The *Lancet* Countdown on Health and Climate Change

Policy Brief for the United States of America: Appendix

2022

LANCET COUNTDOWN: TRACKING PROGRESS ON HEALTH AND CLIMATE CHANGE

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LANCET COUNTDOWN:
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CASE STUDY

Health and Climate Impacts of Methane Gas in Buildings

Most homes and buildings in the United States (U.S.) burn gas, oil, or other fossil fuels for heating, cooking, and hot water. Gas stoves and appliances produce harmful levels of indoor air pollution that can lead to respiratory diseases and other health harms, especially for children.

Most homes and commercial buildings in the United States (U.S.) burn gas, oil, or other fossil fuels indoors for heating, cooking, and hot water. The U.S. Environmental Protection Agency estimates that fossil fuel use in these buildings accounts for 13% of U.S. greenhouse gas (GHG) emissions.[1] However, this excludes contributions from methane emissions, a powerful GHG that can leak from distribution lines[2] and home appliances, including gas stoves that are not in use.[3]

Gas stoves produce high levels of indoor air pollutants — including nitrogen dioxide, formaldehyde, carbon monoxide, particulate matter, and benzene[4,5] — leading to exacerbation of asthma and other respiratory diseases, especially in children.[6,7] Pollution concentrations are higher in small areas and homes without properly vented stove hoods or other ventilation.[3] Energy-burdened households that use gas stoves as a source for warmth have even greater exposure.[8] These exposures add to the disproportionate, cumulative pollution exposure that burdens low-wealth communities and communities of color. In addition, gas extraction is linked to a number of adverse health effects, including asthma and other respiratory diseases, adverse pregnancy outcomes, and cancer risk (Case Study on Health Impacts of Pollution Along the Oil and Gas Lifecycle).[9–11]

Through policy action, U.S. cities are leading the charge in protecting health by reducing harmful indoor air pollution. Such policies work to electrify homes and buildings, including replacing gas appliances with efficient, zero-emission alternatives like electric or induction stoves, electric dryers, and heat pumps that provide highly efficient space heating and cooling.

Nearly 80 cities across 10 states have adopted plans to phase out gas use in buildings by adopting all-electric codes for new construction or building performance standards.[12] For instance, New York City plans to phase out gas in all new buildings by 2027, which will eliminate emissions equivalent to taking 450,000 cars off the road for a year.[13] Neighborhood researchers in Washington, D.C. found nearly 400 methane gas leaks on D.C. streets.[14] The research helped generate momentum for new legislation passed in July 2022 that will phase out all gas use in new buildings and retrofits in the city by 2026. The Los Angeles city government used a community engagement process to design a policy requiring all-electric new residential and commercial construction starting in 2023. In May 2022, Washington became the first state to require electric heat pumps for space heating and cooling in new commercial and multi-family buildings.[15]

However, many states are now advancing laws that prohibit cities from taking action to phase out gas in buildings, so-called preemption laws, often with the support of the oil and gas industry. These laws have now passed in 20 states, hindering local action.[16]

At the federal level, the Inflation Reduction Act will expand electrification tax credits, which will support cities and states seeking to set new building codes or performance standards. There is, however, more work to be done at the federal level. The Environmental Protection Agency should list gas appliances as a source category under the Clean Air Act, enabling the agency to set strong pollution standards for indoor appliances to ensure better protection for people in the entire U.S.[17] At the same time, the Consumer Product Safety Commission can set standards limiting emissions from stoves, set ventilation standards, and require gas stoves to have warning labels.[18] Together, action at the local and national level can protect children and families from harmful indoor air pollution.

