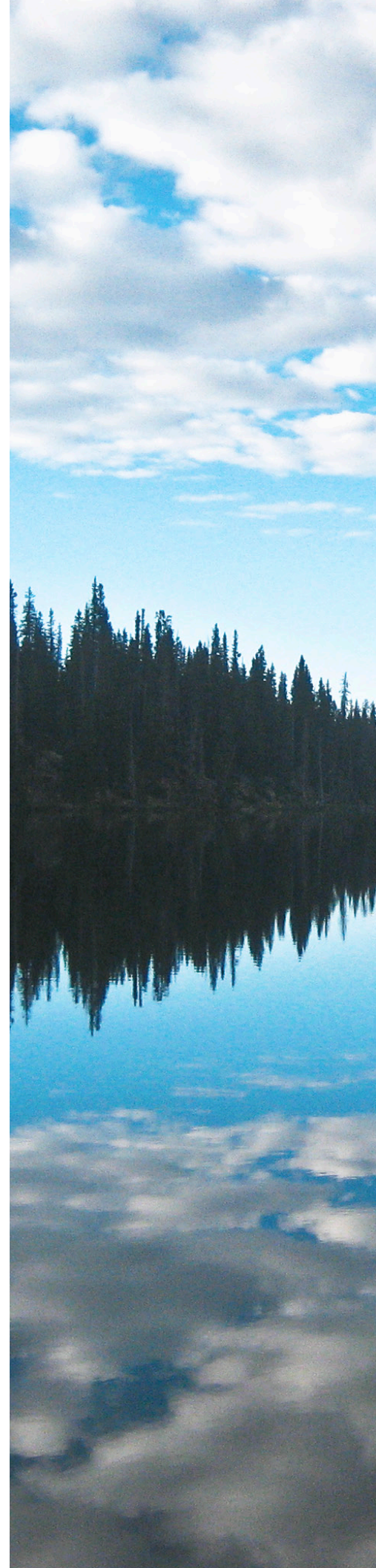

AIR POLLUTION AND PUBLIC HEALTH IN UTAH



ENVIRONMENTAL
PUBLIC HEALTH TRACKING





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Air Pollution and Public Health in Utah is another installment of educational reports produced by the Utah Environmental Epidemiology Program. This report provides an overview of the air pollution risk factors, how exposure to air pollution occurs, and improvement strategies that are associated with air quality.

In addition to what is provided in this report, you can find more information through Utah's Indicator-Based Information System for Public Health (IBIS-PH) and the Utah Environmental Public Health Tracking Network (UEPHTN). These resources provide a wealth of important information about the public health of Utah. If you have any questions, please do not hesitate to contact us at the Utah Department of Health.

I would like to thank all agencies within Utah who share data, maintain public information sources, and promote public and environmental health. Protecting the public health of Utah is a collaborative effort that requires the input of many to achieve a common goal. I hope that you will read this report and use it to promote health in your home and community.

A handwritten signature in black ink, appearing to read "Allyn Nakashima".

Allyn Nakashima, MD
State Epidemiologist





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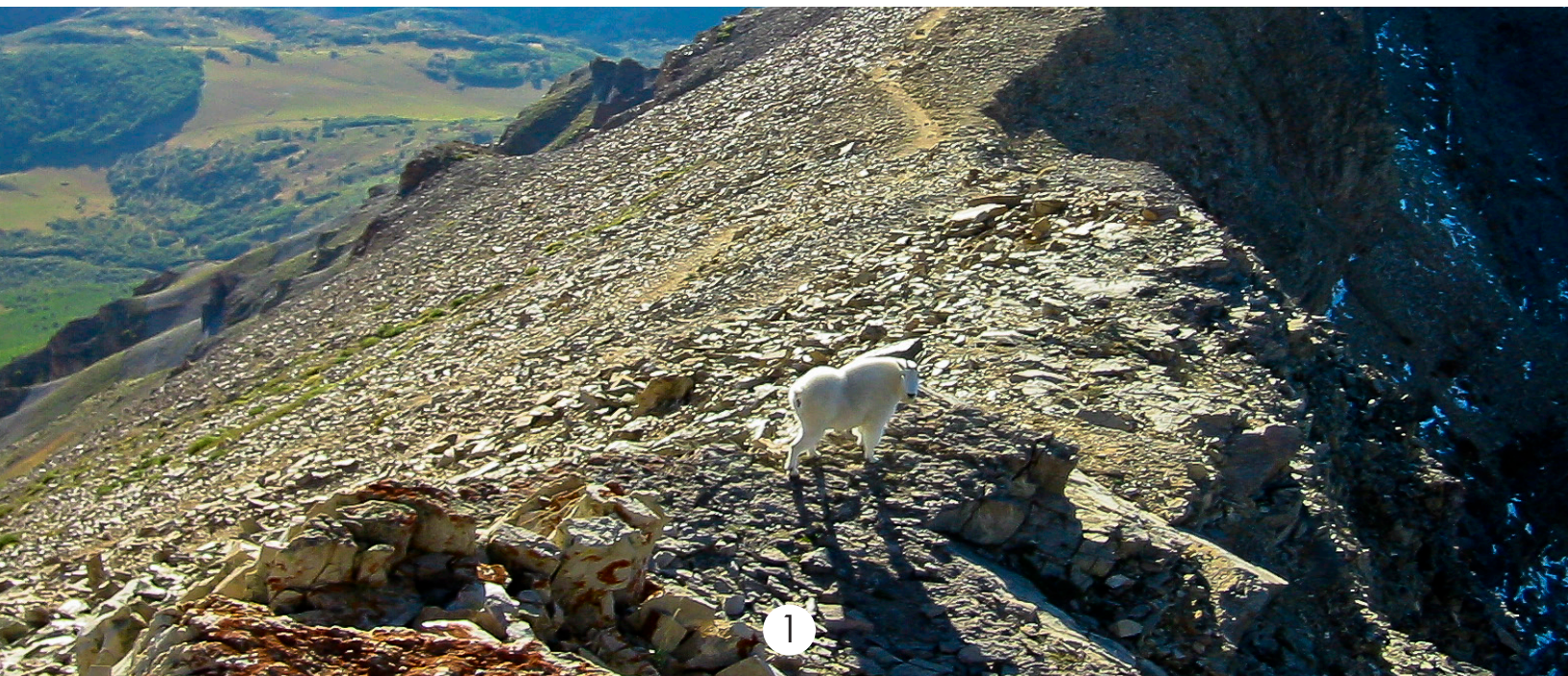
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Utah Department of Health

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FOREWORD

In most of the United States, it is easier to breathe than it was 25 years ago; however, air pollution has become a growing concern for the public's health and well-being. Although there are about 85% more vehicles being driven and about 105% more miles driven a year, current vehicles emit about 80% less pollution per mile than vehicles produced in the 1970s. Nonetheless, emissions from vehicles still account for nearly a third of the air pollution in the United States.^[1] Even though we live during a time when pollution isn't as bad as it used to be, air pollution is still hazardous to all who breathe.

Air pollution comes from many different sources. These sources include factories, power plants, dry cleaners, degreasing operations, vehicles and trains.^[2] Some pollutants are natural elements of the air. Plants, animals, and natural activity cause some pollution even without man's contribution through technology.^[2, 3] Naturally occurring sources of pollution include windblown dust, volcanic eruptions, and forest fires.^[2] There is no possible way to remove all pollution from the air.^[3]

This booklet was assembled to provide a better understanding of the different types of air pollutants, where they come from, and how to avoid exposure. Inside, readers will also find a variety of health effects from air pollutants. Everyone is invited to find more environmental and public health data at the Utah Environmental Public Health Tracking website (<http://epht.health.utah.gov>) and the National Public Health Tracking website (<http://ephtracking.cdc.gov>).

The Environmental Epidemiology Program hopes that this publication will provide valuable information to everyone involved in public health and air quality including policymakers, environmental professionals, public health professionals, educators, health care providers, and the general public. It is our goal to educate everyone about air pollution, what the contributing factors are, how we are exposed, and how each of us can help to improve the air quality in Utah.

Authors: Katie Ostler, Matt McCord



INTRODUCTION

There are periods of good air quality and poor air quality throughout the state of Utah. During the summer and winter months, weather patterns can lead to poor air circumstances for long periods of time making it difficult to enjoy Utah's natural surroundings without negative health effects. This section will discuss ways that you as an individual can help contribute to better air quality in Utah. It will define inversion, the Air Quality Index (AQI), and show trends over a period of time of the six criteria pollutants.

This section provides information about the following:

- ✓ Inversion
- ✓ Behavior Changes
- ✓ Six Criteria Pollutants
 - Ozone
 - Particulate Matter
 - Sulfur Dioxide
 - Nitrogen Dioxide
 - Lead
 - Carbon Monoxide





WHAT CAN I DO?

