



National Tribal Air Association’s **2020 Update:**

A White Paper Detailing the Science and Connections ***Between Air Pollution, Tribes, and Public Health****

The National Tribal Air Association (NTAA) was founded in 2002 with a grant from the United States Environmental Protection Agency’s Office of Air and Radiation with a mission to advance air quality management policies and programs, consistent with the needs, interests, and unique legal status of American Indian Tribes and Alaska Natives. Since 2002, NTAA has grown to include over 150 federally recognized member Tribes making NTAA the nation’s second largest national Tribal membership organization. Tribes are important partners with federal, state and local agencies to protect ambient air quality, indoor air quality and mitigate climate change.

Each year, the NTAA publishes the Status of Tribal Air Report (STAR), which includes a section highlighting the health impacts of common air pollutants. This white paper seeks to provide a careful analysis into the science and research behind the health impacts of air pollution, and to help Tribes write effective comments on proposed regulatory actions that will impact the health and well-being of their Tribal members and lands.

Background

2020 marks the 50th Anniversary of the promulgation of the Clean Air Act (CAA). Many people working in the field of air quality will not be able to remember a time before this landmark piece of legislation was enacted. One of the most important things the CAA did was to define the six criteria pollutants that form the backbone of its regulatory efforts. These pollutants are: nitrous oxides (NO_x), sulfur dioxide (SO₂), particulate matter (PM), lead, ground level ozone (O₃), and

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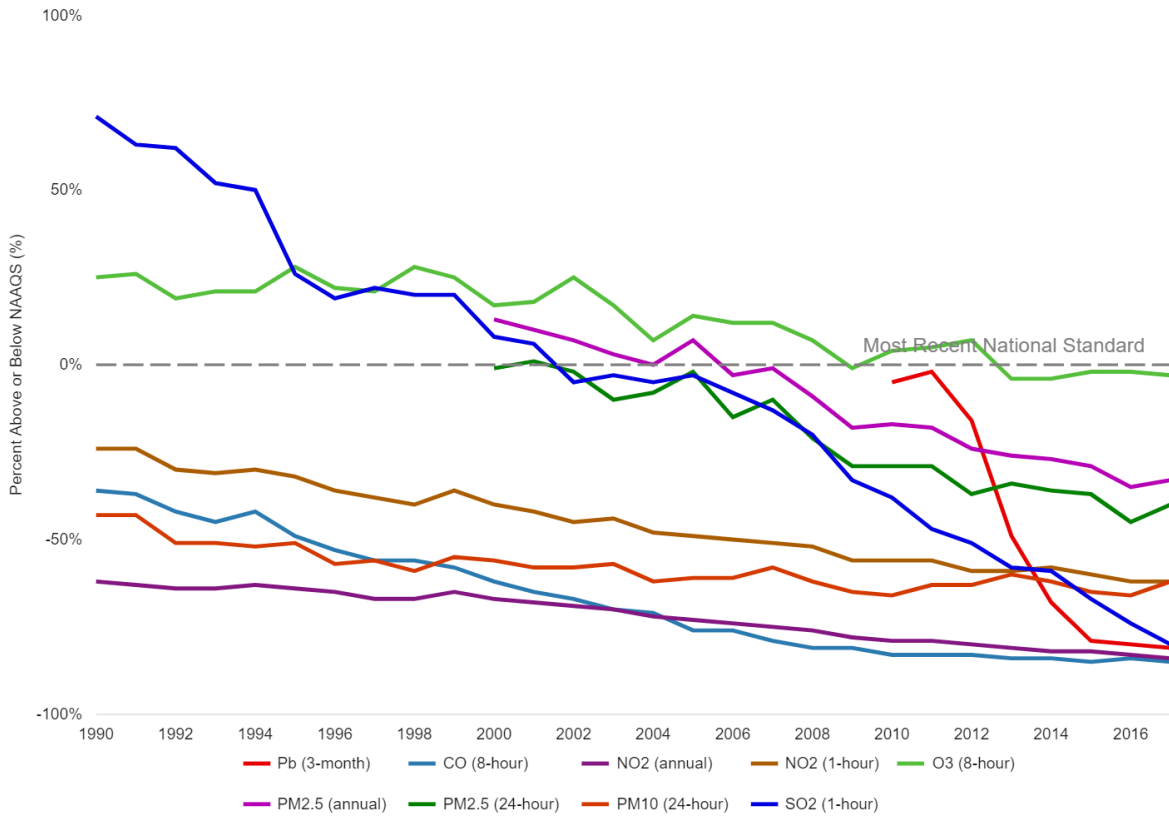
carbon monoxide (CO), and are known as the National Ambient Air Quality Standards, or NAAQS.

