RESPIRATORY HEALTH ASSOCIATION®

Issue Brief

Climate Change and Respiratory Health

As global warming accelerates, climate disruptions pose a serious and increasing threat to people with lung disease. The climate change issues that are expected to affect respiratory health include an increase in ***extreme weather events****, including heat waves, extreme precipitation, and droughts; an increase in* ***wildfires and wildfire smoke****; an increase in* ***particulate matter (soot)****; an increase in* ***aeroallergens****, including pollens, mold and fungus; an increase in* ***insect and water borne diseases****; and higher levels of* ***ground-level ozone (smog)****.*

Caretakers and advocates for individuals with lung disease should familiarize themselves with these issues. The public health response to climate change cannot merely be one of adaptation; the medical and public health communities need to be an active voice in broader climate policy discussions. This paper serves as a brief primer on how climate change will affect lung health, with a focus on Illinois, and the policies aimed at mitigating further climate disruption. To access more environmental health resources, including white papers and fact sheets, or to sign up to become an advocate for stronger lung health policies, visit www.lungchicago.org.

EXTREME WEATHER EVENTS

Extreme weather events are on the rise. These events include heat waves, floods, and droughts, all of which can have negative consequences for persons living with respiratory disease.

Heat Waves

As the climate changes, we will continue to experience longer, hotter summers. The entire Midwest is projected to have more days above 95 degrees each year.[1] In Chicago, projections suggest that heat related deaths could increase by 120 percent by 2080.[2] Chicago heatwaves like the one in 1995 that killed more than 700 people could occur as frequently as every two years.[3] Nationally, temperatures that would have ranked in the hottest 5 percent of recorded summertime temperatures between 1950-1979 are now projected to occur at least 70 percent of the time by 2035-2050.[4]

Heat is the leading cause of weather-related death. Such deaths are likely to increase as greenhouse gas emissions continue to rise.[5] For persons living with a chronic respiratory disease, high temperatures can be particularly life threatening.[6] High temperatures can cause people with chronic obstructive pulmonary disease (COPD) to hyperventilate and have shortness of breath. Many people with COPD also have circulation issues that can make it harder for them to dissipate heat and cool off.[7]

Cold Weather Events

Despite an increase in heatwaves, Chicago is not expected to experience more pleasant winters. While temperatures increase, winter precipitation is expected to increase as well, which will ultimately maintain levels of snowfall similar to today.[8] One projection suggests that future Chicago winters could be akin to those of Ohio or Pennsylvania, with

no reprieve from snow and ice.[9] While warmer winter temperatures may make breathing easier for those with asthma or COPD, persistent snow and ice could still limit those with impaired mobility.

Flooding

Climate change is projected to bring with it more intense precipitation,[10] which can lead to greater flooding.[11] Unfortunately for Chicago, the greatest total rainfall increases in the past 50 years have occurred in the Midwest.[12] A study of extreme weather in Chicago suggests extreme precipitation events in Chicago will increase by the end of the century, particularly in the fall and spring.[13]

Extreme precipitation can be a hazard for people with respiratory disease, as flooding can bring heavier levels of mold and fungus growth and can cut off persons with limited mobility from essential services, such as caregivers, emergency services, and oxygen deliveries.

Droughts

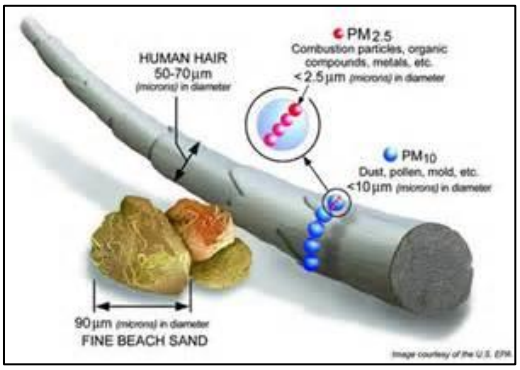
As summers become hotter and drier, accompanying droughts will likely occur with more frequency.[14] Droughts are also more likely to fill in the spaces between extreme precipitation events.[15] Droughts can exacerbate issues with particulate matter, since dry conditions enable particulates such as pollen and smoke to stay in the air longer.[16]

WILDFIRES

Projected longer, hotter, and drier summers in the Midwest are expected to cause more wildfires and increase wildfire severity.[17] While wildfires themselves can cause heavy property damage locally, the smoke from wildfires actually affects a larger population. In 2011, about two-thirds of the U.S. lived in areas affected by smoke from fires that originated in the Western U.S.[18]

Consequences of wildfire smoke on respiratory health can be particularly severe. Studies of past wildfires have found that exposure to particulate matter from wildfire smoke led to increased medication use, physician visits, emergency room visits, hospital admissions, and mortality, particularly for asthma, bronchitis, bronchiolitis, and COPD.[19, 20] Some research suggests that wildfire smoke particulate matter may in fact be more toxic to the lungs than particulate matter from other emission sources.[21]