CASE STUDY

Health Impacts of Pollution from Oil and Gas Production

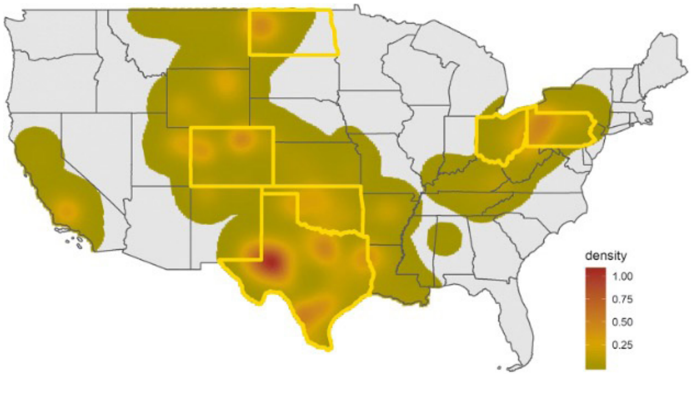
Activities along the oil and gas production life cycle — ranging from extraction and production, transportation and storage, and refining and transmission — produce air and water pollution that can lead to many harmful health impacts for workers and communities living near fossil fuel infrastructure

The United States (U.S.) is the world's largest producer of oil and methane gas (hereafter referred to as "gas").[19]
Over the past two decades, the number of people living near oil and gas production sites has grown due to developments in unconventional drilling technologies; in the U.S., approximately 18 million people (6% of the population) live within a mile of at least one active oil or gas well (Figure 1).[20]

Multiple harmful health impacts are generated along the oil and gas life cycle, from extraction to combustion. These harms disproportionately impact pregnant people, children, Indigenous people, communities of color, and low-wealth communities.[21–24]

FIGURE 1.

Density of productive oil and gas wells completed between January 1, 2005 and December 31, 2018, in the continental U.S.



Reproduced from Johnston and Cushing, 2022.[25] Highlighted states represent those in which recent health studies had been conducted at the time of study publication.

In addition to emitting climate-warming pollutants, activities along the oil and gas supply chain (Figure 2) generate harmful air, water, waste, light, and noise pollution that affect the health of industry workers and people in nearby communities.[10,11,26,27] For example, well drilling, venting and flaring processes, leaks from storage tanks and pipelines, and oil and gas processing and refining all lead to emissions of fine particulate matter ($PM_{2.5}$), as well as nitrogen oxides (NO_x) and volatile organic compounds (VOCs). These air pollutants themselves are harmful and will lead to further $PM_{2.5}$ and ozone formation in the atmosphere. These air pollutants emitted along the oil and gas production life cycle cause a slew of health effects including heart and lung disease, fertility and neurological problems, dementia, and premature death (Appendix Table B). Production processes also release hazardous air pollutants like benzene and toluene, which can cause cancer, adverse reproductive effects, and birth and developmental defects.[25,28]

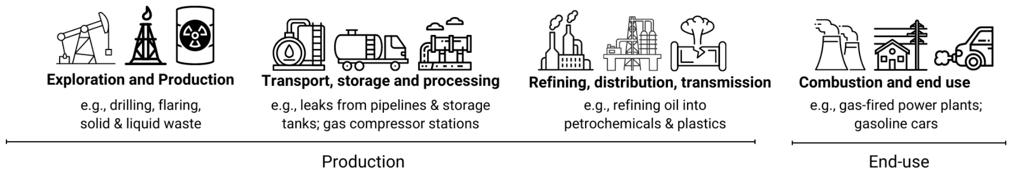
Here, we highlight some of the major public and occupational health harms of pollution from oil and gas production and distribution processes by drawing on illustrative examples across the U.S.

Flaring

Flaring is the intentional burning of by-product gas, mostly methane, from oil and gas exploration, production, and processing. This process releases carbon dioxide, carbon monoxide, $PM_{2.5}$, NO_x, and toxic heavy metals, and is linked with increased respiratory hospitalizations, adverse birth outcomes, and premature death.[29] In the U.S., flaring is a common practice due to weak regulations combined with a lack of monitoring and economic incentives. For example, Texas has flared about as much gas as its residential users consume in a year.[30] In southern Texas, pregnant people who

FIGURE 2.