During the past 50 years, much has been learned about how these criteria pollutants adversely impact the human body. Study after study has shown the detrimental health effects of pollutants on our bodies in the areas of respiration, reproduction, endocrine systems, and more, meaning that reductions of pollutants are important for public health reasons. Some of the successes of the CAA are demonstrated by the following metrics:

1. Emissions Decreases

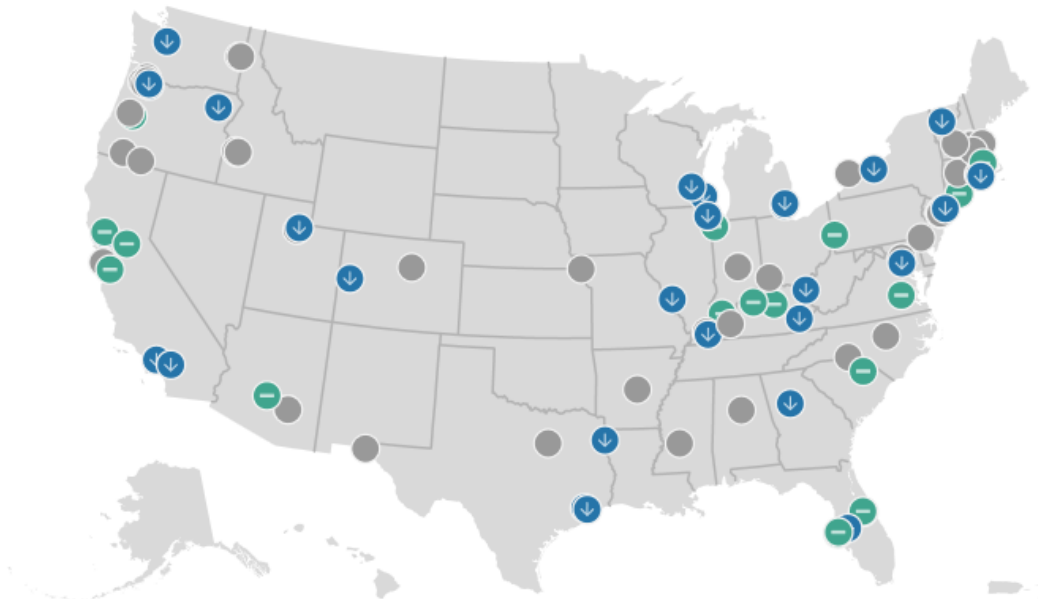
- In the years between 1970 and 2018, the combined emissions of the six criteria pollutants (NO_x, SO₂, PM, O₃, CO, and lead) have decreased by 74%.
- Ambient air quality concentrations fell by these amounts between 1990 and 2018:
 - O₃ – 21%
 - SO₂ – 89%
 - NO_x – 57%
 - CO – 74%
- Ambient concentration of PM_{2.5} decreased by 39% between 2000 and 2018
- Between 2010 and 2018, lead emissions fell by 82%
- Between 2016 and 2018, lead emissions fell by 12% and SO₂ emissions by 22%

Declining National Air Pollutant Concentration Averages



(Table is from <https://www.epa.gov/clean-air-act-overview>)

Lead PM10 LC Concentration Trend





(Table is from <https://www.epa.gov/clean-air-act-overview>)

2. Health Impacts and Improvements

A new study looked at seven separate datasets for fine particulates in New York State and found that as PM_{2.5} levels dropped by 28-37% between 2002 and 2012, air pollution mortality correspondingly dropped by 67%, from 8,410 premature deaths in 2002 to 2,750 in 2012 – saving an estimated 5,660 lives.¹