Poor air quality is caused by several different sources. Whether it is from vehicles, homes, businesses, or industries, everyone can make choices to help lower air pollution. Utah is currently working to reduce vehicle emissions and improve air quality through programs such as the Utah Diesel Program. The Utah Diesel Program started in 2008 and was created to help small businesses, school districts, government entities, and universities purchase cleaner and more fuel efficient equipment. These successful projects demonstrate the commitment to help improve the air quality challenges faced in Utah.^[1] However, this is not enough and there are more changes that people can make to help reduce poor air quality.

Currently, the majority of the fine particles (see page 21) found in air pollution come from vehicles and area sources such as homes, small businesses, and commercial buildings. Vehicles contribute 48% of emissions that lead to the formation of fine particulates, whereas small industrial and commercial sources, known as area sources, contribute 39%.^[2, 3] Examples of area sources include gas stations, dry cleaners, and home heating. Only 13% of fine particulates come from large manufacturing industries.^[4] Driving less or being more energy efficient in our daily lives are personal behavioral changes that will decrease vehicle emissions and contribute to a significant, positive impact on our air quality throughout the year.^[2]

When it comes to our own personal vehicles, there are several different methods we can use to help reduce emissions.

- Reduce the number of trips or plan your trips more efficiently, such as making a “trip chain” to lessen the amount of time your car needs to warm up.^[3]
- Be idle free. That means turning off your engine next time you are in a pick-up, drop-off zone. Ten seconds of idling can use more fuel than turning off your engine and restarting it.^[5]
- Carpools and using public transportation are beneficial in many ways other than just decreasing your contribution to air pollution. Carpooling has been shown to decrease commuter-related stress resulting in greater productivity at work.^[5] Public transportation is more available because of the growing infrastructure of transit lines. Utah offers a variety of public transportation options like buses, light rail, and commuter rail.^[3, 5]
- Drive your newest car on poor air quality days. Newer vehicles emit less pollution and run cleaner. When buying a new vehicle, choose a fuel efficient car.^[5]
- Stay on top of your current vehicle’s upkeep by changing the oil regularly, checking tire pressure, and having regular engine tune ups.
- Drive the speed limit and don’t accelerate too quickly causing your engine to emit more pollutants.^[3]
- Don’t top off gas to avoid gas fumes escaping.^[6]



Bike lanes, sidewalks, and complete streets are becoming more frequent making it easier to travel on foot or by bike.^[7] Bicycle transportation is becoming more common in Salt Lake City with more than 150 miles of bicycle lanes and access to non-motorized trails. The City offers facilities for bike parking, storage, and maintenance for the convenience of the community.^[8] For more biking information, visit <http://bikeslc.com/>. Biking not only benefits air quality, but it benefits your health and quality of life through exercise. As the demand for oil increases and gas prices fluctuate, biking can help consumers spend less money on fuel for vehicles.

The Utah Division of Air Quality releases action alerts when the air has the potential to exceed an air quality standard. The action alerts are forecast three days in advance, permitting individuals to be proactive in planning their activities.^[2] For example, a moderate or severe action day forecast may encourage the use of different modes of transportation to reduce air pollution emissions. Action alerts can also be used to help you make informed decisions about outdoor activities. This includes avoiding outdoor activities that would increase your exposure to air pollution or choosing less intense activities such as walking instead of a running. It is especially important if you have a health condition that may be exacerbated by air pollution.^[9]

You can receive email alerts from the Utah Division of Air Quality by signing up at <http://air.utah.gov/forecast.php?id=slc>.

Inversions (see page 8) happen often in Utah during the winter months and home heating contributes to inversions. Here are some ideas to reduce the buildup of emissions during inversion periods.

- Turn down your thermostat while you are away or use a programmable thermostat to improve your home heating and decrease your heating costs.
- Wood-burning emits pollutants that are harmful to our health. Do not use a wood-burning stove during inversions.^[5] When using wood-burning stoves, clean the stove pipe and chimney regularly.^[3]
- Instead of using a snow blower, choose to shovel the snow to decrease emissions and become physically active.^[3, 5]
- Instead of using hot water to wash clothes use warm or cold water to save energy by decreasing water heater usage.
- Use rechargeable batteries for things that are used more frequently. This decreases the manufacture of heavy metals and corrosive materials that go into making disposable batteries.^[10]
- Buy energy star products for appliances and lighting. These products are environmentally friendly and help conserve energy.^[6]

Most large industries and some smaller industries are bound by national air quality standards for criteria pollutants (see page 9) and Hazardous Air Pollutants (HAPS). These standards reduce emissions by requiring upgrading emissions controls with new technology.^[3]

AIR QUALITY INDEX

The Air Quality Index (AQI) is a tool that helps you understand the air quality in your local area every day. You can use the AQI to learn how the air may affect your health and to make decisions to protect your health.

The AQI is a calculation of four major air pollutants that are regulated by the Clean Air Act: ground-level ozone, particulate matter, sulfur dioxide, and carbon monoxide. As the level of air pollution increases, so does the calculated AQI value.^[1] The AQI is color coded and divided into six different categories to help explain the quality of air: green means good, yellow means moderate, orange means unhealthy for sensitive groups, red means unhealthy for all groups, purple means very unhealthy, and maroon means hazardous for everybody.^[2] To view the complete AQI chart, see page 53. To see the current AQI status, visit www.airnow.gov or www.air.utah.gov.

Here are some terms to help you better understand the AQI chart:

- **Sensitive groups:** People who have certain underlying diseases or health conditions may be more susceptible to the effects of air pollution. This includes people with heart disease, lung disease, children, and the elderly.
- **Prolonged exertion:** Any activity done intermittently for several hours and makes you breathe slightly harder than normal, such as working in the yard for part of the day.
- **Heavy exertion:** Any intense activity that makes you breathe hard.

Air Quality Conditions	AQI Range	Health Recommendations
Good	0-50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51-100	People who are unusually sensitive to air pollution should consider limiting prolonged or heavy outdoor exposure. The general public is not likely to be affected.
Unhealthy for Sensitive Groups	101-150	People with respiratory disease (such as asthma), children, older adults, and people who are active outdoors should limit prolonged or heavy outdoor exertion. The general public is not likely to be affected.
Unhealthy	151-200	People with respiratory disease (such as asthma), children, older adults, and people who are active outdoors should avoid prolonged outdoor exertion. Everyone else, especially children, should limit prolonged outdoor exertion.
Very Unhealthy	201-300	People with respiratory disease (such as asthma), children, older adults, and people who are active outdoors should avoid all outdoor exertion. Everyone else, especially children, should limit all outdoor exertion.
Hazardous	301-500	Everyone should avoid all outdoor exertion.

Source: Utah Department of Health. (2015, January 8). Air Quality Index (AQI). Retrieved on April 22, 2015 from <http://health.utah.gov/utahair/AQI/>

INVERSION

During normal atmospheric conditions in the summertime, the warm air stays near the earth's surface and the cool air is above. During an inversion, the opposite happens and the cold air gets trapped below a layer of warm air.^[1-3] This results in air pollutants being trapped closer to the ground. As the city below continues to release pollution, concentrations of pollutants increase. Inversions typically happen during the winter months: December, January, and February.^[1]

Inversions are very common in Utah because of the many mountain ranges and valleys. The surrounding mountain ranges can block wind and air flow making the cold air with pollution stagnant along the valley floor or base of a mountain. Strong winds can help move pollutants away and clean the air.^[2] Vehicles and urban area sources such as fireplaces, wood stoves, and industries contribute the largest amount of the emissions responsible for the fine particles during inversions.^[1, 2]

Nocturnal inversion happens when the ground cools at night leaving the air above warm. This commonly happens when the sky is clear of clouds at night or during the winter when the nights are longer. Typically by mid-morning, nocturnal inversion disappears when the sun warms the earth floor allowing the trapped pollutants to scatter and mix with the warm air above. If heating from the sun is weak, the inversion may linger until later in the day or until the next wind storm.^[4]



Source: air.utah.gov 1/8/15 @ 3 p.m.
*54.9 $\mu\text{g}/\text{m}^3$ of PM

Source: air.utah.gov 2/25/15 @ 2 p.m.
*2 $\mu\text{g}/\text{m}^3$ of PM

*These pictures were taken from the same location on different days to demonstrate the difference based on air pollution. These measurements are for particulate matter (PM2.5) and $\mu\text{g}/\text{m}^3$ stands for micrograms per cubic meter of air.

SIX CRITERIA POLLUTANTS

The Clean Air Act (CAA) was passed in order to control air pollution and improve air quality throughout the United States. As authorized by the CAA, the U.S. Environmental Protection Agency (EPA) established national ambient air quality standards (NAAQS) by which all states must comply.^[1] The national air quality standards are designed to protect the majority of sensitive people from the harmful effects of air pollution. The EPA uses scientific studies and laboratory tests to determine at what levels the NAAQS should be set. If an area of the country has air pollution levels lower than the national standard, then it is designated as an “attainment” area. When an area of the country consistently has air pollution levels higher than the national standard, it can be designated as a “nonattainment” area.^[2] In this case, a plan to reduce air pollution levels must be made by the state in which the nonattainment area is designated.