Emissions of harmful air pollutants occur along all stages of the oil and gas lifecycle, from exploration to end-use.



live near areas with routine flaring have a 50 percent greater chance of giving birth prematurely than those who do not.[31] These impacts are not experienced equally: Hispanic residents in this region are exposed to more flares.[32]

Extraction Waste

The processes of well drilling and oil and gas extraction generate massive amounts of solid and liquid wastes that are contaminated with toxic substances including arsenic, lead, and naturally occurring radioactive materials.[33–35] Industry workers and the public have been exposed to these carcinogens for decades due to a lack of federal regulations to ensure safe management and disposal of these waste streams.[36] Exposure can occur directly or through contamination of water resources and soil from oil and gas wastewater being spread on roadways or sent to municipal water plants, from solid wastes being shipped to municipal landfills, and from spills during transportation.[36] For example, in Irvine, Kentucky, a landfill located close to local schools illegally accepted nearly 2,000 tons of radioactive wastes from oil and gas production in West Virginia and Ohio in 2016.[37] People working in the petroleum industry or living near petroleum facilities are at increased risk of developing several different cancer types, including lung cancer, skin cancer, and childhood leukemia.[10]

Transport

Crude oil transport can result in accidents occurring along pipelines, rail lines, waterways and at trans-shipment sites, causing harm to public health, surrounding environments, and local economies.[38] For example, in 2010, the Enbridge pipeline ruptured in the Great Lakes region, resulting in one of the largest inland oil spills in U.S. history.[39] Residents living near the Kalamazoo River and Talmadge Creek were advised by local health departments to stop using the water for drinking and cooking for several months.[39] More than half of people living in or near the spill site had at least one symptom of exposure to hazardous compounds, including headaches, nausea, and respiratory and gastrointestinal symptoms, and at least 40 percent had multiple symptoms.[40]

Petroleum Refining

Oil and gas can be refined into petrochemicals that are used to manufacture a wide array of products including plastics, rubber, and synthetic fibers — more than 98 percent of plastic and synthetic chemicals are produced from fossil fuels.[41] This process releases a wide array of toxic air pollutants with devastating health consequences for nearby communities.[42] For example, in Reserve, Louisiana, the Denka chemical plant is the nation's only producer of chloroprene, a component of synthetic rubber. Residents of Reserve have been exposed to deadly levels of air and toxic pollution for decades, leading to cancer risks 50 times higher than the national average.[43–45] Reserve is part of the region referred to as "Cancer Alley" which contains over 150 petrochemical plants and refineries.[46]

This case study highlights just four examples of how communities are harmed by activities of the fossil fuel industry. There are many other pollution sources along the oil and gas supply chain, as well as from coal mining.[47] Altogether, the health impacts of the fossil fuel industry include, but are not limited to, cancer; diseases of the respiratory, cardiovascular, and nervous systems; adverse impacts on maternal health and newborn health; poor mental health; and premature death.[10,26,48] Choosing a net-zero emissions strategy that continues to rely on fossil fuels by capturing or offsetting emissions would still allow for harmful health impacts and environmental injustices for nearby communities and industry workers,[49] while the transition to electrification using renewable sources is the surest way to reduce these health risks.

Critical Insights

Sea Level Rise and Health

In 2020, more than 1.7 million people in the United States (U.S.) lived less than 3 feet above current sea level in 2020 (Indicator 2.3.3, Table 1).[50]

Sea level has risen eight to nine inches since 1880, as a result of melting snow and ice and thermal expansion of water.[51] The pace of sea level rise is accelerating in the U.S.[52] In many U.S. coastal locations, high-tide flooding — independent of storm surge — is occurring three to nine times more often than it did 50 years ago.[51] Significant further increases are projected for some areas by the mid-2030s.[53]

Rising seas affect health through a range of pathways, particularly when combined with storm surge. There are physical, mental health, and financial consequences of flooded homes, schools, businesses, and houses of worship.[54,55] Sea level rise and flooding contaminate drinking water supplies and soil with waterborne pathogens from failing septic systems,[56] toxic substances from contaminated facilities,[57] and saltwater.[58] Communities of color and low-wealth communities are at greater risk of toxic exposure as a result of flooding[59] and are less insured, making recovery challenging.