A separate study showed that a 13 month closure of a steel mill in the Utah Valley led to a 50% decrease in winter PM₁₀ concentrations, a 40% in school absenteeism, a 16% decrease in deaths, a decrease in the number of premature births, as well as a decrease in the number of “hospital admissions for pneumonia, pleurisy, bronchitis, and asthma,” especially among children.²

Although the health impacts of air pollution on cardiovascular disease, cerebrovascular disease, chronic obstructive pulmonary disease, type 2 diabetes, lung cancer, and pneumonia have long been identified, a study published in November of 2019 showed the relationship between PM_{2.5} and death from these conditions, and identified three new causes of death attributable to PM_{2.5}: chronic kidney disease, hypertension, and dementia.³

An EPA study⁴ shows that, in 2010 alone, reductions in fine particulates and ozone due to the Clean Air Act Amendments (CAAA) of 1990 had the following impacts:

- More than 160,000 premature deaths were avoided, along with 130,000 heart attacks, millions of cases of respiratory problems, and 86,000 hospital admissions.
- More than 13 million lost work days were avoided.
- 3.2 million lost school days were avoided.
- In 2020, the CAAs will prevent over 230,000 early deaths, 200,000 heart attacks, 120,000 emergency room visits, 5.4 million missed school days, and 17 million missed work days.

Additionally, long-term reductions in air pollution have had positive effects on the respiratory systems of children ages 11-15.⁵

3. Attainment

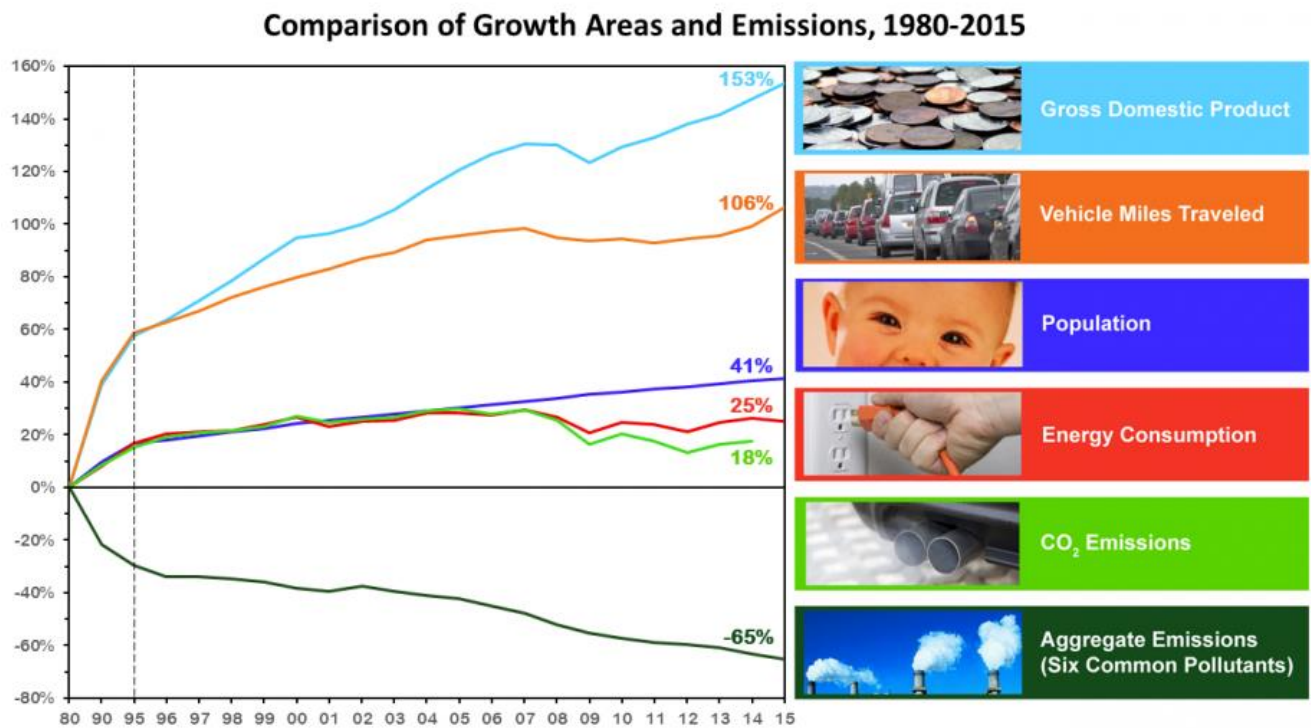
According to the most recent monitoring data, more than 80% of low-income counties are in attainment with the NAAQS, compared with only 43% in 2008.

