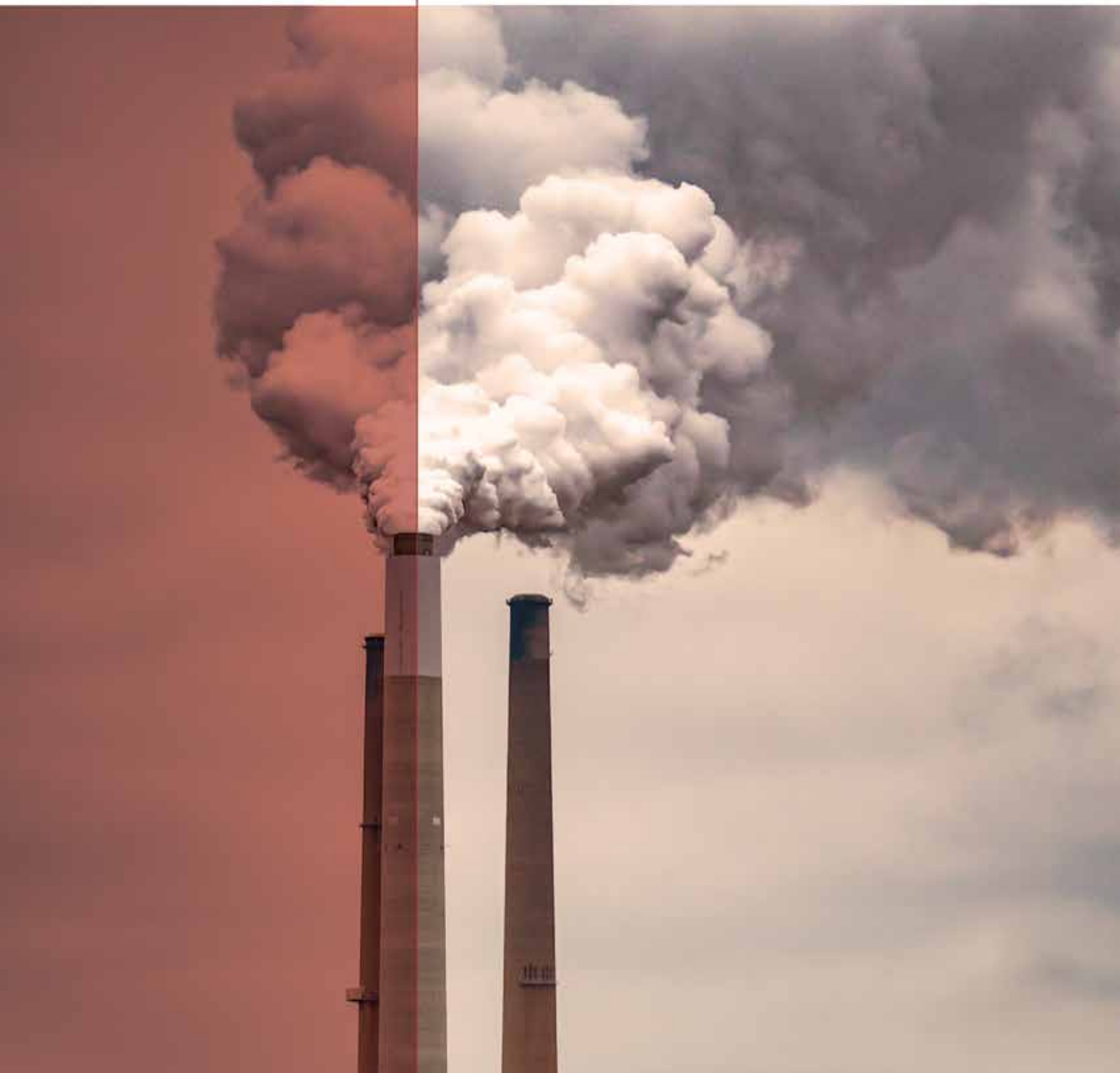
Fueling Sickness:
The Hidden Health Costs of Fossil Fuel Pollution



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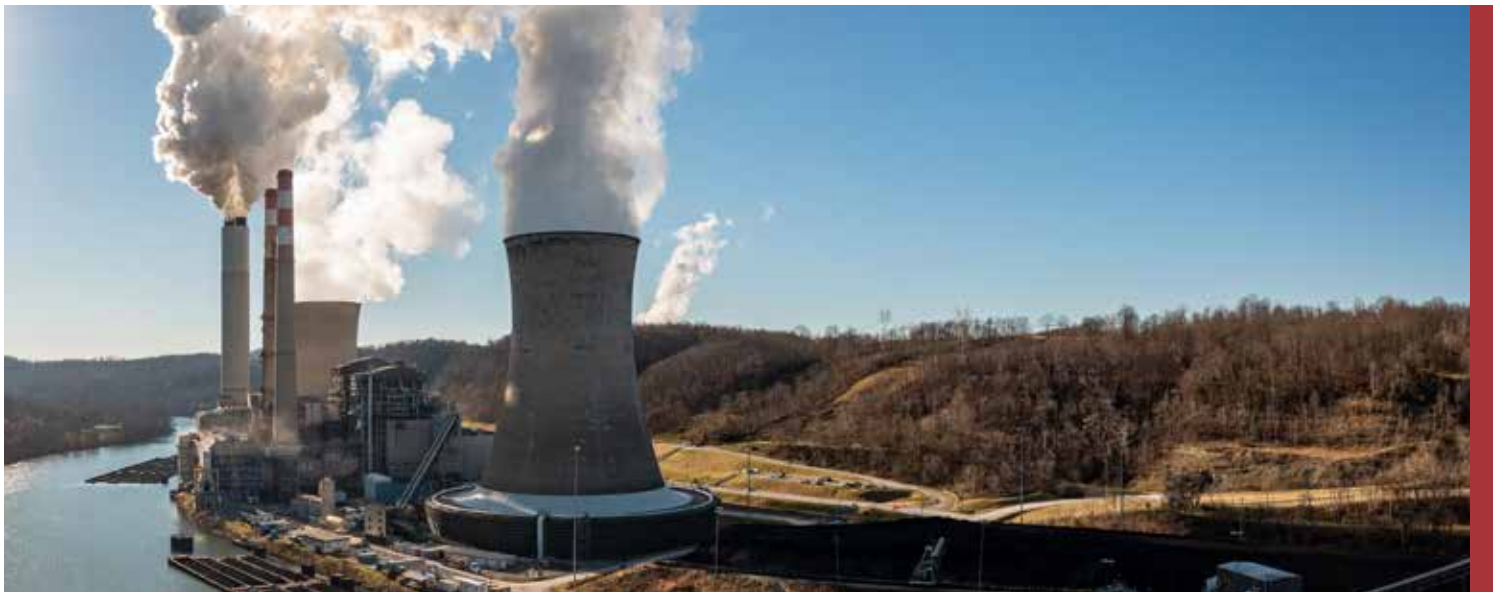