Flooding can also make it harder for people to access medical care. Roadways and transportation systems from patients' homes to medical facilities may be inaccessible, even if the facilities themselves remain functional (Figure 1).[60]

Mental health impacts can be long-lasting, as people may be displaced from their homes and communities and experience devastating economic losses.[61] Sea level rise and flooding can also impact cultural heritage sites and undermine opportunities for engaging in traditional practices and livelihoods.[62] Thus, the health impacts of sea level rise may particularly harm Indigenous communities and other communities reliant on coastal resources for their economic, social, or cultural practices.

In addition, recurrent flooding of coastal property diminishes its value, with implications for property taxes that fund local emergency services such as paramedics and ambulances.[63,64] Although some communities can afford to harden their infrastructure (e.g., sea walls) to forestall impacts, many others cannot, particularly as their property tax base is diminished by rising seas. In addition, these types of infrastructure interventions can push the impacts of sea level to nearby communities. Thus, soft defenses (e.g., mangroves, dune systems) may minimize unintended negative consequences.

FIGURE 1.

Many access roads for Miami's North Shore Medical Center would be affected by a five-foot flood (flooded areas are marked in red on the above Climate Central map), even though the facility itself, which is more than two miles inland, would remain dry. North Shore Medical Center of Miami is indicated by a black star.[60]

Health Care Sector Role in Emissions Reductions

Climate change poses a significant threat to health care infrastructure and operations. Consistent with health care's mission to first do no harm, it is imperative for the health care sector to mitigate its own contributions to climate change. The health care sector accounts for over 8% of United States (U.S.) greenhouse gas emissions.[65] Despite this large footprint, there is wide variation across health systems in efforts to reduce health care emissions and waste and to prepare for climate-driven disruptions to health care delivery.[66,67]

The Biden Administration has taken steps to support the health care sector in reducing emissions by 50 percent by 2030 and achieving net-zero emissions by 2050, in alignment with U.S. climate goals. The Administration now requires all federal facilities — including federally managed hospitals and health facilities — to align their actions with U.S. emissions reduction goals.[68] In 2022, the Department of Health and Human Services launched the Health Sector Climate Pledge and encouraged non-federal hospitals, health systems, health associations and other industry organizations to voluntarily commit to meet the

Administration's climate goals.[69] As of June 2022, 61 entities, including health systems representing 650 hospitals, have signed the pledge. This is an important first step, and yet represents only a small fraction of U.S. hospitals. Additional leadership is needed to mobilize more health care partners and to ensure participating organizations fulfill their climate pledges. Health care systems can invest more resources into decarbonization. Simultaneously, the Inflation Reduction Act (IRA) may lower the cost of the energy transition by expanding access to tax credits for non-profit hospitals to switch to clean energy sources.[70]

In addition to these federal efforts, the National Academy of Medicine (NAM) formed the Action Collaborative on Decarbonizing the U.S. Health Sector — a public-private partnership of health care stakeholders working to develop goals and strategies to decarbonize the health care supply chain and health care delivery, and expand health professional education on climate change.[71] A focus of the NAM work is to develop policies, innovation, and metrics that support organizations in reducing their emissions. About 80 percent of all health care sector emissions stem from activities of assets not owned or controlled by health care organizations (so called “Scope 3”) and cannot be ignored. These include emissions from the supply chain, including the manufacturing, transport and disposal of food, pharmaceuticals, and medical supplies and devices.[72] The Agency for Health Care Research and Quality provides guidance on metrics and strategies to track and reduce carbon emissions from buildings, transportation, anesthetic gases, pharmaceuticals, medical devices and supplies, and food systems and waste.[73]