4. Energy and Transportation

Even as pollution has decreased, vehicle miles traveled have increased by 189% since 1970, while the population has grown by 59% and energy consumption by 44%, showing that Americans have continued to enjoy a comfortable lifestyle during this time.⁶

5. Economic Development

Between 1970 and 2018, the US economy grew by 275%. A 2011 EPA study shows that the 1990 CAAAs have yielded benefits that exceeded costs by more than 30-to-1⁴ and has saved \$2 trillion.² Additionally, the economic welfare of American households was found to be better with post-1990 programs than without them. These improvements are believed to be a result of fewer air pollution-related illnesses, along with less money spent on medical treatments and fewer missed work days.



(Table from <https://www.epa.gov/transportation-air-pollution-and-climate-change/accomplishments-and-success-air-pollution-transportation>)

While the CAA has demonstrated tremendous success, this white paper cites many studies that demonstrate the clear link between clean air and public health. There are many challenges that remain in the field of air quality, as seen in the sections below.

Purpose

As stated in the paragraph above, the work for clean air must continue. The American Lung Association's "State of the Air 2019" found that more cities had high days of ozone and short-term particulate concentrations from 2015-2017 than from 2014-2016.⁷ Further, the years 2015-2017 ranked as the hottest years on record globally. Evidence was also found of spikes in ozone and particulate concentrations during this time. In all, around 43.3% of the US population lives in counties that have unhealthy levels of ozone and/or particulates. This is equivalent to 141.1 million people, which is an increase from the 133.9 million in 2018 and the 125 million in 2017 that lived in these areas. Worldwide, air pollution causes 7 million early deaths annually, more than AIDS, diabetes, and traffic accidents combined.⁸

As the earth's climate changes, increases in air pollution are expected to occur. Recently, 74 medical and public health groups warned of a "health emergency" due to climate change.⁹ One reason for this is that increased temperatures will lead to higher ozone levels because the rate of the chemical reaction that drives ozone formation is increased by warmer temperatures. Higher humidity levels could also lead to higher levels of PM, as formation as a secondary pollutant. Overall higher temperatures and higher levels of precipitation in some areas will lead to higher pollen counts and to mold outbreaks, which will impact people with allergies and affect indoor air quality (IAQ). Areas experiencing drought conditions will also experience more frequent and larger wildfire activity. Wildfires have been increasingly problematic in the Western US, with growing impacts on Tribal air quality (see the 2019 STAR, Section 2.2).

IAQ is increasingly a concern for many people as hot, wet weather conditions lead to higher pollen counts and increased mold growth. Larger and more frequent wildfire activity also has impacts on IAQ, even as people try to spend more time indoors to escape wildfire smoke.

Additionally, in recent months the EPA has issued or given advance notice of many proposed changes in policies related to air emissions that do not give the appropriate consideration to scientific studies. Attempts have been made to undermine or ignore robust, peer reviewed studies that clearly show links between ambient air pollution and health problems. Some of these studies have been used in the field of public health for decades and are very strongly supported by the underlying science. One purpose of this paper is to cite these studies supporting the links between air pollution and public health so that Tribes can have a resource for responding to EPA policy proposals that fall short of the mark concerning the protection of public health. Recent air quality concerns related to the COVID-19 pandemic indicate the importance of air quality research (see section 9 under Health Impacts from Air Pollution).

There has also been a recent attempt by the EPA to change the manner in which costs and benefits associated with various environmental policies are calculated. This paper will attempt to provide Tribes with scientifically strong ways to fully demonstrate the benefits of clean air.