PARTICULATE MATTER



Particulate matter are tiny solid and liquid particles in the air, which include substances like soil dust, black carbon, sea salt, organic carbons, and nitrates and sulfates.[22] These tiny particles can be inhaled and can have varying negative effects on lung health. Particulate matter is grouped by size. The sizes having the greatest effect on lung health are PM10 (particulate matter smaller than 10 micrometers) and especially PM2.5 (particulate matter 2.5 micrometers or smaller).[23] The smaller the particle, the deeper it can penetrate the lungs.[24]

Gaseous pollutants like nitrogen oxides (NO_x) and sulfur oxides (SO_x) can form particulate matter hundreds of miles downwind from their source. Fossil fuel power plants are a large source of NO_x and SO_x. Power plant emissions typically increase substantially during heat waves.[25] As climate change will bring more frequent and severe

heatwaves, power plant emissions could likewise increase. Increases in emissions can negatively affect those with asthma, as nitrogen dioxide (NO_2) in the air is known to exacerbate coughing, wheezing and shortness of breath.[26] NO_x emissions are also critical to summertime ozone formation, which is also linked to asthma exacerbations.

Another kind of particulate matter of consequence to lung health is black carbon. Black carbon is formed when fossil fuels are burned but do not combust completely, thereby leaving residual material.[27] Black carbon can get deep into the airways and burden people with asthma or COPD. However, black carbon only stays in the air a very short time and can be reduced by limiting agricultural and leaf burning, as well as requiring particulate filters on vehicles and coal power plants.

Because particulate matter isn't composed of one chemical and because of regional differences in emissions, trends in particulate matter caused by climate change can vary widely by area. Research shows that particulate matter has been decreasing in the Eastern U.S. over the last few decades due to stricter regulations on coal-fired power plants and diesel engines.[28] Several models show continuing decreases in particulate matter in the future with more stringent emissions controls, though these gains may be confounded by climate change consequences like forest fires and desertification, which raise levels particulate matter in the air.[29, 30]

AEROALLERGENS

High counts of aeroallergens like plant pollen and molds can be very problematic for those with allergic asthma, or those whose health is compromised by COPD, lung cancer, or other respiratory issues. Studies suggest that many plants and molds are responsive to the changing temperatures and atmospheric CO_2 levels caused by climate change.[31] With more pollen being produced over longer pollen seasons, allergic symptoms could worsen and trigger more asthma attacks.[32]

Pollen

As atmospheric CO_2 and temperatures increase, some plants are producing more pollen per season. Birch, oak, and nettles are already producing more pollens per season,[33] and research suggests that ragweed may produce more pollen under elevated CO_2 conditions as well.[34]

Rising temperatures may also be lengthening the pollen season and causing earlier flowering for certain plants. Plants such as lilacs, honeysuckles, streamflow, and ragweed, have already exhibited earlier flowering seasons.[35, 36] Studies of plants such as poison ivy, poison oak, and poison sumac suggests that potency of allergens may also be increasing with rising CO_2 levels.[37]

Climate change is also causing more frequent severe thunderstorms. Thunderstorms have been linked to asthma exacerbations.[38, 39] While increased ozone from lightening is a known asthma trigger, most thunderstorm-related asthma is tied to pollen allergies.[40] Thunderstorms can break pollen grains into smaller, more easily inhalable pieces that can penetrate deeper into the lungs.[41] With the projected increase in the frequency of severe thunderstorms, an increase in asthma exacerbations could follow.

Pollen also has a substantially larger effect on respiratory health when in the presence of other respiratory irritants. While high pollen, particulate matter, and ozone levels alone can exacerbate respiratory conditions, when more than one is present at the same time, the health consequences for the individual are compounded.[42] In addition, for those who live in urban areas, research suggests that urban air pollution can cause damage to the lungs which in turn can cause more severe allergic responses to aeroallergens.[43]

Mold and Fungus

Environmental changes driven by global warming could affect the growth and allergenicity of molds and funguses.[44, 45] Increased average temperature and humidity due to climate change could increase building dampness, which in turn would increase the risk for health effects such as coughing, wheezing, asthma exacerbations, and airway infections.[46] Increased temperature will also drive more frequent use of air conditioning, which may increase the incidence or prevalence of indoor allergens including mold and fungus.[47] Also, as climate change is likely to increase the number and severity of extreme weather events, an increase in severe flooding is likely to follow.[48] Flooding often leads to mold and fungal growth, which can create serious respiratory hazards.[49] Some common molds, such as "black mold," have been linked to respiratory illness and asthma.[50] Likewise, in agricultural areas, increases in more frequent and severe alternating droughts and floods can weaken seed kernels, allowing for contamination of toxic molds linked to respiratory disease.[51]