Meeting climate goals, however, will require rapid and dramatic emission reductions from the entire health care sector while recognizing that voluntary action may be insufficient to achieve the Administration’s goals and timelines. Other actions that could accelerate health sector decarbonization include: mandated reporting of all health sector emissions; linking Centers for Medicare & Medicaid Services (CMS) accreditation and payment to annual, transparent, verified, and standardized disclosure of emissions; and incentivizing low-emission health care delivery choices by clinicians and health systems.[65,74] Hospitals and health systems must also work with communities and public health partners to prepare for climate impacts by mapping needs, building climate resilient infrastructure and care delivery pathways, empowering vulnerable communities, strengthening climate change and health literacy among the health care and public health workforce, and ensuring equitable access to care.[67,75]

Health and Equity Considerations for Carbon Capture and Storage

Carbon capture and storage (CCS) is a process through which carbon dioxide (CO_2) produced through energy generation and industrial processes is captured and stored, rather than emitted into the atmosphere. CCS is receiving considerable attention by industry and policymakers. Yet its cost, technical feasibility, scalability, and importantly, its health and safety impacts, raise questions about its value as a mitigation strategy[76] relative to other strategies such as electrification with renewable energy. Renewable energy avoids most of the health impacts associated with the production and combustion of fossil fuels (Case Study on Health Impacts of Pollution from Oil and Gas Production).

The 2022 Intergovernmental Panel on Climate Change Sixth Assessment Report (IPCC AR6) on mitigation suggests, in modeled scenarios, that removal of carbon from the atmosphere through technologies such as CCS may be required to meet global climate targets.[77] However, the IPCC also reports that CCS may allow fossil fuels to be depended on for longer, is costly, and faces various technological, economic, and other barriers to implementation. By diverting resources away from healthier and more technically feasible carbon mitigation strategies, CCS may prolong and in some cases increase the emission of some health harming industrial and energy-related air pollutants.[78,79]

Despite these caveats, the U.S. has committed billions of dollars in funding and tax credits to incentivize industry to research and deploy CCS.[70,80] From a health perspective, CCS warrants caution. This is particularly true in juxtaposition to the significant and near-term health benefits of climate mitigation strategies such as policies and investments to attain a rapid transition to clean, safe, reliable renewable energy.[81,82]

Pollution associated with fossil fuel industries for which CCS may be an option in the future disproportionately impacts frontline communities, which are often communities of color or areas of low wealth. Carbon leaks from CCS equipment, transport, and storage facilities may expose communities to further harmful emissions.

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Critical Insights continued

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The health impacts of CCS remain largely unknown. Life cycle analyses of the health, equity, and climate impacts of CCS on workers and communities are needed to better understand the potential health harms. Safeguards for the protection of human health must additionally be integrated into any further deployment of CCS. This must include requiring implementation of the best available technologies to reduce direct emissions of harmful air pollutants from facilities that utilize CCS; preventing CO_2 leaks from CCS infrastructure; prohibiting the use of CCS for further fossil fuel extraction such using captured CO_2 for enhanced oil or gas recovery; and requiring fossil-fuel facilities that receive CCS subsidies to develop phase-out plans. Finally, there must be robust community engagement in decisions regarding the siting of CCS facilities, transportation, and storage infrastructure.

Climate Change and the U.S. Food System

Agriculture accounts for approximately 11% of United States (U.S.) greenhouse gas emissions. These emissions come predominantly from crop and livestock production and on-farm energy use.[1] Reducing these emissions can be accomplished by transitioning away from the use of fossil fuels and synthetic fertilizers, using regenerative agriculture practices, reducing the production and consumption of animals, and reducing food waste, each of which can have added health co-benefits.[83–86]

Climate change and climate-related extreme weather events, in turn, are impacting agricultural systems at national, regional and local levels in the U.S. Flooding, droughts, and high temperatures can reduce food production, safety, and access to food.[87] These extreme events also disrupt the food system, decreasing supply and increasing prices, thereby increasing household food insecurity.