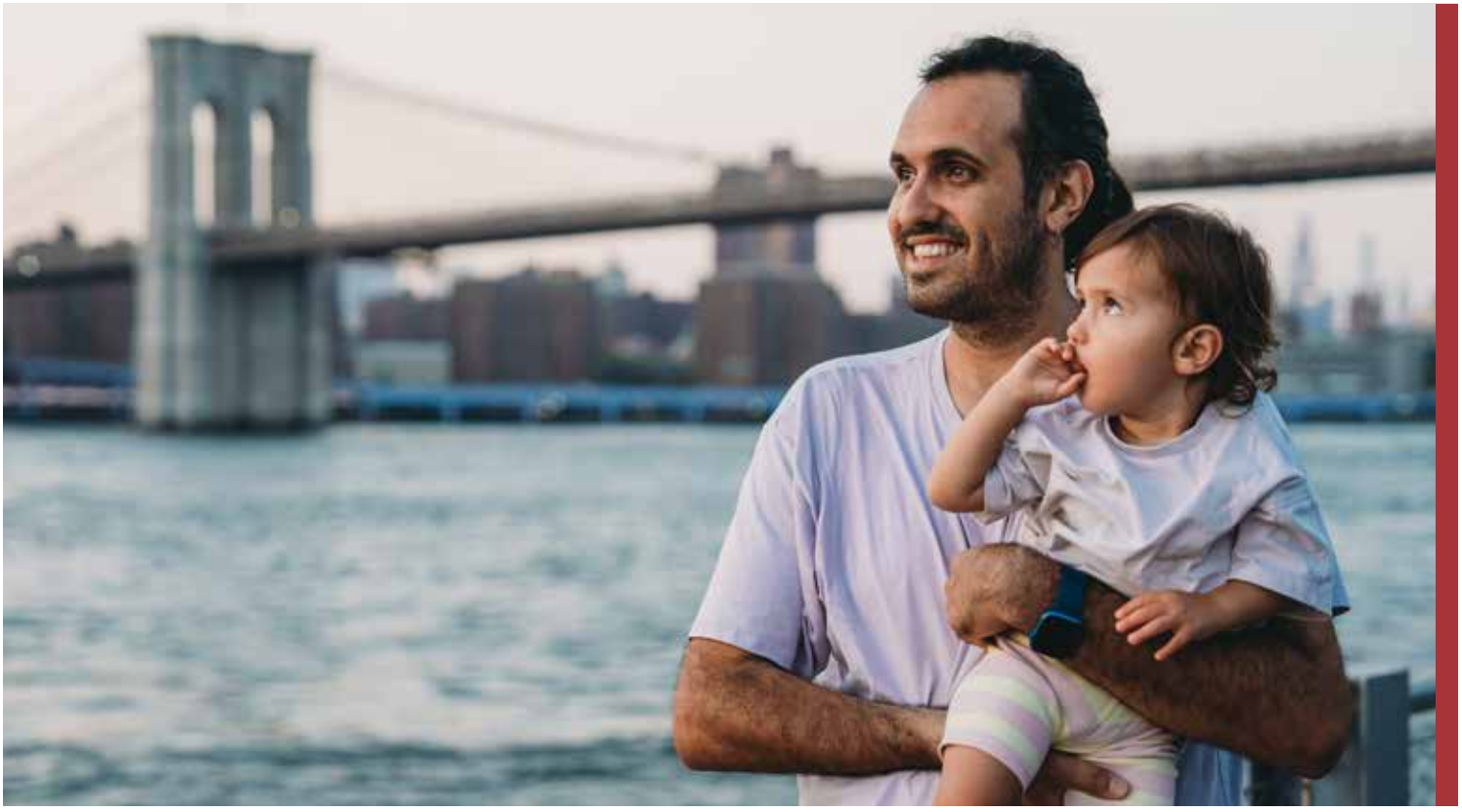
Introduction

Fossil fuels - including coal, oil and gas - have shaped the modern world, powering advances in industry, mobility and daily life, including in medicine and public health. Yet the human health costs of fossil fuel use are enormous. From extraction to end use, pollution from fossil fuels contaminates the air we breathe, the water we drink and the food we eat, driving illness and premature death across every stage of life and every system of the body.

Air pollution from fossil fuels kills hundreds of thousands of people in the U.S. and millions worldwide every year. Fossil fuel combustion also causes climate change, another profound threat to human health. They also pollute our water and food through their use in making plastics and other petrochemicals.

This brief is not a comprehensive technical report. Instead, it offers a summary of how fossil fuels directly damage health: across the human life span and body systems and across the fossil fuel life cycle, from extraction to end use. It also highlights populations at heightened risk and points to key steps for protecting health. The extensive health impacts of climate change, driven by fossil fuel usage, are addressed after the direct health impacts.

Health and medical professionals see these harms in patients and communities every day. Our aim is to elevate the often-overlooked health costs of fossil fuels in conversations about our energy future. Too often, debates about the energy transition focus on economics, security or consumer choice. But we cannot ignore the devastating health burden of fossil fuels, especially when cleaner, more affordable alternatives are available. As health and medical professionals and organizations, we believe a transition to non-polluting energy is not only possible, but essential - for a healthier future.



Key Health Impacts

Fossil fuels are non-renewable resources. They formed millions of years ago when prehistoric plants and animals died and were gradually buried by layers of rock, then transformed by changing temperatures and pressure into coal, oil and gas. These fossil fuels are now extracted, processed, transported, burned and disposed of in ways that pollute air, water and land. At every stage of their life cycle, they harm human health and the environment.