DISEASES

As the climate warms, disease-transmitting insects and rodents may be able to travel farther north into the Midwest. An increase in flooding may also increase the prevalence of certain water-borne diseases. Common examples of climate impacts on disease include dengue fever encroaching back into the American South as the climate becomes more hospitable to dengue-transmitting mosquitos; Lyme disease-transmitting ticks spreading farther as summers lengthen; and Chikunguya virus appearing in the Caribbean and Southern Europe.[52] With regards to respiratory disease, periods of high precipitation have been linked to outbreaks of hantavirus in the U.S. southwest [53] and legionellosis on the East coast.[54]

GROUND-LEVEL OZONE (SMOG)

Ozone is a colorless gas found in the air, formed by electrical discharges and complex chemical reactions involving gases emitted both by natural processes and by industrial activities. Climate change has the potential to increase ozone levels above where they would otherwise be, making progress toward controlling ozone more difficult, even as health standards used to trigger air quality warnings are tightened based on medical evidence.

Ozone is a respiratory irritant, short-term exposure of which can cause shortness of breath, coughing, inflammation, chest pain and tightness. Ozone is also a leading trigger of asthma exacerbations, with children being especially susceptible. Long term exposure to ozone is hypothesized to be a factor in asthma development.[55]

As the climate warms, areas such as Chicago could expect more unhealthy air quality days/summers for ozone.[56] One study predicts the number of summer unhealthy ozone days in Chicago could increase three- to eight-fold.[57] This would result in more Ozone Action Days where citizens would be advised to conserve energy, and limit use of motors and time spent outdoors.

Because ozone is formed through a chemical reaction involving the presence of gases that are emitted by transportation and power generation sources, higher temperatures in more heavily polluted areas such as major cities will lead to increases in peak levels of ozone.[58] This bodes poorly for cities like Chicago that already struggle to keep their ozone levels below current health standards. Projections for comparable large cities like New York City predict increases in summer ozone-related asthma emergency department visits for children age 0-17 by as much as 10 percent.[59]

CONCLUSION – POLICY STRATEGIES

Expert consensus recognizes that it is imperative to reduce greenhouse emissions by at least 80 percent from 1990 levels by 2050 in order to keep the worldwide temperature increase from exceeding 2°C above preindustrial levels, a level that would cause severe worldwide disruption. While greenhouse gasses already in the atmosphere will continue to warm the planet and disrupt the climate for many years, cutting emissions going forward will help prevent even more extreme and dangerous climate disruptions.

Key in reducing emissions in the U.S. will be de-carbonizing transportation and power generation systems, as these two sectors together account for more than half of all greenhouse gas emission in the U.S.[60] This will entail increasing the use of zero-emission vehicle propulsion systems to eliminate fossil fuels. Likewise, electric generation will need to eliminate the use of fossil fuels and transition to clean, renewable sources of power generation.

The push for increasingly efficient and cleaner vehicles has already encouraged the use of cleaner fossil and bio-fuels, as well as the production of new technologies, including hybrid and zero-emission fuel cell and battery powered vehicles. Federal policy already requires that new passenger vehicles achieve a fleet-wide average fuel economy of 54.5mpg by 2025;[61] tighter emission standards for heavy-duty vehicles are being finalized as well.[62]

Transitions are likewise occurring in electricity generation, with extensive and expanding growth of wind and solar power. Proactive and stable clean air policies, which increase commercial investment and create larger economies of scale, have helped foster this growth. However, despite recent spectacular growth, renewable power sources still generate a small percentage of electricity. More such policies are necessary to continue driving down costs of clean, renewable electric generation and to further accelerate the transition to cleaner power sources.

Fossil fuel power plants remain a leading driver of climate change, but reducing wasted electricity through maximizing energy efficiency and transitioning to clean, renewable power generation are reducing harmful emissions. In 2015, the U.S. EPA enacted a rule known as the Clean Power Plan, requiring a 30 percent cut in greenhouse gas emissions from power plants by 2030.[63] In addition to addressing climate change, limiting greenhouse emissions ensures that smog, soot, and toxic pollution generated by fossil fuel extraction, transport, processing, and use will also be reduced. Implementation of the Clean Power Plan could ultimately prevent more than 3,600 deaths a year between 2020-2030, *solely* from the emission cuts that reduce the formation of fine particulate matter and ground-level ozone.[64]

While those who care for and advocate on behalf of people living with lung disease need to familiarize themselves with how climate disruptions may affect their clients and loved-ones, we encourage the medical and public health communities to fully engage in these broader climate change policy discussions. Supporting policies that move us towards greater use of clean, renewable sources of energy will improve lung health for all by removing air pollution that hinders the ability to breathe and by decreasing the damaging lung health effects global warming could cause. Strong, sustained implementation of policies that achieve these near and long term goals is a key way to protect public health.

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