Agricultural workers, in particular, face health risks in a changing climate. There are one million U.S. agricultural workers, who are especially susceptible to extreme heat, experiencing heat mortality rates up to 35 times higher than workers from other industries.[88,89]

Among the most common health effects for agricultural workers are acute heat-related illnesses and life-threatening heat strokes.[90] Chronic kidney diseases are a growing concern in agricultural communities in Central America[91] and may additionally affect agricultural workers in the U.S.[92] Heat exposure also exacerbates respiratory, cardiac, renal, and other chronic diseases.[93] Climate change is altering pest populations and resistance, increasing the perceived need for pesticide utilization,[94–96] and may increase farmworker exposure to toxic chemicals. Migrant workers, who make up approximately 75 percent of all agricultural workers in the U.S.,[97] have fewer occupational protections and are therefore at greater risk of suffering health harms.[98,99] Outdoor workers are particularly vulnerable to co-occurring climate hazards. For example, in 2020, outdoor workers in California were exposed simultaneously to extreme heat and wildfire smoke.[100]

Climate risks, such as extreme heat and wildfire smoke, result in lost workdays and lost productivity. This can harm both economic and food security of agricultural workers and communities.[98,101] Overall, it is anticipated that these detrimental health effects on agricultural workers could also significantly reduce agricultural productivity within the U.S., separate from the direct impacts of climate change on crop systems.[102] Lastly, climate impacts on the U.S. food system can have far-reaching impacts on food systems, including food prices and supply, with rippling impacts on global food insecurity.

Appendix Table A: Factors that Shape Climate Change Susceptibility, Exposure, and Adaptation

Many factors — historic and current, political and economic, biological and social — shape who is at risk from climate change. This table provides an overview of some of the communities most impacted by climate change. It includes examples of forces that shape their increased susceptibility and exposure, and inequities in adaptive capacity.

Burden Group: Susceptibility – Factors influencing risk are generally biologic in nature	
Children	Children are more susceptible to harm from climate-related impacts such as toxic air pollution and extreme heat. Children's developing organs can make them more susceptible to hazardous exposures, their biologic defense mechanisms are immature, they breathe in more air for their body weight compared to adults,[103] and some pollutants can travel through breastmilk[104] or cross the placental barrier.[105] Thermoregulation is particularly impaired in infants, which places them at an increased risk of mortality from extreme heat.[106] Children are dependent on adults for their safety and wellbeing; for example, during extreme weather events children have added susceptibility due to the threat of displacement and injury.[103] In addition, children are more vulnerable to the mental health impacts of climate events.[107]
Pregnant people	Physiological changes experienced during pregnancy can leave pregnant people at increased susceptibility when exposed to environmental toxins and extreme weather.[108] For example, adverse reproductive outcomes (e.g., preterm birth) increased following Hurricane Katrina[109] and were associated with disruptions to public health, health care, and infrastructure services; exposure to toxins; lack of access to safe food; and poor shelter conditions. Ozone, $PM_{2.5}$, and heat exposure are associated with adverse birth outcomes, including preterm birth, low birth weight, and stillbirth.[110] Pregnant people experiencing socioeconomic disadvantage may also experience a greater burden of exposure to climate-related events.[111]
Older adults	Older adults are more likely to have pre-existing illnesses, including cardiovascular[112] and respiratory diseases,[113] weakened immune responses,[114] impaired thermoregulation,[115,116] and medication use.[117] This places them at increased risk of harm during climate-related events like heat waves. Older adults can also have more limited mobility, experience more social isolation, and have higher levels of economic insecurity. These factors can place older adults at greater risk during extreme events as they are less able to access social services and adaptive resources, evacuate, or relocate.
People living with preexisting illness	Respiratory illness,[118] cardiovascular disease,[119] and diabetes[120] can heighten sensitivity to climate impacts. People with psychiatric conditions can experience difficulty regulating their internal body temperature in extreme heat exposure, which can be related to medication use or their disease.[121] Certain medications, such as antihypertensives and antidepressants place patients at increased risk of heat-related illness and dehydration.[93,122]
Burden Group: Exposure – Factors influencing risk are closely related to disproportionate exposures	
Communities of color	People of color include, but are not limited to, people that identify as Black, African American, Latino, Indigenous (described below), Asian, Pacific Islander, and multiracial.[123] Systemically racist policies, including historic redlining, create segregated communities in which people of color disproportionately live in neighborhoods burdened by hazardous exposures,[124] high heat,[125] flooding,[126] and less tree canopy.[127] As such, urban heat islands are more likely to occur in Black and African American, and Latino communities.[125] Further, systemic disempowerment has contributed to communities of color being home to polluting facilities and comprising the majority of people living in close proximity to a toxic facility,[128,129] thereby heightening exposure to air pollutants,[130] and increasing risk of toxin exposure during flood events.[59]