Everyone in the U.S. is exposed to many toxic pollutants from fossil fuels. These exposures accumulate in our bodies over time and cause long-term health harms.[1] They affect every stage of human life, from before birth through old age. There is no safe threshold for fossil fuel pollution exposure – even very low levels of exposure may be harmful.[2]

While national and state air quality standards have led to significant improvements in air quality over several decades, air pollution remains a leading environmental health risk in the U.S. Globally, studies estimate that fossil fuel pollution is responsible for between 5 and 8 million deaths each year - including an estimated 350,000 premature deaths in the U.S. alone.[3,4]

Beyond deaths, fossil fuel pollution is making people sick, including through heart and lung disease, cancer, adverse reproductive outcomes, neurological disorders and other chronic conditions. The healthcare, economic and societal costs of illness and deaths attributable to fossil fuel pollution are immense. These illnesses and deaths are preventable, which is why strong, evidence-based policy action is essential. This report includes recommendations that policymakers can take to protect health and accelerate the transition to a cleaner, healthier future.

Health Harms Across the Fossil Fuel Life Cycle

Each stage of the fossil fuel life cycle – extraction, processing, transportation, combustion and waste - creates significant health harms. Emissions from oil and gas use in the U.S. alone are estimated to cause more than 216,000 cases of childhood asthma and 10,000 preterm births each year. Communities of color and low-income populations bear a greater share of the health burden at nearly every stage of the fossil fuel supply chain.[5] The cumulative health harms of fossil fuels extend far beyond climate change, imposing an enormous and preventable toll on public health.

Extraction:

Coal mining, oil drilling and hydraulic fracturing (fracking) for gas release harmful air pollutants that endanger workers and nearby communities. Coal extraction also scars the land, pollutes waterways and leaves behind toxic waste that threatens both ecosystems and human health. Fracking for methane gas (called “natural gas”) is linked to water contamination and health problems including childhood cancer, birth defects, kidney and respiratory disease. Gas leaks and flaring (the burning of excess gas) release hazardous pollutants such as volatile organic compounds (VOCs) and nitrogen oxides (NOx), which increase cancer risk and trigger asthma, respectively.

Processing, Refining and Petrochemical Manufacturing:

After extraction, fossil fuels are processed and refined in industrial facilities called petrochemical plants, often located near residential neighborhoods. Workers and nearby residents are exposed to a complex mixture of hazardous air pollutants, including benzene, formaldehyde and other carcinogens, which heighten risks of cancer, respiratory illness and adverse birth outcomes. These facilities also emit particulate matter, nitrogen oxides and sulfur dioxide, worsening asthma and other chronic lung diseases in surrounding communities.

Transportation and Distribution:

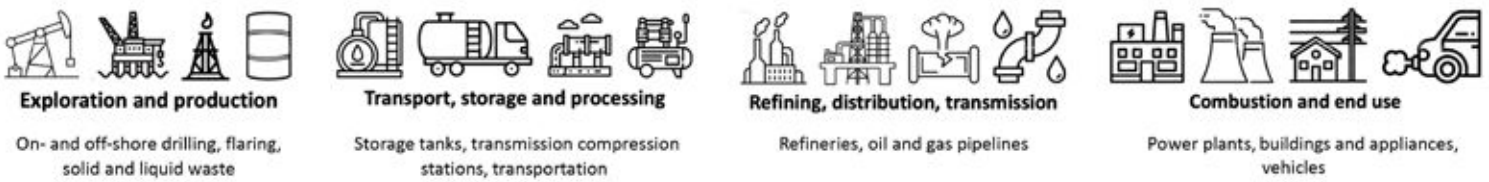
Pipelines, trains, ships and trucks each pose hazards throughout the transport of fossil fuels. Pipeline leaks and ruptures happen regularly and contaminate soil and water and can cause explosions. Transport by rail and truck increases risks of accidents, spills and community exposure to harmful pollutants. Port communities near shipping hubs also face high concentrations of diesel exhaust, which is classified as a known carcinogen and linked to asthma, heart disease and premature death.

Combustion:

The greatest health damage arises from burning coal, oil and gas for electricity, transportation, heating and industrial use. Alongside greenhouse gases, combustion generates harmful air pollutants, including fine particulate matter (PM2.5), NOx, sulfur dioxide, ozone and toxic metals – pollutants strongly linked to cardiovascular disease, respiratory illness, adverse birth outcomes and premature death. Transportation is a major source of this pollution, as cars, trucks, trains, ships and other equipment powered by fossil fuels emit large volumes of exhaust that directly harm health, particularly in urban areas and those nearest traffic-related pollution sources.[6,7]

Waste Products:

Even after combustion, fossil fuel waste continues to harm health. Coal-fired power plants generate coal ash, one of the nation's largest industrial waste streams, containing arsenic, cadmium, lead, mercury and radioactive elements. When stored in unlined ponds or landfills, these contaminants can leach into groundwater, pollute surface waters and contaminate drinking water supplies.[8] Oil and gas refining produces chemicals that are used to manufacture plastics, pesticides and fertilizers, extending fossil fuel harms into consumer products. Many of these byproducts, such as plastics and agricultural chemicals, are associated with additional health harms from endocrine disruption to cancer (see Plastics section).



How Do Fossil Fuels Impact Our Health?