The term “criteria pollutant” refers to six common air pollutants that are regulated by the NAAQS: ground-level ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead.^[3] These pollutants can harm people’s health, the environment and people’s property.^[3] The terms “primary” and “secondary” are used to differentiate between types of NAAQS. A primary standard is designed to protect people’s health.^[3] A secondary standard is designed to reduce damage to animals, crops, and buildings, as well as protect visibility.^[3] In addition to the criteria pollutants, the EPA regulates 187 other air pollutants, which are called “hazardous air pollutants.”^[4]

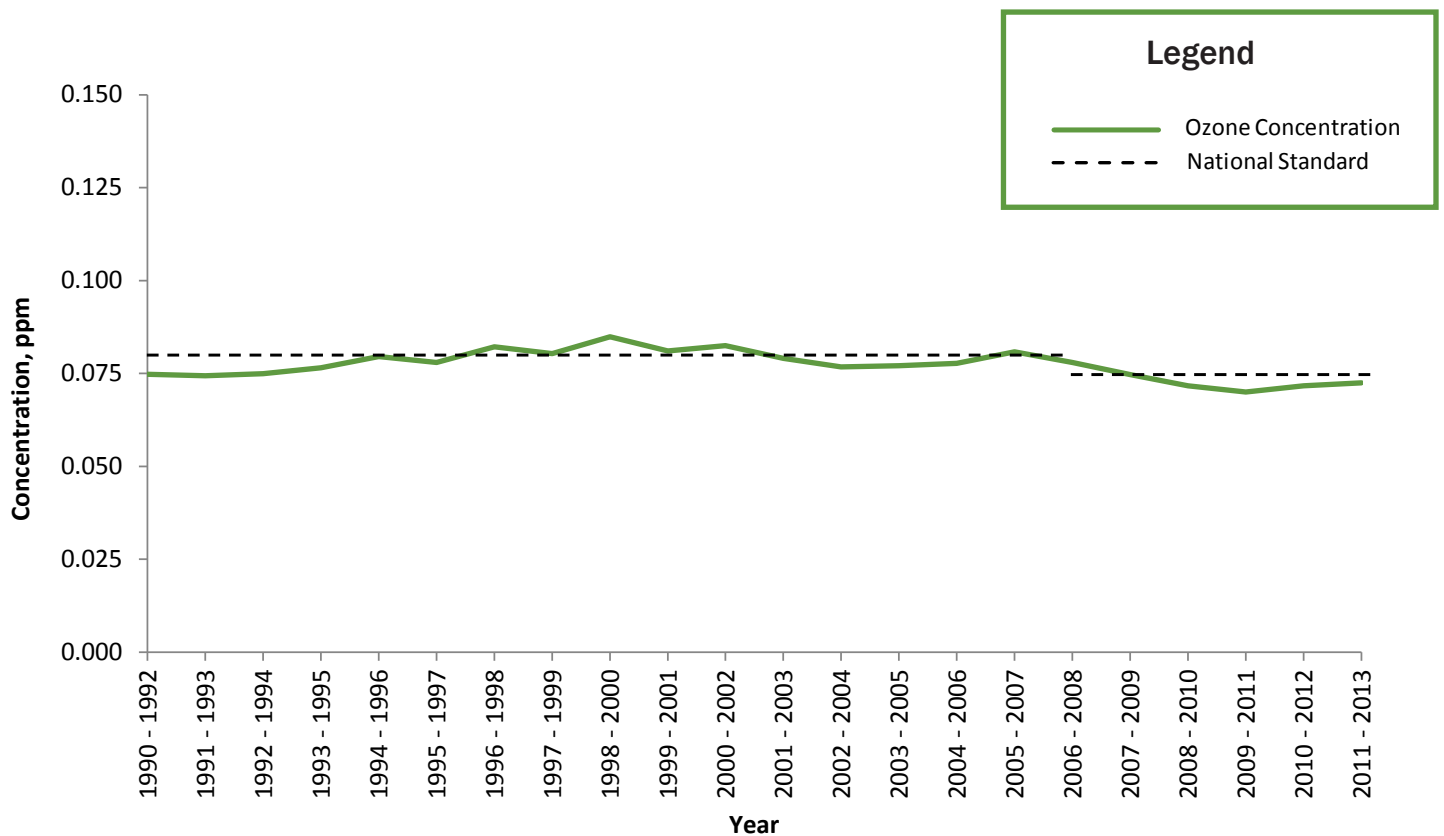
These graphs show an average of all air monitor stations along the Wasatch Front. The Wasatch Front includes all cities between Brigham City and Spanish Fork. Exposure to these pollutants may vary based upon location. For example, someone in Ogden may have different exposure to particulate matter than someone in Provo. Visit www.epa.gov/airtrends/ to find a more accurate reading for a specific location.



OZONE

Ozone is a colorless gas that is found in two layers of the earth's atmosphere.^[5] The primary and secondary standard for ozone is 0.075 parts per million (ppm) over an eight-hour average. This national standard has been revised several times, with the most recent change in 2008 when it was lowered from the previous standard of 0.08 ppm.^[6] Since weather conditions play a large role in the data collected year to year, this standard is evaluated over rolling three-year periods. Ozone levels along the Wasatch Front have remained relatively stable (Figure 1). See page 19 to learn more about ozone.

Figure 1. Three-Year Average of the Annual 4th Highest Daily Maximum 8-Hour Average Ozone Concentrations, Wasatch Front, Utah, 1990-2013



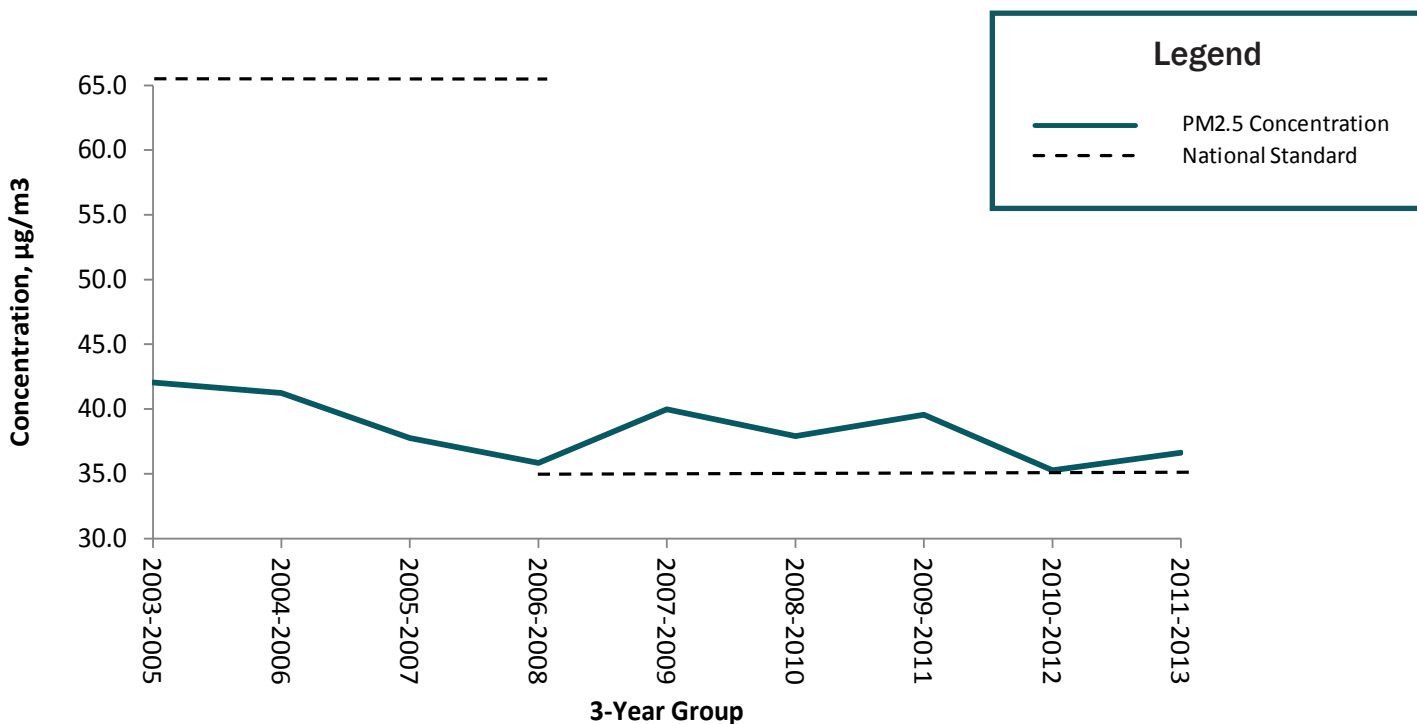
Source: Utah Department of Health. (2015, April 8). Ozone. Retrieved on April 22, 2015 from <http://health.utah.gov/utahair/pollutants/O3/>

Data generated by averaging all air monitoring stations along the Wasatch Front

PARTICULATE MATTER

Particulate matter (PM) is composed of small particles. $PM_{2.5}$ are particles that are smaller than 2.5 micrometers (μm) in diameter. A micrometer is one thousand times smaller than a millimeter and one million times smaller than a meter.^[7] PM_{10} are particles that are smaller than 10 μm but larger than 2.5 μm in diameter.^[8] There are three primary standards for particulate matter, which were most recently revised in 2012. There is an annual primary standard for $PM_{2.5}$ of 12 micrograms per cubic meter of air ($\mu g/m^3$), and $PM_{2.5}$ and PM_{10} have 24-hour primary standards of 35 $\mu g/m^3$ and 150 $\mu g/m^3$, respectively. In 2006, the $PM_{2.5}$ 24-hour standard was decreased from 65 $\mu g/m^3$ to 35 $\mu g/m^3$.^[9] Figure 3 shows that concentrations of PM_{10} along the Wasatch Front have typically been below the national standard. Also, areas along the Wasatch Front were attaining the previous $PM_{2.5}$ primary standard of 65 $\mu g/m^3$. However, when this standard was lowered to 35 $\mu g/m^3$ in 2006, the urban areas along the Wasatch Front were unable to comply and were designated as nonattainment (Figure 2). See page 21 to learn more about particulate matter.

