deaths each year.

From an equity perspective, the groups FEMA project's to have higher than average exposure to losses from extreme events are elderly people, people in rural communities, white people, and native Hawaiian/Pacific islanders.

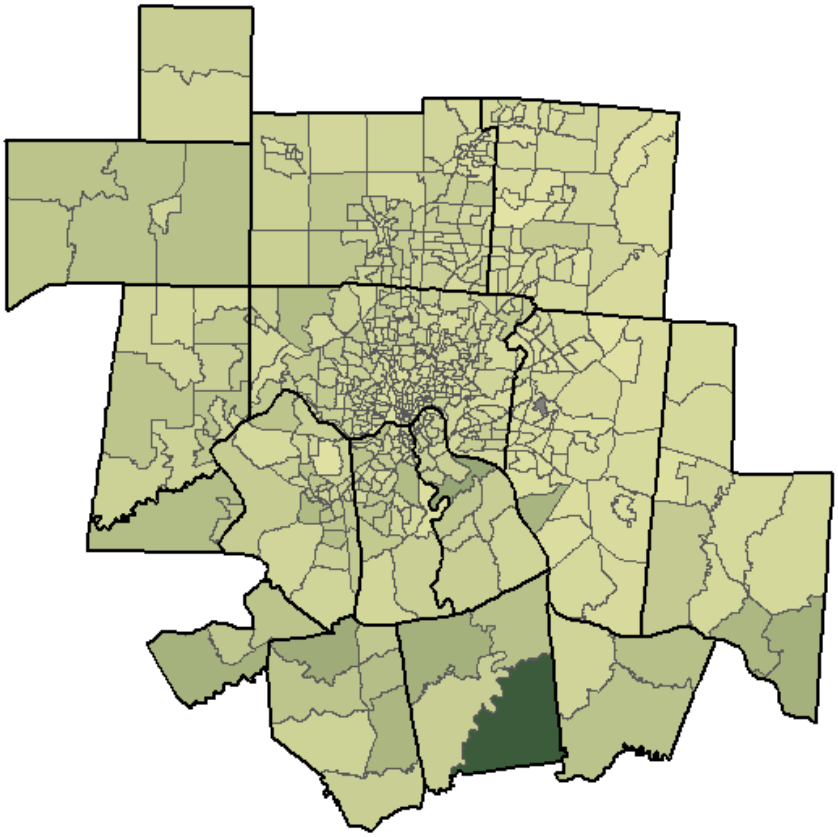


Figure 10: cost of expected annual deaths by Census tract across 16 counties in Greater Cincinnati, ranging from $500,000 (light green) to $1,000,000 (dark green).

For example, the census tract that contains the city of Falmouth KY, in Pendleton county is in the 95th percentile nationwide for expected annualized loss. That particular census tract has a PEAL over twice as high as any other tract in the region.

Looking forward, rural communities that have fewer people and often fewer resources might find it more difficult to adapt to the challenges of climate change. Especially in the context of extreme weather events, which often involve expensive and time consuming recoveries.

Mental Health

There are many ways to examine how climate change impacts mental health. Researchers Lawarence Palinkas and Marleen Wong propose that climate change can influence mental health in three ways: (1) acute events such as flash floods, (2) subacute events such as droughts, and (3) the existential threat of long-term changes.[53]

Research has shown that acute climate events can lead to increased rates of a wide range of negative mental health outcomes such as anxiety, post traumatic stress disorder, and suicide.[54, 55] Specifically, research from the American Public Health Association has found that up to 54% of adults and 45% of children suffer depression after a natural disaster.[56]

The evidence also suggests that these effects are not going to be distributed evenly. Traditionally disadvantaged groups such as women, people who are less educated, people of color, or are lower-income are at greater risk for developing mental illness in the aftermath of these events.[57]

The research on subacute events suggests that the effects will be very similar to the effects of acute events. One concern with these types of events is the long term economic effects and how that will influence mental health.

For example, there is a causal pathway linking the increased drought prevalence to negative mental health impacts, especially for rural farming populations. During the 1980's Farm Crisis following a record breaking drought, over 900 farmers across the Midwest committed suicide at double the previous rate.[58] Farmers across Ohio continue to have among the highest rates of suicide across the state due in part to an uncertain future from climate change.[59]

We could expect similar subacute events to have impacts on other industries and further on the mental health of people who work in those industries, such as heat waves impacting outdoor workers.

General worry about climate change and its long lasting effects is already a prevalent issue for many people today. Researchers have recognized that climate change has been the source of emotional distress for people for over 15 years.[60] In particular, young people seem to experience these feelings more frequently.[61] A national survey in 2021 found that 70% of Americans feel "somewhat worried" about climate change, with 35% feeling "very worried."[62]

There is also a body of research linking increases in temperatures to increased rates of suicide.[63] This connection is especially important for people who are already living with mental illness, as they are more at risk.

Mental health providers are underprepared to assist people facing mental health challenges caused by climate change. One survey of mental health professionals from

Minnesota reported that over 80% of respondents believed climate change was an important problem affecting mental health, while only 33% felt well prepared to have that conversation and only 15% were familiar with treatment resources.[64] Access to climate change specific training for mental health professionals will be critical going forward.

Another challenge facing the region is its rapidly changing population. The Ohio-Kentucky-Indiana Regional Council of Governments projects that the population of the region will grow by 10% by 2050.[65] Part of this population growth will likely be climate migrants, people who are forced to leave their homes due to climate change.

Traditionally underserved communities have been at risk for worse mental health outcomes for many years,[66] and past mental health problems are one of the most important risk factors for worsening future outcomes. Therefore, as climate change continues in the region, we should expect the current equity gaps to be exacerbated unless intentional action is taken.

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