Fossil Fuels and Respiratory Health

The extraction, processing and burning of fossil fuels releases air pollutants that can penetrate deep into the lungs to cause inflammation, cell and tissue damage, immune system disorders, changes in the structure of the airways and chronic respiratory damage. Long-term exposure causes asthma and asthma attacks, chronic obstructive pulmonary disease (COPD), reduced lung function and lung development in children, increased respiratory infections, premature deaths from COPD and lung cancer.[9,10]

Children are particularly vulnerable: they have greater exposure than adults as they spend more time outdoors, are more physically active and have faster respiratory rates. As children's lungs are still developing, they are more susceptible to damage from pollutants.[11,12]

People living and working near the extraction or processing of fossil fuels also face significant risk. Coal miners can develop black lung disease, COPD and lung cancer from breathing in coal dust.[13,14] Those living near coal-burning plants or coal ash storage facilities are at increased risk of respiratory symptoms (such as cough) and respiratory infections. Air pollution from oil and gas production (e.g. drilling and fracking) in one year alone resulted in 410,000 asthma flare-ups, 2,200 new cases of childhood asthma and 7,500 excess deaths.[15] Residents living near mountaintop removal mining are exposed to pollutants such as particulate matter, polycyclic aromatic hydrocarbons (PAHs), heavy metals and hydrogen sulfide, linked to higher rates of birth defects, cardiovascular disease and respiratory illness.[16]

Reducing air pollution from fossil fuel facilities can deliver immediate and measurable health benefits. For instance, when a coal coking plant in Pittsburgh, Pennsylvania shut down, nearby communities saw a rapid decline in emergency department visits - over 20% fewer for respiratory symptoms and more than 40% fewer for pediatric asthma.[17]

Methane ("natural") gas is used to generate electricity and to power home appliances such as dryers, furnaces, ovens, stoves and water heaters.[18] It is linked to an array of health problems including childhood cancer, birth defects and respiratory issues. Methane gas appliances (like gas stoves and furnaces) in our homes can emit carcinogenic benzene, carbon monoxide, nitrogen dioxide and fine particulate matter, increasing the risk of asthma and other respiratory symptoms, particularly in children and vulnerable populations.[19]

Burning fossil fuels releases air pollutants that lead to respiratory harm, such as particulate matter (PM2.5 and P10), ozone, nitrogen oxides (NO2) and sulfur dioxide (SO2).

$PM_{2.5}$

Everyone in the U.S. is exposed to $PM_{2.5}$ and at risk of its harmful effects, which accumulate over time. There is no safe threshold of exposure, meaning even low levels of exposure are associated with health risks. People with higher exposures – most often found in urban and low-income communities and communities of color – are most impacted.[20,21] Short-term $PM_{2.5}$ exposure can cause coughing, wheezing, phlegm production, increased respiratory infections, asthma attacks, increased emergency department visits and hospitalizations for respiratory conditions and deaths from respiratory illness. Long-term exposure is associated with significantly escalated risks of asthma, chronic respiratory diseases like COPD and pneumonia, lung cancer and premature death, even at low exposure levels routinely experienced in the US.[22]

Ozone

Short-term ozone exposure (up to 8 hours) causes injury and inflammation of the respiratory tract leading to airway constriction and coughing. This results in decreased lung function, increased respiratory symptoms (such as coughing, throat irritation, chest discomfort, increased sensitivity to asthma triggers), emergency department visits and hospital admissions from asthma exacerbations and respiratory infections. Even healthy individuals have experienced decreased lung function and respiratory symptoms after short-term ozone exposure.[23] Long-term ozone exposure causes new-onset asthma as well as worsening symptoms in individuals with asthma. It is also associated with altered lung development, COPD and respiratory mortality.[24]

NO_2

Short-term exposure to nitrogen dioxide causes development of asthma in children, increases airway responsiveness (or sensitivity) in adults with asthma, decreases lung function and increases respiratory-related hospital admissions and emergency department visits.[25] Long-term exposure can also decrease lung development in children and increase asthma or chronic bronchitis in adults. [26]

SO_2

Exposure to sulfur dioxide worsens asthma. SO_2 may increase the risk of lung disease and death, especially in the elderly and people with chronic lung disease or cardiovascular disease.[27]

Fossil Fuels and Cardiovascular Disease

Fossil fuels significantly increase the risk for cardiovascular diseases – heart attacks, strokes and heart failure - which are leading causes of death both in the U.S. and globally. Of the millions of deaths attributable to fossil fuel pollution, the greatest proportion are due to cardiovascular diseases.[28]

Hundreds of studies have shown that short-term (hours to days) elevations in outdoor $PM_{2.5}$ levels increase the risks for heart attacks, strokes and deaths from cardiovascular disease. Short-term exposure to particulate matter has also been linked to higher risks of atrial fibrillation, other arrythmias and heart failure.[29] While brief exposures can be harmful, living in locations with poor air quality over the long term is related to much larger increases in cardiovascular risk. Fine particulate matter and NOx are consistently associated with hypertension, myocardial infarction, stroke and ischemic heart disease, while long-term exposures to $PM_{2.5}$ increase the risk of atherosclerosis, incident stroke and stroke mortality.[30]

Fossil Fuel Use and Impacts on Brain Function

Air pollution from burning fossil fuels can harm the brain. Research shows that exposure to air pollutants - especially $PM_{2.5}$, NO_2 and ozone - can cause inflammation, stress and changes in brain chemistry. These changes can damage brain cells, interfere with how the brain communicates and increase the risk of neurological diseases such as Alzheimer's or Parkinson's.[31,32]

Both short-term and long-term exposures to $PM_{2.5}$ raise the risk of stroke.[33] Studies have found that people living in areas with higher levels of $PM_{2.5}$, NO_2 or ozone are more likely to experience strokes, hospitalization or premature death. A nationwide study of millions of Medicare enrollees found that reducing NO_2 levels by just 12.4 parts per billion - the difference between living in a large city like Los Angeles and a smaller one like Portland- was associated with a 6% reduction in stroke rates.[34]

Long-term exposure to polluted air has also been linked to dementia and cognitive decline.[35] Another large study of Medicare beneficiaries found that every small increase in annual $PM_{2.5}$ levels was associated with a higher risk of hospitalization for Alzheimer's, Parkinson's and other dementias, even at pollution levels below current air quality standards.[36]

Children's developing brains are especially sensitive to fossil fuel pollution. Studies show that when pregnant women are exposed to high levels of air pollution, their children are more likely to have behavioral and learning problems. In one study, children exposed to more NO_2 before birth and $PM_{2.5}$ in early childhood had more behavioral challenges and performed worse on cognitive tests at ages 4 to 6.[37] Other research has found that children exposed to polycyclic aromatic hydrocarbons (PAHs), compounds produced during incomplete fossil fuel combustion, have more difficulty with impulse control later in childhood.[38]

Exposure to higher levels of air pollution has also been linked to poor cognitive function in adults. Although specific findings vary, a recent review of research found general agreement across studies that NO_2 and $PM_{2.5}$ exposure is associated with lower cognitive performance in adults.[39]

The neurocognitive harms of fossil fuel pollution disproportionately impact children, older adults and communities already facing environmental and health inequities. People living near busy roadways, diesel truck routes or polluting industries are exposed to higher levels of $PM_{2.5}$ and other air pollutants. These communities are more likely to be low-income or communities of color, compounding the risks.