Figure 2. Three-Year $PM_{2.5}$ Annual 98th Percentile Average, Wasatch Front, Utah, 2003-2013

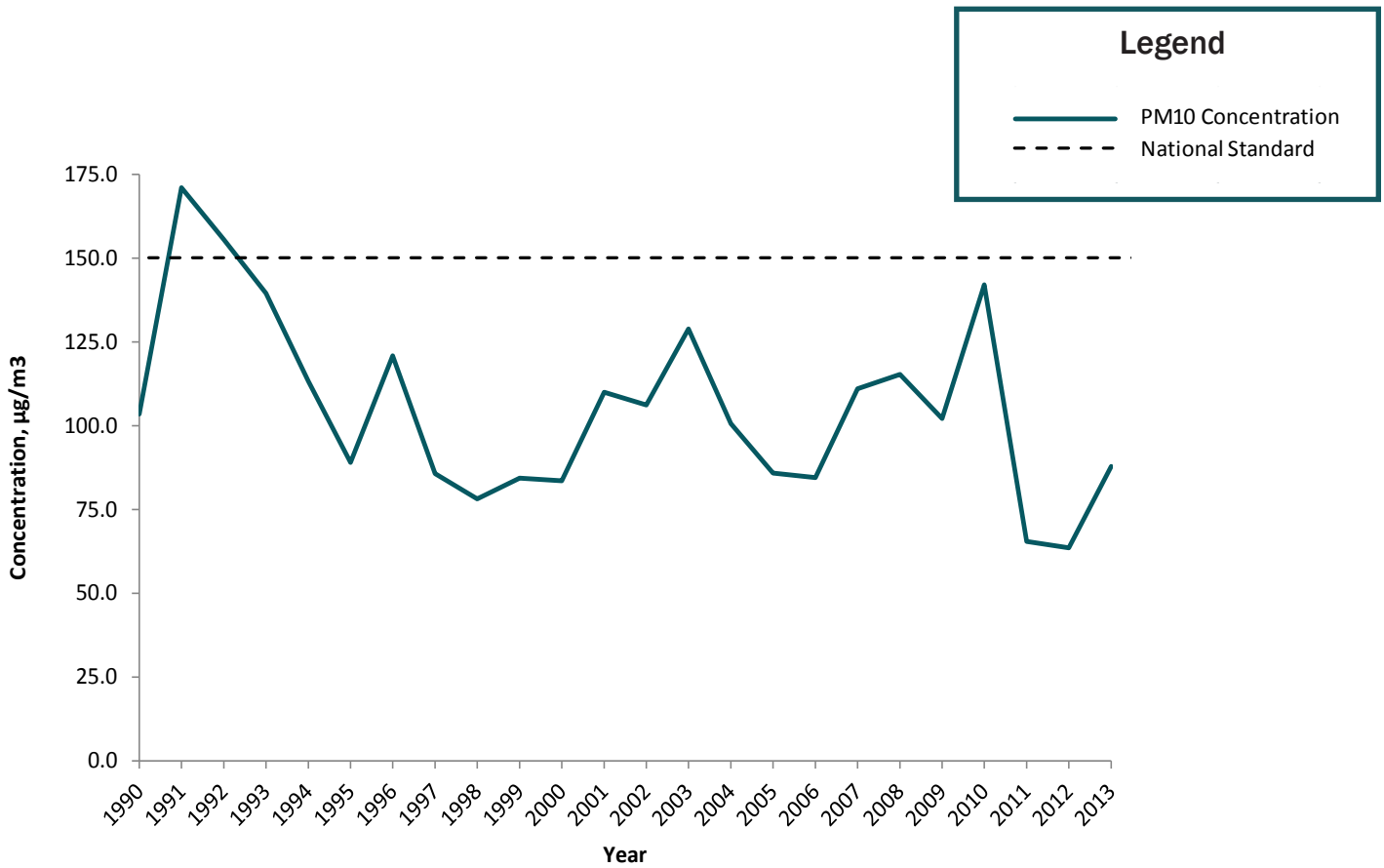


Source: Utah Department of Environmental Quality. (2014, February 24). AMC: Data Archive: Particulate $PM_{2.5}$. Retrieved on February 24, 2015 from <http://www.airmonitoring.utah.gov/dataarchive/archp25.htm>

Data generated by averaging all air monitoring stations along the Wasatch Front

PARTICULATE MATTER *CONTINUED*

Figure 3. Second Highest Average Annual PM₁₀ Concentrations, Wasatch Front, Utah, 1990-2013



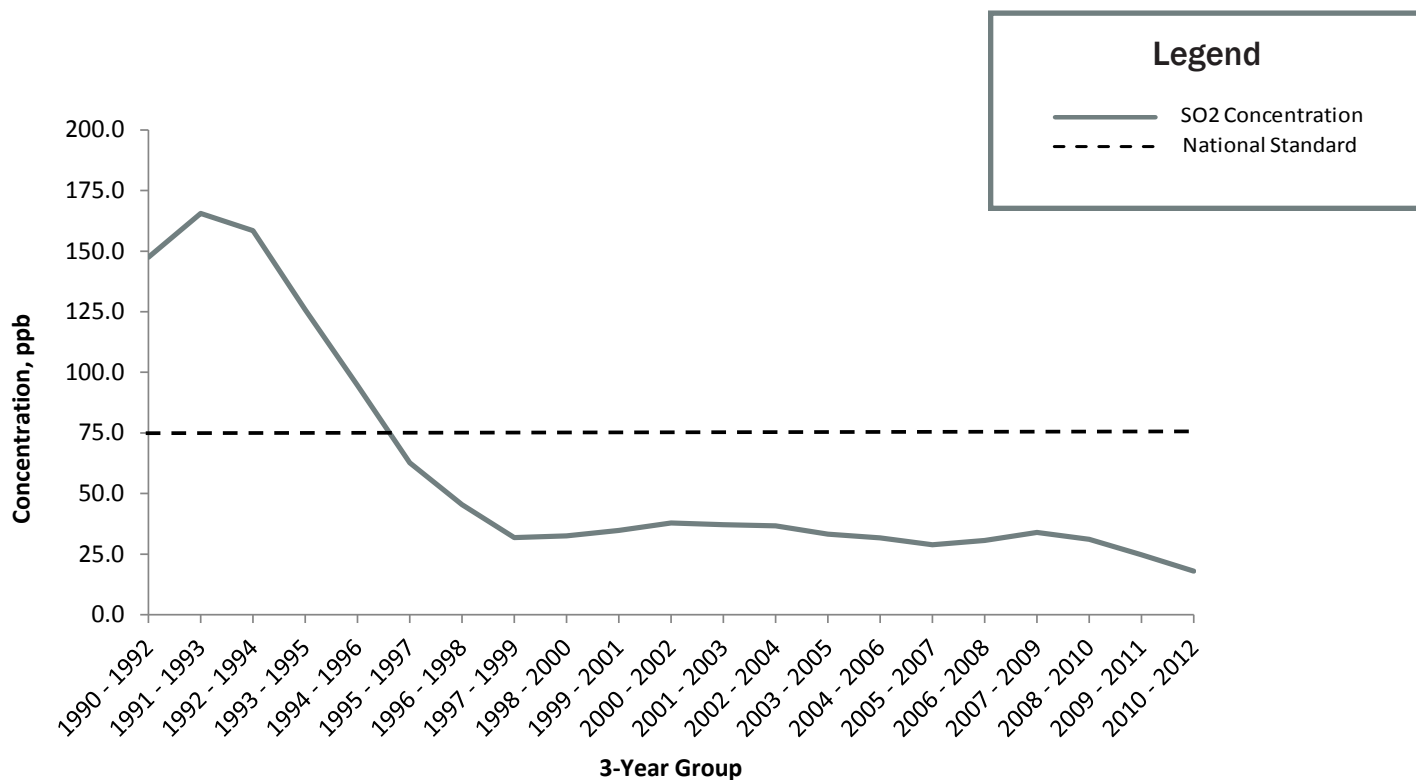
Source: U.S. Environmental Protection Agency. (2014, October 16). Particulate Matter. Retrieved on February 24, 2015 from <http://www.epa.gov/airtrends/pm.html>

Data generated by averaging all air monitoring stations along the Wasatch Front

SULFUR DIOXIDE

Sulfur dioxide (SO₂) is a gas that is released by burning fuels that contain sulfur such as coal, oil, natural gas, and wood.^[10] Along the Wasatch Front, SO₂ levels have decreased substantially since 1990, with the majority of the decline occurring during the mid-1990s (Figure 4). This decrease was largely due to improving the smelting processes and equipment of the Kennecott Copper Corporation.^[11] Since that time, SO₂ concentrations have remained steady and well below the national standard. See page 23 to learn more about SO₂.