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Burden Group: Exposure – Factors influencing risk are closely related to disproportionate exposures continued	
Pregnant people	People of color include, but are not limited to, people that identify as Black, African American, Latino, Indigenous (described below), Asian, Pacific Islander, and multiracial.[123] Systemically racist policies, including historic redlining, create segregated communities in which people of color disproportionately live in neighborhoods burdened by hazardous exposures,[124] high heat,[125] flooding,[126] and less tree canopy.[127] As such, urban heat islands are more likely to occur in Black and African American, and Latino communities.[125] Further, systemic disempowerment has contributed to communities of color being home to polluting facilities and comprising the majority of people living in close proximity to a toxic facility,[128,129] thereby heightening exposure to air pollutants,[130] and increasing risk of toxin exposure during flood events.[59]
Older adults	Poor housing conditions may be more concentrated in low-wealth communities.[135] Inadequate shelter, poor quality housing, and lower wealth can render people more susceptible to poor air quality,[136] extreme temperatures,[137] extreme weather,[138] and flooding.[139] Further, inadequate shelter may lack features that are protective, including window screens that can help reduce household exposure to insects or weatherproofing to reduce exposure to extreme cold temperatures. Economic insecurity can also make it more difficult to adapt to climate change (e.g., lacking access to health protective cooling) and effectively recover after a climate-related event.[136]
People living with preexisting illness	Exposure to climate events like heat waves and decreased access to protective resources during extreme weather events may be higher for people experiencing homelessness, due to lack of access to safe housing.[138] They also are more likely to have risk factors that exacerbate climate change susceptibility, such as cigarette smoking, substance use, mental illness, and poorly controlled chronic illnesses.[140] Veterans who are experiencing homelessness may have added susceptibility to heat-related illness due to the heightened likelihood of complicating factors that include, chronic diseases like cardiovascular disease, diabetes, and chronic obstructive pulmonary disease, and psychiatric conditions including PTSD, alcohol abuse, and anxiety and mood disorders.[141]
Occupational groups	People who work outdoors, including those in agriculture, construction, firefighters, police officers, emergency medical service providers, and delivery workers, can have increased exposure to heat; poor air quality, including wildfire smoke; and disease-carrying insects.[142–144]
Burden Group: Ability to Adapt – Factors influencing risk hinder adaptation	
People living with disabilities	Multidimensional inequities can exacerbate the burden of climate-related events and hinder adaptive capacity for people living with disabilities.[121] Systemic gender, race, and economic inequities and discriminatory policies (see above section) compound risks for people who are living with disability who are also subject to experiencing other forms of marginalization. In addition, people living with disabilities may have limited ability to prepare for extreme weather events, lack an optimal ability to evacuate, and have less capacity for recovery.
Rural communities	Rural areas are often home to agricultural communities that can have strong economic and cultural ties to the land. Drought, changes in temperature, and extreme weather events can decrease agricultural yields, causing economic harm and increasing mental health risks.[145,146] In addition, warming waters can decrease aquatic food safety in rural communities reliant on aquatic industries, threatening economic security and wellbeing.
LGBTQIA	Discrimination, unequal access to resources, threats of violence, exclusion from shelters, displacement, unique post-disaster recovery and resource needs, and mental illness can increase the climate change and health burden for LGBTQIA people and communities.[147]