In children, exposure before and soon after birth can alter brain development, leading to smaller head circumference, reduced brain volumes and long-lasting neurologic effects.[40] Such exposures are associated with increased risks of autism spectrum disorder, attention deficit hyperactivity disorder (ADHD), behavioral problems, lower IQ and reduced academic performance.[41] Alarmingly, studies have even found early signs of brain changes linked to Alzheimer's and Parkinson's disease in children exposed to high levels of air pollution.[42]

Fossil Fuels and Mental Health

A substantial and growing body of research demonstrates that fossil fuel pollution has adverse impacts on mental health. Exposure to pollutants such as $PM_{2.5}$ and NO_2, can cause inflammation, stress and neurotoxicity on the brain and nervous system, which are linked to higher risks of depression, anxiety and other mental health challenges.

Both short-term and long-term exposure to air pollution have been connected to depression.[44] Risks of depression grow even larger with long-term exposure to elevated levels of $PM_{2.5}$ and NO_2. Research has also found that long-term exposure to higher levels of PM_{10} and NO_2 is associated with higher risk of anxiety.[45]

Air pollution has also been linked to suicide risk. In one study, short-term exposure to significant increases in particulate matter was found to be associated with a 1-2% increased risk of completing suicide[46], while a second found that increases in NO_2 were associated with a 3% increased risk.[47] Separate research has also found a connection between PM_{10} exposure and increased suicide risk over the subsequent 24-48 hours.[48]

Children are especially vulnerable to the mental health effects of fossil fuel pollution.[49] Research has found that children who grow up breathing higher levels of air pollution are more likely to develop depression and behavioral disorders as teenagers. One study found that children experiencing the highest levels of air pollution at age 12 were up to 4 times more likely to be diagnosed with depression and up to 5 times more likely to be diagnosed with conduct disorder by age 18 - effects comparable to those seen from childhood abuse or trauma.[50]

Pollution exposure may also play a role in more severe mental health conditions. While schizophrenia is largely influenced by genetics, environmental factors also contribute. Research found that people exposed to higher levels of NO_2 from birth through age 10 were 62% more likely to develop schizophrenia by age 37 compared to those growing up with cleaner air.[51]

Fossil Fuels and Reproductive Health

Exposure to fossil fuel pollution is linked to poor pregnancy health, pregnancy loss, fetal neurodevelopmental disruption and adverse birth outcomes such as preterm birth, low birth weight and birth defects.[52] Inequitable distribution of fossil fuel pollution in the US is driving and worsening social and racial inequities in reproductive health.[53,54,55]

Pregnant women and the developing fetus are especially vulnerable to the impacts of pollution because they experience many crucial and precisely timed physical and psychologic changes. When these processes are disrupted by pollutants, the impacts on pregnancy and the fetus can be profound and sometimes lifelong.[56] Due to pregnancy stress on the body, pregnant women are at additional risk of many serious diseases that can also be worsened by fossil fuel pollution, such as hypertension[57] and diabetes.[58] Pregnant women also breathe in more air than non-pregnant people, exposing them to more air pollution.[59]

Numerous studies find convincing evidence that exposure to $PM_{2.5}$ during pregnancy raises the risks of unfavorable birth outcomes and pregnancy complications, including low birth weight, preterm birth, stillbirth, small for gestational age and birth defects.

Pregnant women exposed to $PM_{2.5}$ had a significantly higher risk of developing hypertensive disorder of pregnancy, gestational diabetes, gestational hypertension and preeclampsia.

Exposure to oil and gas well sites during pregnancy is associated with increased risk of spontaneous preterm birth.[60] Babies born in Pennsylvania within 1 km of a fracking site were more likely to have low birthweight[61], and fracking has been associated with pre-term birth.[62] Pregnant women living close to an oil or gas extraction site during pregnancy have an increased risk of hypertensive conditions, such as preeclampsia.[63]

One of the strongest associations between air pollution and negative birth outcomes like low birth weight and preterm birth are with power plants and petrochemical industries.[64] Oil refineries produce a wide range of toxics, including benzene, which can harm fetal development and the male reproductive system; carbon monoxide, which during pregnancy can affect fetal brain development and cause pregnancy loss; and lead, a heavy metal that can adversely impact fetal brain developments, cause learning and behavioral problems in children and harm the reproductive systems of both men and women.[65]

A study of exposure to traffic-related pollutants near the end of pregnancy showed that greater exposure was associated with an increase in NICU admissions.[66] Air pollution can disrupt fetal brain development.[67] People who live closer to fossil fuel power plants are more likely to have preterm delivery, even if they live up to 20 km (12.4 miles) away.[68]

Other Reproductive Health Harms

Many petrochemicals are endocrine-disrupting chemicals (EDCs), which means they interfere with normal hormonal activity and increase risk for adverse health risks, including infertility.[69] A growing body of evidence also suggests that EDCs, including from fossil fuel-derived products are associated in studies with female reproductive health diseases such as painful and underdiagnosed conditions like fibroids, breast cancer and girls getting their periods increasingly earlier in life.[70]

Exposure to endocrine disrupting chemicals is associated with reproductive harms (including reduced fertility in both women and men and adverse pregnancy outcomes).[71] Consistent with these observations, women living near fracking sites have increased risks of preterm birth.[72] Another report documented that women living near coal and oil power plants had a lower rate of preterm births after the plants were closed.[73]

Fossil Fuels and Kidney Health

Fossil fuel pollution increases the risk of chronic kidney disease (CKD).[74] It has been estimated that the global burden of CKD attributable to $PM_{2.5}$ is 6.95 million new cases of CKD each year.[75] The burden is greatest in low- and middle-income countries, where air pollution levels are higher and health risk factors like diabetes and high blood pressure are also more common. Both of these conditions, which can be made worse by fossil fuel pollution, increase the risk of developing CKD.[76,77]