Figure 4. Three-Year Average of the 99th Percentile of the Daily Maximum 1-Hour Average SO₂ Concentrations, Wasatch Front, Utah, 1990-2012



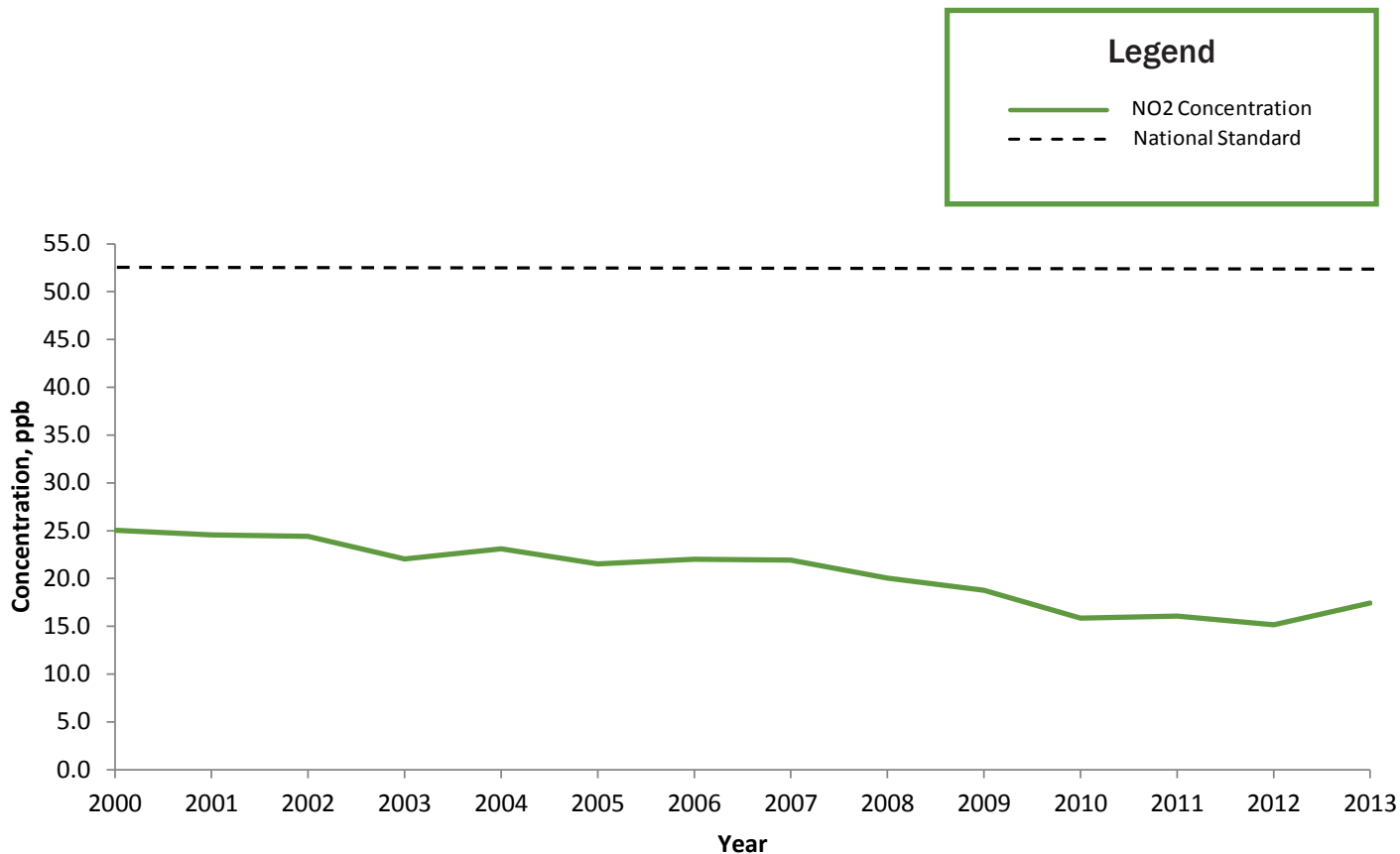
Source: Utah Department of Health. (2015, January 25). Sulfur Dioxide. Retrieved on February 24, 2015 from <http://health.utah.gov/utahair/pollutants/SO2/>

Data generated by averaging all air monitoring stations along the Wasatch Front

NITROGEN DIOXIDE

Nitrogen dioxide (NO₂) is a reddish-brown gas with a strong odor and is emitted into the air through combustion from vehicles, natural gas, wood burning, and power plants.^[12, 13] There are two primary standards for NO₂: 53 ppb averaged over one year (established in 1971), and 100 ppb averaged over one hour (established in 2010).^[3] Figure 5 shows NO₂ levels along the Wasatch Front have remained below the annual national standard. Additionally, there is no evidence of any violations of the hourly 100 ppb standard.^[14] See page 25 to learn more about NO₂.

Figure 5. Primary and Secondary Annual Average NO₂ ppb Concentrations, Wasatch Front, 2000-2013



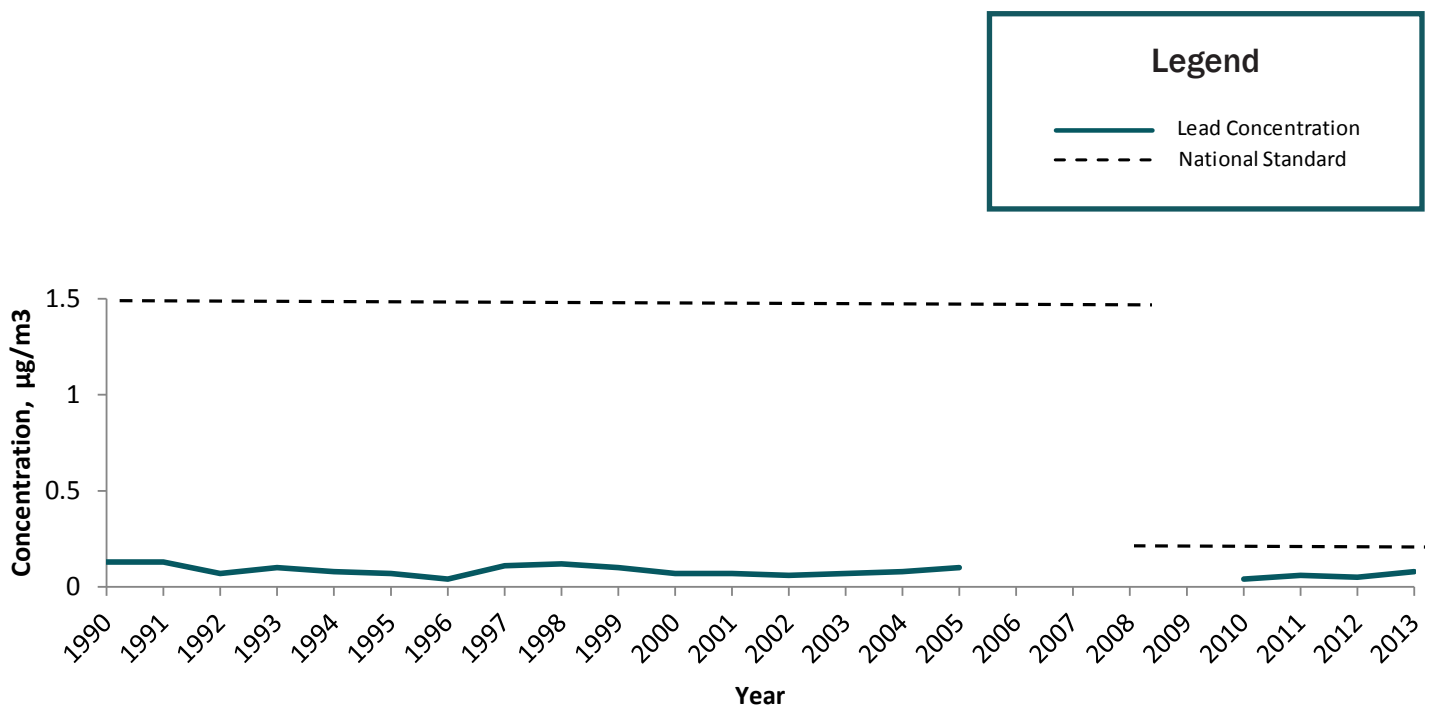
Source: Utah Department of Environmental Quality. (2014, April 28). AMC: Data Archive: NO₂. Retrieved on February 24, 2015 from <http://airmonitoring.utah.gov/dataarchive/archno2.htm>

Data generated by averaging all air monitoring stations along the Wasatch Front

LEAD

Lead is a metal that was once used in paint, gasoline, water pipes, and many other products.^[15] The primary and secondary standards for lead are $0.15 \mu\text{g}/\text{m}^3$, based on a rolling three month average.^[3] This level was enacted in 2008, prior to which the primary standard was $1.5 \mu\text{g}/\text{m}^3$.^[16] Between 1982 and 2005, the Utah Division of Air Quality monitored lead air levels along the Wasatch Front; no violations of the former national standards were measured. Lead monitoring was restarted with the 2008 revision of the national standards. Due to a lack of current air monitoring data, all areas in the state are currently designated as unclassifiable for lead.^[16] However, concentrations at the longest running lead monitor in Utah (located in Magna near the Kennecott smelter and refinery) have consistently been below the national standard (Figure 6). See page 27 to learn more about lead.