Holistic Methods and Traditional Knowledges

Tribal governments take a great interest in environmental protection partly due to the poor health outcomes of many of their Tribal members. For instance, the US Department of Health and Human Services has found that American Indians and Alaska Natives (AI/ANs) have an infant death rate that is 60% higher than the rate for Caucasians.¹⁰ AI/ANs also experience a rate of diabetes that is twice as high as for Caucasians, as well as disproportionately high death rates from unintentional injuries and suicide.¹⁰ The tuberculosis rate in 2012 for AI/ANs was 6.3%, compared with 0.8% for the white population. Further, Native people struggle with cultural barriers, geographic isolations, food insecurity, inadequate sewage disposal, and low incomes. While not Native-specific, a study performed in Duluth, Minnesota, showed that residents in low-income zip codes have a life expectancy eleven years lower than residents from more affluent zip codes in the same city.¹¹

Tribal people, as a rule, take a more holistic approach to the interaction between health and the environment than Western cultures do. In the eyes of many Native people, the health of natural resources and the environment are inseparable from the health of the people. This is due to the subsistence lifestyle that many Native people lead, as well as their commitment to maintaining cultural practices such as hunting, fishing, and gathering. Contaminants in natural resources can find their way into the bodies of the people consuming those resources. But AI/ANs also see the links between participating in meaningful, healthy activities and physical wellbeing. For example, the Fond du Lac Band of Lake Superior Chippewa recently co-authored a Health Impact Assessment focused on wild rice that highlighted several themes linking wild rice to the health of the Fond du Lac people, including cultural identity, social relations, health, physical activity, and economic considerations.¹²

In contrast, the typical cost/benefit analyses performed by governmental agencies in the US do not recognize costs or benefits that are less tangible than deaths caused directly by a pollutant and direct costs of pollution controls. Nor do these analyses study how, for example, a decrease in a readily available healthy food source can lead to the substitution of less healthy foods, and the results this can have on obesity rates, diabetes, and other diseases.

Likewise, most US studies of impacts of pollutants on lung function do not go beyond immediate causes of disease or death to look at secondary impacts, for example how inactivity on poor air quality days leads to reduced physical fitness.

While this paper focuses on published, peer reviewed scientific research, traditional knowledge can provide an important enhancement to the understanding of Tribal and Indigenous perspectives of their connection to the environment, environmental impacts, and changes over time. It is critical that any agency/state, researcher, or individual who seeks to engage with Tribes or Tribal

Knowledge Holders on any topic abide by the two principles of “Cause No Harm” and “Free, Prior, and Informed Consent.” These principles are described in detail in the paper, *Guidelines for Considering Traditional Knowledges in Climate Change Initiatives*, and in essence serve to protect Tribal and Indigenous People and foster the sharing of knowledge in an “equitable and productive relationship.”¹³

Health Impacts from Air Pollution

1. Respiratory/Pulmonary

Studies on the impacts to the respiratory system from both indoor and ambient air pollution are some of the most widespread and well-established studies conducted. Asthma, COPD (chronic obstructive pulmonary disease), and lung cancer have all been shown to either be exacerbated by, or have an increased risk due to, exposure to air pollution, as evidenced below. Furthermore, climate change is leading to an increase in the same respiratory issues.¹⁴

a. Asthma

Due to the rapid development of the respiratory system both *in utero* and during early childhood, children and adolescents are more susceptible than adults to developing asthma or other respiratory conditions related to air pollution.¹⁵ Multiple studies show that exposure to key environmental pollutants such as PM and other ambient air pollutants can damage the development of the respiratory system,¹⁶ exacerbate allergic inflammation in the lungs,¹⁷ and lead to reduced lung function in asthmatic children.¹⁸ The development and exacerbation of asthma in children has also been linked to high levels of ozone.¹⁹ Lastly, a study conducted in southern California between 1993 and 2014 demonstrated that decreases in nitrogen dioxide and PM_{2.5} led to significantly lower incidences of children developing asthma.²⁰