Both short- and longer-term exposure to $PM_{2.5}$ are associated with significantly increased risks for development of acute kidney injury, progression of CKD and increased mortality in those with end state kidney disease (ESKD).[78] Several studies

have demonstrated an association between short-term elevations in $PM_{2.5}$ and higher risk of death from kidney disease as well as emergency department visits.[79,80] Short-term exposure to $PM_{2.5}$ is also associated with an increased risk of hospital admissions and deaths in patients receiving dialysis for ESKD.[81] A meta-analysis showed a higher risk for CKD and lower kidney function among people living near petrochemical plants than those without such exposure.[82]

Fossil Fuels and Endocrine (Hormonal) Disease

Fossil-fuel driven air pollution poses substantial risks to the endocrine system, which controls growth and development, metabolism and reproduction. Studies have consistently demonstrated significant associations between levels of $PM_{2.5}$ in the air and risks of obesity[83], Type 2 diabetes (and diabetes-associated mortality)[84] and high blood pressure.[85] Higher exposure to $PM_{2.5}$ is also associated with higher risk for preterm birth, low birthweight, stillbirth[86] and preeclampsia.[87] While most of the evidence linking air pollution to endocrine system dysfunction is observational, a randomized trial in healthy adults showed significantly lower blood pressure, and lower levels of markers of stress and inflammation in healthy adults given air purifiers to reduce $PM_{2.5}$ exposure.[88]

Fossil fuel extraction releases many chemicals that interfere with normal function of the endocrine system. For example, hormone-disrupting chemicals are used in fracking for gas and often contaminate surface water, groundwater and even drinking water. A study of water samples from a region in Colorado with a high density of gas drilling and reports of spills and discharges found significantly elevated endocrine-disrupting activity compared with water from areas without gas drilling.[89] In addition, coal mining releases toxic metals (including lead, arsenic and mercury) that also act as endocrine disrupters.

Endocrine disrupting chemicals are also produced from fossil fuel products, such as microplastics/nanoplastics and PFAS, which have been detected in a variety of human tissues, including placenta.[90] Additionally, other fossil-fuel derived chemicals including pesticides act as endocrine disrupters.

Fossil Fuels and Cancer

Fossil fuel pollution is a contributor to the large burden of cancer in the U.S., affecting both the occurrence of cancer and its outcomes. About 2 million Americans will be diagnosed with cancer and more than 600,000 will die from cancer in 2025.[91]

Lung cancer is one of the most common cancers worldwide. It is estimated that approximately 15% of lung cancer worldwide is due to air pollution.[92] The International Agency on Research on Cancer (IARC) has found $PM_{2.5}$ and diesel exhaust are proven to cause cancer, damaging and mutating lung cells.

There is extensive evidence that people exposed to outdoor air pollution from car, truck and diesel exhaust have an increased risk for lung cancer and death.[93] Studies show that for each 10 mg/m3 increase in $PM_{2.5}$ in the air, there is about a 13% increase in the risk for death from lung cancer.[94] Individuals who have never smoked can also face as much as a 27% increase in lung cancer deaths due to $PM_{2.5}$.[95] People of color who are diagnosed with lung cancer face worse outcomes compared to white Americans, including: less likely to be diagnosed early, less likely to receive surgical treatment, more likely to receive no treatment and less likely to survive five years.[96]

A growing body of evidence also shows an association between air pollution and increased risk for breast, colorectal, brain, bladder and liver cancers, including many studies linking traffic pollution with increased adult cancer risk.[97] Similarly, many studies have found an increased risk of brain, kidney, bone cancers and leukemia in children living near heavy-traffic roads or near industrial sites.[98,99]

Workers and communities can be exposed to cancer-causing substances across the life cycle of fossil fuels. Fracking for oil and gas uses many chemicals - including benzene, 1,3-butadiene and formaldehyde - that are known human carcinogens. Children living near unconventional oil and gas development have shown an increased risk of leukemias and lymphomas and some studies suggest that it may be related to fracking. [100]

Refinery and other petroleum workers may have repeated exposures to cancer-causing substances - including asbestos - and have been found to have increased risks of mesothelioma, lung cancer, malignant skin melanoma, acute lymphoid leukemia, multiple myeloma and bladder cancer.[101] Residents in fence-line communities near petroleum industry sites and facilities also have elevated risks for leukemia.

Plastics and Health

Plastics are manufactured chemical products, more than 98% of which are made from coal, oil and gas. They persist in the environment for years to decades, contributing to a rapidly growing global pollution burden that now totals an estimated 8 billion tons. Despite efforts to promote plastics as recyclable, fewer than 10% of plastic (and only 1-2% of single use plastics) is recycled globally, leaving the vast majority to accumulate in landfills, waterways and ecosystems.[102]

All plastics contain chemical additives, of which more than 10,000 are in use, and the vast majority have not been tested for toxicity. Of the chemicals that have been closely studied for health impacts, four major categories of chemicals are of particular concern: phthalates (used to soften plastic), bisphenols (BPA - used to produce linings), per- and polyfluoroalkyl substances (PFAS); and brominated flame-retardants.[103] These additives include known carcinogens (vinyl chloride, 1-3 butadiene and PFAS), neurotoxicants (lead and brominated and organophosphate flame retardants) and endocrine disruptors (phthalates and BPA). As these substances leach from plastics into the environment, they drive many of the health and ecological harms now associated with plastic pollution.