Figure 6. Concentrations of Lead per Cubic Meters of Air, Wasatch Front, Utah, 1990-2013



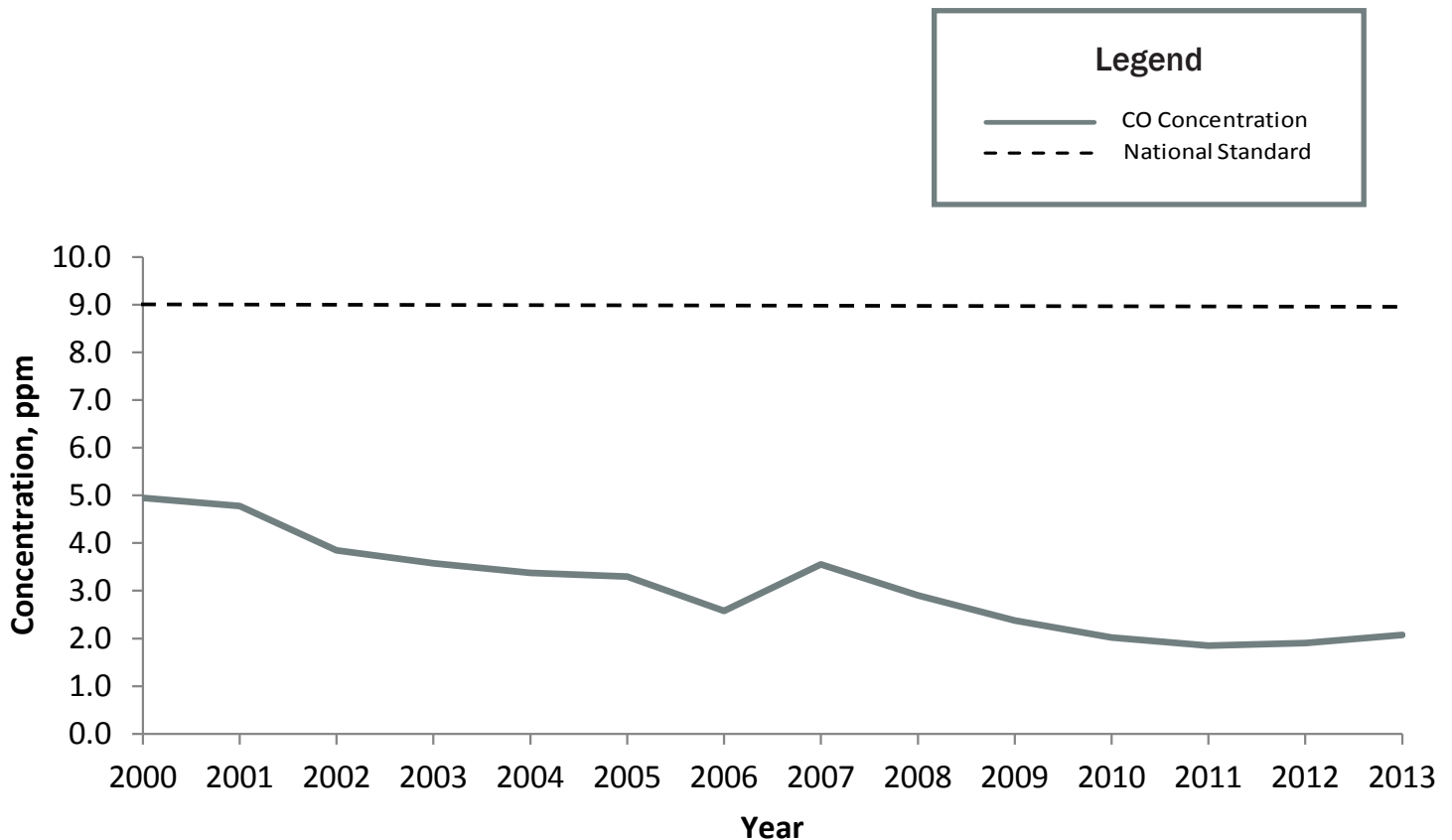
Source: U.S. Environmental Protection Agency. (2014, October 8). Lead. Retrieved on February 24, 2015 from <http://epa.gov/air/airtrends/lead.html>

Data generated by averaging all air monitoring stations along the Wasatch Front

CARBON MONOXIDE

Carbon monoxide is a colorless, odorless, and tasteless gas that is emitted into the air through burning things such as coal, natural gas, charcoal, kerosene and propane.^[17, 18] The primary standard for carbon monoxide is 9 ppm over an 8-hour period.^[3] There have been no carbon monoxide violations in Utah since 1993. Figure 7 shows that the concentration of carbon monoxide in the air has been decreasing along the Wasatch Front. See page 29 to learn more about carbon monoxide.

Figure 7. Second Highest 8-Hour Carbon Monoxide Concentrations, Wasatch Front, Utah, 1990-2013



Source: Utah Department of Health. (2015, January 30). Carbon Monoxide. Retrieved on February 24, 2015 from <http://health.utah.gov/utahair/pollutants/CO/>

Data generated by averaging all air monitoring stations along the Wasatch Front

AIR POLLUTANTS

Public health in Utah is affected by air pollution. A pollutant is anything that is harmful to humans, plants, or animals. Air pollutants in particular, usually are a result of human activity or industry. This section will discuss both indoor and outdoor air pollutants to which people are commonly exposed to. This section will discuss where each pollutant comes from, the negative health effect associated with the air pollutant, and ways to prevent exposure to the air pollutant. Data has been provided to demonstrate where a majority of the pollutants come from and where in the state exposure is likely to occur.

This section provides information about the following air pollutants:

- ✓ Ozone
- ✓ Particulate Matter
- ✓ Sulfur Dioxide
- ✓ Nitrogen Dioxide
- ✓ Lead
- ✓ Carbon Monoxide
- ✓ Radon
- ✓ Asbestos
- ✓ Environmental Tobacco Smoke





OZONE

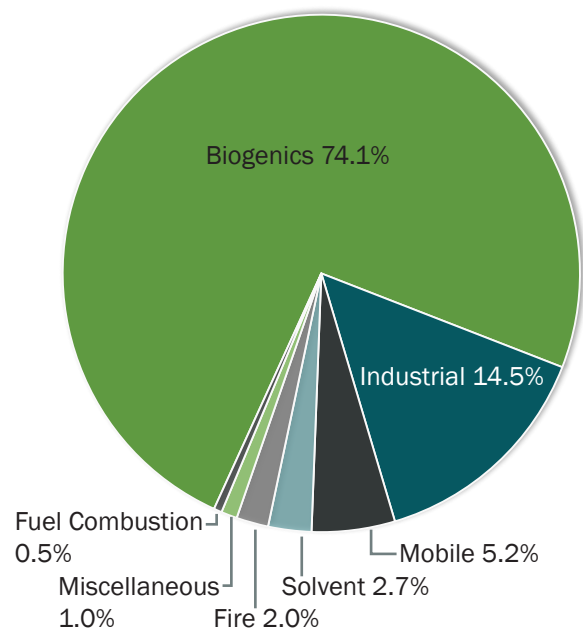
Ozone is a colorless gas that is present in two layers of the earth's atmosphere: the troposphere and the stratosphere.^[1] The layer of the atmosphere farthest from the earth's surface is called the stratosphere. The stratosphere starts about six miles up from the ground and extends to about 30 miles.^[2] The stratosphere contains a good form of ozone that shields the Earth from ultraviolet (UV) rays of the sun.^[3]

The troposphere is the layer closest to the earth. Ozone can be harmful when present in the troposphere. The bad version of ozone is a ground level air pollutant that is the main ingredient found in smog in urban areas.^[4] Ozone can damage vegetation, including crops and trees. When ozone enters the leaves of a plant, it restricts the ability of sensitive plants to produce and store food. It does visible damage to the leaves of trees in urban areas, national parks, and recreation areas.^[5]