Appendix Table B: Key Fossil Fuel-Related Air Pollution* and Health Linkages

Organ System	Description	Air Pollution-Associated Health Impacts
Cardiovascular	Heart, blood vessels	Heart disease progression[118] Heart attack[118] Hypertension and elevated blood pressure[118] Cardiovascular death from ischemic heart disease, arrhythmia, heart failure[118]
Respiratory	Lungs, throat, and nose	Asthma development and exacerbations[118] Chronic Obstructive Pulmonary Disease progression[118] Increased pneumonia risk[118] Allergies[118] Lung cancer development[118] COVID-19 incidence and mortality[118]
Endocrine	Hormones, glands, and metabolism	Diabetes[118]
Urinary	Kidneys, ureters, bladder, and urethra	Chronic kidney disease[118]
Gastrointestinal	Stomach, mouth, liver, small and large intestines	Early onset Crohn's disease and ulcerative colitis[118] Fatty liver disease[118] Gastric and liver cancers[118]
Immune	Lymph nodes, skin, spleen, and bone marrow	Systemic autoimmune disease[118] Rheumatoid arthritis[118] Cancer death (digestive, lung, breast, and female genital cancer)[118]
Reproductive and Developmental	Genitals, hormones, and pheromones	Low birth weight[110] Preterm birth[110] Stillbirth[110] Congenital heart disease[148]
Neurologic and Psychiatric	Brain, spinal cord, and mental health status	Stroke and death from stroke-related conditions[118] Dementia[118] Parkinson's disease[118] Anxiety[118] Depression[118] Suicide[118] Adverse sleep effects[149]
Children's Health		
Cardiovascular	Heart, blood vessels	Hypertension[103]
Respiratory	Lungs, throat, and nose	Asthma development and exacerbations[103] Lower respiratory infection[103] Bronchitis[103]
Immune	Lymph nodes, skin, spleen, and bone marrow	Disease activity and renal involvement in juvenile lupus erythematosus[118]
Neurologic and Psychiatric	Brain, spinal cord, and mental health status	Long-term intellectual disabilities[103] Autistic traits[103] Attention deficit hyperactivity disorder[103] Anxiety[103] Depression[103] Reduced cognition[103]

*Air pollution from fossil fuel combustion includes: particulate matter less than 2.5 ($PM_{2.5}$) or 10 (PM10) microns, nitrogen dioxide (NO2), nitric oxide (NO), sulfur dioxide (SO2), carbon monoxide (CO), traffic-related air pollution, polycyclic aromatic hydrocarbons (PAH), and ground-level ozone (formed through a chemical reaction from precursors from fossil fuel burning that include nitric oxides [NOx] and volatile organic compounds [VOCs] in the presence of sunlight).

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The Lancet Countdown

The *Lancet* Countdown: Tracking Progress on Health and Climate Change exists to monitor the links between public health and climate change, and the transition from health threat to opportunity. We are a global collaboration of over 300 leading experts from academic institutions and UN agencies across the globe, bringing together climate scientists, engineers, energy specialists, economists, political scientists, public health professionals and doctors. Each year our findings are published annually in the medical journal The *Lancet* ahead of the UN climate change negotiations. Our data makes clear how climate change is affecting our health, the consequences of delayed action and the health benefits of a robust response. For the full 2022 assessment, visit **https://www.lancetcountdown.org/2022-report**.

The American Public Health Association

The American Public Health Association (APHA) champions the health of all people and all communities. It strengthens the public health profession, promotes best practices, and shares the latest public health research and information. The APHA is the only organization that influences federal policy, has a nearly 150-year perspective, and brings together members from all fields of public health. In 2018, APHA also launched the Center for Climate, Health and Equity. With a long-standing commitment to climate as a health issue, APHA's Center applies principles of health equity to help shape climate policy, engagement, and action to justly address the needs of all communities regardless of age, geography, race, income, gender and more. APHA is the leading voice on the connection between climate and public health. Learn more at **www.apha.org/climate**.

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