Plastics threaten human health across their entire life cycle – from fossil fuel extraction to production, use and disposal. Workers in fossil fuel extraction, plastic production, plastic textile workers and plastic recycling workers are all exposed to air pollutants and to multiple toxic chemicals. They suffer increased rates of cardiovascular, pulmonary, metabolic and neurologic diseases and cancer.[104]

Microplastics and nanoplastics, very tiny plastic particles, have been detected in human hearts, brains and blood vessels, where they are associated with cardiovascular disease. Everyday exposures from food packaging, bottled water, indoor air and dust contribute to infertility, obesity, kidney disease, cancers and other chronic conditions. These chemicals disrupt endocrine function and increase risk for premature births, neurodevelopmental disorders, male reproductive birth defects, obesity, cardiovascular disease, renal disease and cancer. These particles are pervasive in indoor air, household dust, bottled

water, tap water, meat, salt, fruits, vegetables, seafood, baby formula and breast milk.[105] When plastic is heated or damaged, bisphenol A (BPA) and phthalates can leach into food and beverages.[106]

Infants and young children are especially vulnerable to plastics. Fetuses in the womb are exposed to plastics chemicals absorbed by their mothers. Prenatal exposures are linked to miscarriages, premature births, stillbirth, low birth weight, birth defects of the reproductive organs, neurodevelopmental impairment, impaired lung growth and childhood cancer. Early-life exposures to plastic chemicals increases risk of heart disease, Type-2 diabetes and obesity in childhood and across the life span.

The harms caused by plastics are not fairly distributed. People of color, Indigenous populations, low-income communities and workers in production and waste facilities face disproportionate exposures and health burdens including have increased risks of premature birth, low birth weight, asthma, leukemia, cardiovascular disease, chronic obstructive pulmonary disease and lung cancer.

People Disproportionately Impacted by the Health Harms of Fossil Fuels

While fossil fuel pollution harms everyone, its health impacts are not evenly distributed. Certain populations, including low-income communities, communities of color, children, older adults and people with preexisting health conditions, face disproportionate exposure and heightened vulnerability. These inequities reflect a combination of environmental, social and physiological factors that place greater health burdens on already at-risk groups.

Vulnerability due to exposure:

Low-income and Communities of Color:

A complex array of interconnected factors (including but not limited to historical redlining, lending discrimination, exclusionary land use policies, disinvestment and urban renewal projects) have resulted in low income and communities of color disproportionally living in areas with a greater concentration of polluting sources, like highways and factories, and thus have greater exposure to multiple pollutants from multiple sources.[107;108] As a result, a higher percentage of racial minorities are exposed to particulate matter and ozone, contributing to a greater incidence of childhood asthma and other respiratory conditions. More than 1 in 5 African Americans live within a half-mile of an oil or gas production, processing or storage facility.[109] Low-income neighborhoods also tend to have older and less maintained housing that allow for greater penetration of outdoor air pollution into homes, making it difficult to escape the poor air quality.

Individuals Who are Unhoused

People experiencing homelessness are significantly more vulnerable to the adverse health impacts of fossil fuels due to increased exposure to air pollution. As many unhoused individuals seek shelter near highways[110], they face long-term exposure to harmful pollutants such as particle pollution coming from car tailpipes.[111] Additionally, individuals who are unhoused are disproportionately impacted by other chronic and pre-existing conditions and may be less able to access care, which further increases their vulnerability to adverse health risks.[112]

Individuals Who Work Outdoors

People who work outdoors can face higher health risks due to their increased amount of time spent outside breathing in air pollution. Additionally, outdoor workers are often engaged in strenuous activity that increases their breathing rate and the amount of polluted air they inhale. Outdoor workers may also have limited options for reducing their exposure without jeopardizing their employment.

Workers in the Fossil Fuel Industry

Individuals who work in the fossil fuel industry face severe occupational health risks and disparities in health outcomes. Miners other than coal workers face disparities in other health outcomes, such as increased mortality from cardiovascular disease and several types of cancer, including mesothelioma.[113] Workers in these industries also face substantial safety hazards, including but not limited to explosions and fires due to the ignition of flammable vapors or gases, falls from platforms or equipment and transportation issues. Highway vehicle crashes are the leading cause of death among oil and gas extraction worker fatalities.[114]

Vulnerability due to physiology:

Children

Children are uniquely vulnerable to the health harms of fossil fuels because their bodies, organs and immune systems are still developing. The impacts of pollution can exert multiple and cumulative adverse effects starting in utero and through childhood. Compared with adults, they spend more time outdoors, are more physically active and breathe more air in relation to their body size - factors that increase their uptake of pollutants that can penetrate deep into the lungs and bloodstream. Research has linked these exposures to a wide range of health effects in children, including low birth weight, asthma, reduced lung function, respiratory infections and allergies, as well as elevated risks for chronic disease later in life. Children living near fracking sites in Pennsylvania around their birth were two to three times more likely to be diagnosed with leukemia between the ages of 2-7 than children not living near these sites.[115] Studies show that children's disproportionate burden stems from both biological and social vulnerabilities. Their developing lungs, brains and immune systems, along with immature detoxification pathways, make them less able to process and recover from toxic exposures.[116] Disadvantaged and minority children are more likely to live in areas with higher concentrations of pollution, leaving them with elevated asthma rates and greater lifelong health challenges.[117,118]

Older Adults

Older adults are more likely to have other pre-existing conditions, such as high blood pressure, that increase their risk of adverse impacts from air pollution. Air pollution can exacerbate COPD and increase the risk of heart attacks and strokes in older adults, especially those who are also obese and/or have diabetes. In terms of fossil fuel extraction, elderly people living near or downwind from gas extraction sites have a higher risk of premature death than seniors who do not.[119]

Individuals with Chronic Illness

People with asthma, COPD, cardiovascular disease, lung cancer, diabetes or obesity are at particularly high risk from particle pollution from fossil fuel combustion. Fossil fuel pollution causes cellular injury and inflammation that puts more stress on the lungs and heart and other systems already harmed by disease. People with chronic illness who are exposed to pollution may experience worse symptoms than those without, and have more emergency department visits, more hospitalizations and higher risk of premature death.[120]

Pregnant Women and Fetuses

Pregnant women are especially vulnerable to air pollution because they breathe more often. Pregnant women who live in counties with higher levels of fracking in Texas have been found to be at much higher risk of giving birth to children with specific birth defects.[121] Additionally, another study found people living close to fracking sites in Pennsylvania had an increased risk of giving birth prematurely and of having high-risk pregnancies.[122] Fetal development and health after birth may also be harmed by environmental contaminants that have been shown to cross the placenta.