There are two types of chemicals that form ground-level ozone: **volatile organic compounds** (VOCs) and nitrogen oxides (NOx).^[6]

VOCs are any compound of carbon whose structure makes it possible for them to evaporate under normal indoor atmospheric conditions of temperature and pressure.^[7] The solvents used in paints contain VOCs. VOCs are released by cars burning gasoline, petroleum refineries, chemical manufacturing plants, and other industrial facilities. NOx is a group of gases made up of nitrogen and oxygen that can cause acid rain. NOx can cause smog and is the reddish-brown color that can be seen in the atmosphere. NOx comes from power plant emissions and the burning of fuels such as gasoline, coal, wood, and oil.^[6]

Figure 1. Volatile Organic Compounds Emissions Sources, Utah, 2011



Source: U.S. Environmental Protection Agency. (2014, March 18). Air Emission Sources. Retrieved on February 12, 2015 from <http://epa.gov/air/emissions/>

SOURCES OF OZONE

The good ozone found in the stratosphere is produced naturally. However, man-made chemicals found in coolants, foaming agents, fire extinguishers, solvents, pesticides and aerosol propellants break down the good ozone. Once the chemicals are released into the atmosphere, they remain in the air and move through the troposphere until they reach the stratosphere. While in the stratosphere, the sun's UV rays break down the chemicals into chlorine and bromine molecules, which then destroys the good ozone.^[3] The VOCs and NOx chemicals react with the sunlight making ozone peak on calm summer days, typically in the middle of the day.^[4]

The bad ozone located in the troposphere is formed from sources such as cars, power plants, and chemical plants.^[8] About 50% of the "bad" ozone comes from motor vehicles, whereas about 34% comes from either industrial, commercial, or residential fuel combustion.^[2]

HEALTH EFFECTS OF OZONE

When the good ozone in the stratosphere slowly diminishes, it causes a negative effect on human health and the environment. Since the ozone in this layer of the atmosphere protects life from the sun's UV rays, this means that life is now becoming more exposed to UV radiation. More UV radiation means more cases of skin cancer, cataracts, and weakened immune systems. Over the past 14 years, melanoma (a fatal form of skin cancer caused by overexposure to UV radiation) has significantly increased in the United States.^[2] The UV rays can do damage to crops by harming photosynthesis. Overexposure to UV rays decreases size, productivity, and the quality in many of the crop plant species.^[9]

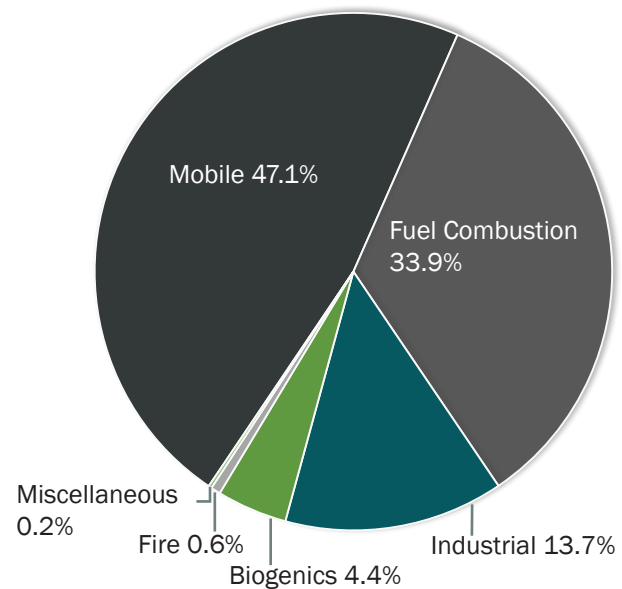
People who are at most risk from ozone exposure include children who spend a lot of time outside playing, people with asthma or lung disease, the elderly, adults who are active outside, and people with occupations that are generally outdoors, such as construction workers.^[4, 8]

Some health effects from exposure to ozone include irritation to the eyes, nose and throat, headaches, difficulty when taking deep breaths, chest pain, coughing, and congestion.^[1, 2] In addition, ozone can worsen bronchitis, emphysema, asthma, and heart disease.^[2, 10] For children, damage to the developing lungs can happen if a child continues to have short term exposures to ozone. Once the child reaches adulthood, he/she experiences decreasing lung function. Eventually symptoms will go away; however, ozone can continue to damage the lungs even when there are no more noticeable symptoms present.^[8] No matter how fit you are, ozone can have the same effect and reducing exposure can help protect you.^[1]

PREVENTION OF EXPOSURE

You can go to the Utah Department of Health's website at <http://health.utah.gov/utahair/> to check the Air Quality Index (AQI) in your area. The AQI can tell you if ozone levels are good or bad. There are simple ways to avoid unhealthy exposure if the air quality is bad. Since ozone is highest in the middle of the day during the summer months, you can avoid doing rigorous activities during that time. If that is the only time you have to exercise then choose more mild exercises like walking instead of vigorous activities like cycling, running, or hiking.^[8] Otherwise, working outside before 11 a.m. or after 8 p.m. can help minimize your ozone exposure.^[1]

Figure 2. Nitrogen Oxides Emissions Sources, Utah, 2011



Source: U.S. Environmental Protection Agency. (2014, March 18). Air Emission Sources. Retrieved on February 12, 2015 from <http://epa.gov/air/emissions/>

Figures 1. & 2.

VOCs and NOx are both precursor gases to ozone. These figures show a breakdown of all sources of the pollutant grouped into seven major categories. **Mobile** sources refer to highway automobiles and trucks, locomotives, and aircraft. **Industrial** sources refer to activities such as oil and gas production, cement manufacturing, chemical manufacturing, petroleum refineries, and mining. **Fuel Combustion** sources refer to the burning of oil, natural gas, wood, and coal. **Biogenics** refers to emissions that come from living sources, like vegetation and soil. **Fires** refer to emissions that come from wildfires, controlled burns, and agricultural burning. **Solvents** are chemicals that are used to dissolve other substances. They are used in various industries such as surface coating, dry cleaning, degreasing, as well as in consumer and household products. **Miscellaneous** refers to emissions from waste disposal, gas stations, and other activities.

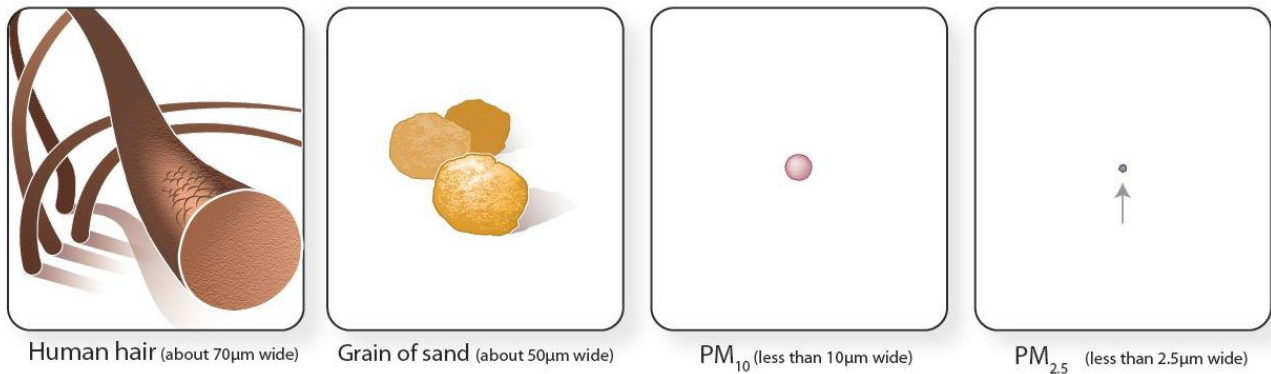
PARTICULATE MATTER

Particulate matter (PM) is an air pollutant composed of very small particles and liquid droplets.^[1] Some particles are big enough that you can see them, such as dust or dirt. Other particles are so small that they require a strong microscope to see.^[2] PM can be made up of acids (like nitrate or sulfate), organic chemicals, metals, soil, smoke, or dust particles. The size of PM is what can determine how hazardous it can be to your health. Any particles smaller than 10 micrometers (μm) in diameter can easily pass through the nose and enter the lungs without difficulty.^[1] A micrometer, or micron, is one thousand times smaller than a millimeter and one million times smaller than a meter.^[3]

Really fine particles that are smaller than 2.5 μm in diameter are called $\text{PM}_{2.5}$. To help understand how small this is, picture a single hair from a human head. The size of this hair is about 70 micrometers in diameter which is 30 times larger than the biggest fine particle.^[4] PM that is smaller than 10 μm but larger than 2.5 μm is known as PM_{10} .