Studies have also been conducted specifically regarding asthma and AI/AN children. We know that AI/AN children have greater incidence of asthma (approximately 13% compared with 8.6% of children of non-AI/AN descent).²¹ Health disparities such as poverty and inadequate access to respiratory care impact AI/AN children with asthma that live on reservations, and environmental challenges such as both indoor and outdoor air pollution compound the problem.²² More AI/AN people use biomass for heating and cooking than do non-AI/AN people (in fact, 89% of families on the Navajo Nation reservation do), elevating the levels of both PM_{2.5} and PM₁₀ in their homes, and contributing to the increased incidence of asthma severity and morbidity.²³

Climate change is leading to an increase in pollen production and mold spores, as well as a longer duration of pollen seasons and possibly an increase in the allergenicity of pollens, all of which exacerbates asthma.^{24, 25} An Australian study showed that particulate matter in the air (which also exacerbates asthma) is increasing in step with temperature increases.²⁶ The pollution produced

from the burning of fossil fuels (such as in power plants and vehicles) negatively affects respiratory defense mechanisms and works in cooperation with specific allergens to worsen asthma.²⁵

b. Chronic Obstructive Pulmonary Disease (COPD)

Indoor air pollution includes multiple pollutants, including intrusion of ambient air pollution, secondhand smoke, heating and cooking fuels, and volatile organic compounds,²⁷ all of which can exacerbate COPD. In fact, a study conducted in 2014 demonstrated that when IAQ in the home is improved, the incidence of COPD is decreased.²⁸ Unfortunately, because warmer temperatures lead to increased concentrations of fine particulate matter and nitrogen dioxide, people with COPD have been shown to have increased breathlessness, cough, and sputum scale scores on warm days.²⁹

c. Lung Cancer

Multiple studies have shown the link between exposure to NO₂ and lung cancer,^{30,31,32} and a meta-analysis from 2015 demonstrated that vehicular emissions of NO_x, SO₂, and PM_{2.5} leads to a significant increase in the risk of developing lung cancer.³³

d. Emphysema

A 2019 study found a link between long-term exposure to air pollutants, especially ozone, and increasing emphysema and worsening lung function.³⁴ Emphysema is a disease that is usually associated with smoking. In fact, an increase of about three parts per billion of ozone was found to be equivalent to smoking a pack of cigarettes a day for 29 years.



(Graphic from <https://www.who.int/airpollution/infographics/en/>)

2. Cardiovascular

A number of seminal studies have found links between air pollution and heart disease. A 1993 study³⁵ suggests that fine particulates, either acting alone or with other air pollutants, contributes to excess mortality in certain US cities. A 2002 study³⁶ found that long-term exposure to combustion-related fine particulates is an important risk factor for cardiopulmonary and lung cancer mortality. A 2015³⁷ study found that higher levels of pollution have been associated with higher mortality rates for cardio-pulmonary or respiratory causes.

More recently, a study published in *The Lancet* in 2016 found that long-term exposure to fine particulate and traffic-related concentrations is linked to cardiovascular risk. The pollutant concentrations in the study are found commonly around the world, and showed an association with progression in coronary calcification, consistent with acceleration of atherosclerosis, which is a build-up of fatty deposits on the inner lining of the arteries.³⁸ Another 2016 study³⁹ states that ambient particulate matter is strongly associated with increased cardiovascular disease such as myocardial infarction, cardiac arrhythmias, ischemic stroke, vascular dysfunction, hypertension, and atherosclerosis.

3. Neurological and Brain Development and Cognition

There is ample science-based evidence that exposure to air pollutants can increase inflammation in the brains of young children, leading to cognitive deficits and the presence of proteins characteristic to the development of Alzheimer's disease.⁴⁰

In a study published on August 31, 2018,⁴¹ the National Academy of Sciences found that long term exposure to air pollution impedes cognitive performance in both verbal and math tests, with the effects being more pronounced as people age, especially for men and for the less educated. These results are important because cognitive decline or impairment are risk factors for the development of Alzheimer's disease and other forms of dementia in the elderly. Pollutants identified in the study include PM, SO₂, and NO₂. The mechanism by which brain function is impacted is not yet well understood, although the pollutants could reach the brain through the bloodstream. A more recent, longitudinal study (November 20, 2019) on women in their 70s and 80s, again provided evidence of the connection between PM_{2.5} and "early decline of immediate free recall/new learning... which is indicative of increased Alzheimer's disease risk."⁴²