Fossil Fuels, Climate Change and Health

Human activities are the cause of increased greenhouse gas emissions causing climate change, and burning fossil fuels is the single largest driver of climate change. Health professionals and scientists around the world agree that climate change is the biggest health threat of this century. Reducing fossil fuel pollution is the most effective way to protect current and future generations from the health harms of climate change.[123]

Climate change causes warmer temperatures, more frequent extreme weather events, changes in drought and rainfall patterns and sea level rise. These changes affect the air, food, water and land on which human life depends, with health impacts already evident in communities across the U.S. Every small rise in global temperatures increases the likelihood of catastrophic health consequences, raising concern that our capacity to adapt or build resilience will be overwhelmed.

Climate Health Impacts

Heat-related deaths are increasing rapidly in the U.S. as extreme heat events become more frequent and severe. Extreme heat increases the risk of heart attack, worsens asthma and COPD, stresses the kidneys, increases the risk of complications from diabetes and worsens mental health. Scientists predict as many as tens of thousands of additional heat deaths in coming decades.[124]

Hotter temperatures also worsen air quality due to the formation of ground-level ozone (smog). Wildfires, driven by hotter, drier conditions, expose millions to $PM_{2.5}$ and toxic pollution that damages lungs, trigger cardiovascular disease, harm brain development and increase cancer risk. Warmer temperatures are even making allergy seasons longer.

Extreme weather events such as hurricanes, floods and severe storms cause injury and death, contaminate drinking water and overwhelm health systems. Power outages and facility closures disrupt medical care, including dialysis, insulin refrigeration and cancer treatment. Many patients - particularly older adults, people with disabilities and those without financial resources or transportation - face added risks because they may be unable to evacuate safely during floods, fires or smoke events.

Climate change also impacts food. Rising temperatures cause increased risk of food poisoning, while droughts and floods can destroy crops, increase prices and worsen food insecurity. Climate change alters the distribution of mosquitoes and ticks, expanding risks for diseases like West Nile virus, dengue and Lyme disease.

Mental health is also deeply impacted. Nearly a third of people who experience a natural disaster may subsequently experience stress, PTSD and depression related to property damage, home loss or loss of loved ones.[125]

Climate Change and Chronic Disease

Climate change compounds existing chronic health burdens, with extreme heat, wildfires, storms and other disasters worsening health outcomes. Heat stress, for example, raises the likelihood of heart attack, stroke, heart failure and dangerous arrhythmias. Heat also can lead to hospitalization for endocrine and metabolic conditions as well as adverse pregnancy outcomes including preterm birth, low birthweight and stillbirth.[126] Wildfire smoke, extreme cold and hurricanes have also been linked to higher rates of heart disease, stroke and cardiovascular deaths. Cancer risks also rise with increased wildfire smoke exposure.[127] The increase in vector-borne diseases aggravates kidney disease and may cause endocrine disturbances such as hypoglycemia and hyponatremia. Kidney disease is also worsened by extreme heat and dehydration.

Extreme weather and disasters also disrupt access to critical healthcare, particularly for those who rely on steady, reliable treatments for their chronic condition. For example, after Hurricane Katrina, women with breast cancer and patients with lung cancer experienced worse long-term survival due to disruptions in care.[128] Similarly, both Hurricane Katrina and Superstorm Sandy were followed by increases in heart attack incidence and mortality. [129] Heat waves have also been shown to disrupt cancer care delivery, further highlighting how climate-related events can endanger patients who rely on timely medical treatment.[130]

Climate Vulnerability

While climate change threatens everyone's health, some populations bear greater burdens, which exacerbates existing health inequities. Children, pregnant women, the elderly and people with chronic illness and disabilities are more vulnerable to climate health threats. Low-income communities and communities of color face higher exposures and fewer resources to adapt, compounded by historic disinvestment, less green space and higher baseline pollution. Outdoor workers, residents of hotter regions and fence line communities near industrial or transportation facilities are also disproportionately affected.

Reducing Climate Health Impacts

The most powerful health protection strategy is to reduce climate pollution by transitioning away from fossil fuels. The recommendations listed below to reduce pollution from fossil fuels will also deliver long-term benefits of mitigating climate change. At the same time, communities can build climate resilience through cooling centers, greening neighborhoods and weatherizing homes as well as implementing early warning systems and stronger healthcare infrastructure. These measures reduce risk from current climate impacts while we work to prevent even greater harm.

Conclusions and Recommendations

Fossil fuels harm nearly every system of the body across the human life cycle both in the U.S. and worldwide. Fossil fuels are also the leading driver of climate change, which the healthcare community recognizes as the greatest health challenge of this century.

Extensive medical and scientific evidence makes clear: to safeguard health today and for future generations, we must transition away from fossil fuels toward clean, non-polluting energy sources as quickly as possible. This transition is not only possible but increasingly practical thanks to affordable clean energy technologies. The health benefits of rapid action are immediate and profound. Each step away from fossil fuels reduces air pollution, prevents disease and saves lives, while also delivering cost savings through reduced healthcare burdens.

As health and medical professionals and organizations, it is our duty not only to treat those already harmed by fossil fuel pollution, but also to speak out about its dangers. We must inform the public and policymakers about the health risks, and advocate for policies that reduce exposure to fossil fuel pollution for our patients and communities.

Individuals can also play a vital role by engaging with local organizations that are advocating for clean air and a clean energy transition, talking to community members and policymakers about the health harms of fossil fuel pollution and reducing personal reliance on fossil fuels where possible.

But individuals and health professionals alone are not enough. Protecting communities from the health harms of fossil fuel pollution requires bold policy and systemic change.

Recommendations for Policymakers

- Transition rapidly from fossil fuels to clean, non-polluting energy and transportation.
- Protect communities from exposure to fossil fuel pollution by protecting, enforcing and strengthening clean air and water standards.
- Implement a public health campaign to educate the public about the health harms of fossil fuel pollution, even at low, everyday levels of exposure.
- Hold the fossil fuel industry accountable for its health harms.
- Invest in public health systems, healthcare infrastructure, research and innovation to protect and promote health and accelerate clean technology progress.

The costs of inaction are measured in illness, lives lost and mounting healthcare burdens. The benefits of a clean energy transition are measured in healthier communities and a safer future for our children and grandchildren. Protecting health demands nothing less than urgent action.

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