The link between lead exposure and impaired brain development has long been established. However, new research has suggested that impairment starts at levels that were once thought to be safe, and that no safe level of exposure exists during human development.⁴³ Also, recent research now helps to show the mechanism by which lead alters new cells in the brain.⁴⁴

Likewise, the links between mercury exposure and neurological problems has long been well-established. A report by the National Research Council at the National Academy of Sciences also lists these endpoints: poor performance on neurobehavioral tests, especially in tests of attention, fine-motor function, language, visual-spatial abilities, and verbal memory.⁴⁵ This is especially worrisome to AI/ANs, as Tribal members consume more fish than the general population because of their tendency toward a subsistence lifestyle, which the EPA has acknowledged in past publications.⁴⁶ Specifically, the EPA concluded that exposure among specific subpopulations, including some Native Americans, may be more than twice as great as that experienced by the average US population.⁴⁷

4. Reproductive

Scientists believe there may be a connection between air pollution and both fertility rates and increased risk of miscarriage.⁴⁸ A study published in October of 2019⁴⁹ quantified the link between air pollution and a specific type of miscarriage, known as a “silent miscarriage” or a “missed abortion in the first trimester.” This type of miscarriage can be particularly traumatic because there are no physical signs of the miscarriage, leading to the assumption that the fetus is developing normally. Related studies also outlined the correlation of air pollution to adverse perinatal events, such as preterm delivery,⁵⁰ low birth weight,⁵¹ and small size for gestational age.⁵²

A 2018 Popular Science article describes how a year after eight coal and oil-fired power plants in California closed, fertility rates in the surrounding areas went up. The resulting research “provided a clear demonstration of an emergency public health problem – the link between poor air quality and reduced fertility.”⁵³ A study from June 2018 found that women who lived closer to major roadways had lower birth success rates when undergoing IVF.⁵⁴

A study conducted in 2016 reviewed the available literature regarding exposures to environmental air pollutants and fertility or reproductive health using the PubMed database over the period from January 1, 2000, to April 1, 2016.⁵⁵ The article referenced over 100 separate studies and concluded, “Both animal and human epidemiological studies support the idea that air pollutants cause defects during gametogenesis leading to a drop in reproductive capacities in exposed populations. Air quality has an impact on overall health as well as on the reproductive function, so increased awareness of environmental protection issues is needed among the general public and the authorities.” The study found links between air pollutants and pregnancy rates, IVF success rates, sperm quality, and female reproductive parameters.

5. Endocrine (diabetes)

A 2004 study linked polycyclic aromatic hydrocarbons and heavy metals, which are found in particulate matter from diesel exhaust,⁵⁶ to hormone levels. A 2018 study⁵⁷ concluded that, “there is a considerable body of evidence documenting the presence of EDCs [*endocrine disrupting compounds*] in both outdoor and indoor air, that EDCs are entering human tissues, and that EDCs

are impacting on human endocrine health,” although the study states that EDCs from air pollutants are likely only one pathway of exposure.

In another 2018 study,⁵⁸ researchers gathered data on pollutants from unconventional oil and gas extraction (UOG) (i.e., hydraulic fracturing) with regard to human health. The study attempted to prioritize future studies in this area. Researchers found that UOG air emissions included 21 pollutants that have been shown to have endocrine disrupting activity, and recommended further study of these emissions.

6. Psychological

A 2012 study discovered that children who were exposed to higher levels of polycyclic aromatic hydrocarbons while in utero were more likely to experience attention problems and symptoms of anxiety and depression,⁵⁹ and that adolescents who are exposed to PM_{2.5} have greater “physiological reactivity to social stressors.”⁶⁰ A 2018 study found links between air pollution and psychological health.⁶¹ Specifically, exposure to higher PM_{2.5} levels are associated with increased psychological distress, even when adjusted for demographic, socioeconomic, and health controls. Another 2018 study⁶² found positive associations between long-term exposure to PM₁₀, NO₂, and CO, and individuals’ mental health status. “Mental health status” was described as one of the following conditions: subjective stress, poor quality of life, depressiveness, depression diagnosis by doctor, and suicidal ideation. A 2018 Chinese study concludes that, “The most severe responses to air pollution were psychologically-associated behavioral problems, indicating a serious threat to mental health, and behavioral vulnerability and variations induced by stress, depression, anxiety, shortened tempers, mood swings, and unpleasant moods.”⁶³ Similarly, a study conducted in the US and Denmark in 2019 found that poor air quality is linked with higher rates of depression and bipolar disorder.⁶⁴

Researchers have derived data-driven evidence that exposure to PM_{2.5} and ozone lead to an increase in violent crimes, particularly assaults and aggressive behavior. This same study demonstrates “that a 10% reduction in daily PM_{2.5} and ozone could save \$1.4 billion in crime costs per year.”⁶⁵

7. Uranium/Radionuclides

Radioactive materials occur in nature, but can be considered air pollutants due to their role in causing a wide range of human health problems. Tribal members are exposed to natural radiation primarily through exposure to radon and uranium, which is often found on Tribal lands in the southwestern US as waste from mining operations. Radon occurs in areas all across the US and has been shown to cause lung cancer,⁶⁶ while uranium can cause a host of health issues, including lung cancer, bone cancer, high blood pressure, kidney disease, and problems with kidney, reproductive, and autoimmune functions.⁶⁷ The impacts of radon and uranium are multiplied in the bodies of smokers.⁶⁸ Since the rate of smoking in AI/AN people is higher than in other ethnic groups, involuntary exposure to radon or radionuclides is more harmful to Native people.

8. Mortality

An August 2019 study published in the New England Journal of Medicine highlights links between daily mortality associated with increased levels of PM-2.5.⁶⁹ The study found that just a 10 ug per cubic meter increase can cause significant increases in mortality. Higher annual mean temperatures seem to increase this impact. The data reinforce a link between mortality and particulate concentrations established previously.^{70, 71}

9. Connection to COVID-19

In late 2019, COVID-19 (caused by the coronavirus) emerged in China as a novel virus. It quickly spread to pandemic proportions, and by March of 2020, the United States was suffering from widespread cases of COVID-19, spanning from asymptomatic and mild cases, to extremely severe cases leading to death. A study published April 5, 2020, (and updated on April 24, 2020,)⁷² found that long term exposure to even a very slight increase (1 µg/m³) in PM_{2.5} levels was associated with an 8% increase in the death rate from COVID-19. A study of air quality in Italy's Northern provinces of Lombardy and Emilia Romagna also found a correlation between COVID-19 mortality rates and high levels of pollution. The researchers investigated the role of low air quality in the two provinces becoming hotspots, concluding that, "The high level of pollution in northern Italy should be considered an additional co-factor of the high level of lethality recorded in that area."⁷³

Because COVID-19 is currently an emerging threat and its connection to air pollution is not fully understood, additional studies are needed.

10. Other areas of health impacts

A study in the United Kingdom (UK) showed a correlation between air pollution and the development of glaucoma, an eye condition that can cause blindness if left untreated. Neuroinflammation, which is a known response to air pollution, "has been identified as a mechanism underlying glaucoma." In this study, data from 111,370 UK residents was analyzed, which included information on air quality and ophthalmic measures. The results showed that "resident[s] in areas with higher PM_{2.5} concentration were more likely to report a diagnosis of glaucoma."⁷⁴

Conclusions

In providing this supplement to the 2019 Status of Tribal Air Report, the NTAA identified more than fifty seminal studies that clearly link air pollutants to human health issues, and those are just a small percentage of the peer-reviewed, scientific studies in this field. The number of studies that clearly reinforce the science behind these links increased since the time of publication, and many were added to this 2020 update. Regulatory changes that are intended to weaken environmental and public health protections standards go against both Tribal lifeways and the intent of both the

EPA and the Clean Air Act. The science behind these studies is robust and credible. It is NTAA's goal that by identifying some of the latest human health studies, Tribes can use this white paper as a foundation to be better prepared to comment on regulatory proposals from the EPA and other agencies. In the interests of citing the latest research and data, this white paper will be reviewed and updated annually along with the STAR.

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