The two particle sizes act different in the atmosphere. $\text{PM}_{2.5}$ can be airborne for long periods of time and travel several miles. PM_{10} , on the other hand, do not linger in the air as long and tend to land on the ground downwind from its releasing source.^[2]

Fine Particulate Matter Size Comparison



μm = micrometer

Source: Centers for Disease Control and Prevention, National Environmental Public Health Tracking Network. (2013, December 17). Health Impacts of Fine Particles in Air. Retrieved on April 22, 2015 from <http://ephtracking.cdc.gov/showAirHIA.action>

SOURCES OF PM

PM_{10} typically comes from mechanical grinding and the mixing of fluid and particles from a solid material. Examples of these are metals from suspended road dust and organic debris.^[5] They can simply be found by roadways and dusty industries.^[6] They are known as primary particles that are released directly into the air.^[2]

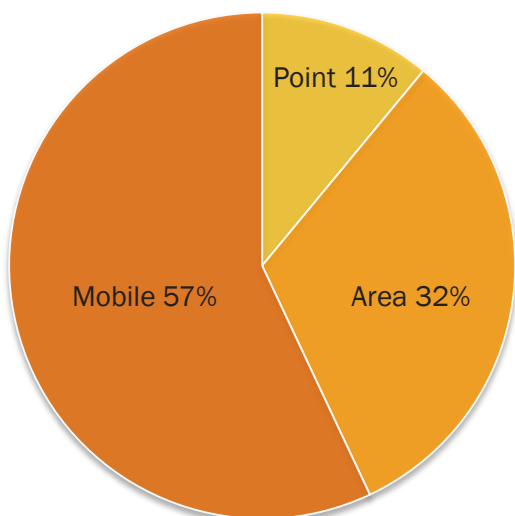
$\text{PM}_{2.5}$, also known as secondary particles, are commonly formed from combustion or photochemical reaction in the atmosphere. The reaction usually includes organic carbon, basic carbon, sulfate, nitrate, and metals.^[5] $\text{PM}_{2.5}$ can be found in smoke or haze and is released into the air from forest fires, gases from power plants, industries, vehicles, fireplaces, and wood burning stoves.^[6, 7] The particles can form from locations that are farther away from a source.^[2]

HEALTH EFFECTS OF PM

Smaller particles have more potential to trigger health problems. Those microscopic particles can go deep into the lungs and possibly enter the bloodstream.^[8] Once the particles enter the lungs, the airways become more narrow, creating more opportunity for small particles to stick to the airway walls.^[7] If small enough, the particles can reach the bloodstream via the alveoli of the lung (see Figure 1. Diagram of the Lung on page 41). Several scientific studies were able to associate PM exposure to a variety of health problems such as nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function, irritation to the airways, coughing, difficulty breathing, and premature death in heart or lung cancer patients.^[8] Those who are at the highest risk to exposure of PM are people who already have heart or lung disease, children, and the elderly.

Not only does PM affect health, but it affects the environment as well. All the pollution particles in the air create haze, which is caused when sunlight touches the particles. The pollutants can absorb and scatter the sunlight reducing our visibility.^[9] Not all haze is man-made (fuel burning, motor vehicle use, etc). Wind storms and forest fires also cause haze. The wind can blow the particles over long distances where they can settle. These particles make lakes and streams acidic, change the nutrient balance in bodies of water, and damage farm crops.^[10]

Figure 1. Sources of PM_{2.5} and PM_{2.5} Precursor Gases, Wasatch Front, Utah, 2008



Source: Utah Department of Environmental Quality. (2014, April 15). Emission Sources of Winter PM_{2.5}. Retrieved on April 22, 2015 from <http://www.deq.utah.gov/FactSheets/fspages/sources.htm>

Figure 1.

This chart shows the sources of PM_{2.5} and its precursor gases on a typical winter day along the Wasatch Front (consisting of Weber, Davis, Salt Lake, and Utah counties). Precursor gases are pollutants that chemically react in the atmosphere and end up forming PM_{2.5}. The precursor gases included in this graph are NO_x, SO_x, and VOCs. *Mobile* sources refer to highway automobile and trucks, locomotives, and aircraft. *Point* sources refer to facilities that release large amounts of air pollution. This includes sources such as power plants, industrial manufacturing, and heating. *Area* sources are similar to point sources, but they are too small and numerous to be considered separately. Area sources include small industries, residential heating, gas stations, pesticides, and dry cleaners. As this graph shows, the majority of PM_{2.5} and PM_{2.5} precursor gases come from mobile sources.

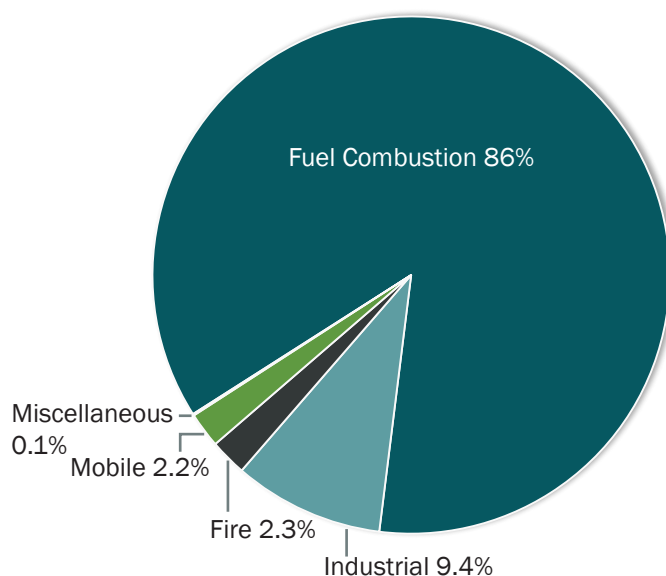
SULFUR DIOXIDE

Sulfur dioxide (SO_2) is a gas that is released by burning fuels that contain sulfur. The most common types of those fuels are coal, oil, natural gas, and wood, which are all used in modern industrial processes. SO_2 has a sharp, rotten odor.^[1] Even though sulfur-containing fuels are used every day, SO_2 is an environmental concern because it directly contributes to creating acid rain. When SO_2 is present in the air, it dissolves easily into water droplets. The resulting reaction with the water droplets in the air produces acid rain.^[1, 2]

Figure 1.

A chart showing the major sources of sulfur dioxide. *Fuel Combustion* sources refer to the burning of oil, natural gas, wood, and coal. *Industrial* sources refer to activities such as oil and gas production, cement manufacturing, chemical manufacturing, petroleum refineries, and mining. *Fires* refer to emissions that come from wildfires, controlled burns, and agricultural burning. *Mobile* sources refer to highway automobiles and trucks, locomotives, and aircraft. *Miscellaneous* refers to emissions from waste disposal, gas stations, and other activities.

Figure 1. Sulfur Dioxide Compounds Emissions Sources, Utah, 2011



Source: U.S. Environmental Protection Agency. (2014, March 18). Air Emission Sources. Retrieved on February 12, 2015 from <http://epa.gov/air/emissions/>

SOURCES OF SULFUR DIOXIDE

While SO_2 comes from both natural and man-made sources, human activity is responsible for the majority of SO_2 that is released into the air. The main source of SO_2 is power plants that burn fossil fuels to generate electricity.^[1, 3] In 2011, power plants accounted for 73% of all SO_2 emissions in Utah.^[4] Other industrial processes that are a part of everyday life release SO_2 too, although in much lower quantities. Those processes include copper smelting, chemical manufacturing, petroleum refineries, and cement manufacturing. An even smaller portion of SO_2 is released through natural processes such as wildfires and volcanic eruptions.^[1, 3]



HEALTH EFFECTS OF SO₂

When air that contains SO₂ is inhaled, SO₂ is absorbed by the body and enters the bloodstream.^[1] The main health effect caused by SO₂ is called **bronchoconstriction**.^[1, 5] Bronchoconstriction means that the airways to the lung become narrower and less air can get into the lungs. The results are asthma-like symptoms such as shortness of breath, chest tightness, wheezing, and coughing.^[1, 5] On a community level, there is a link between SO₂ exposure and more hospitalizations and emergency department visits due to respiratory issues.^[5] In general, the severity of symptoms depends on how much SO₂ a person is exposed to and how long that exposure lasts. Even though nobody is immune from the effects of SO₂, symptoms can be worse in children, the elderly, and people with existing health conditions like asthma, cardiovascular disease, and lung disease.^[1, 5] Being exposed to very high levels of SO₂ over a short period of time can be fatal.

Aside from the health effects of SO₂, SO₂ can interact with other particles in the air to form even smaller particles.^[1] The smaller particles can go deep inside the lungs and cause respiratory disease or make existing respiratory disease even worse.^[5] SO₂ is not known to cause cancer.^[1]

PREVENTION OF EXPOSURE

The most common way to be exposed to SO₂ is by breathing in air that contains SO₂. People who live near industries that emit SO₂ are more likely to be exposed. In this situation, the best way to prevent exposure is to reduce outdoor activity on days with poor air quality.^[1] To help protect people's health, the Environmental Protection Agency (EPA) enforces air quality standards that limit the amount of SO₂ emissions. The current air quality standard for SO₂, established in 2010, is 75 parts per billion (ppb) averaged over one hour.^[6] In the Wasatch Front area of Utah, SO₂ levels have been declining since 1990 and have remained far below the 75 ppb air quality standard for many years.^[7] People who work in industries that emit SO₂ are more likely to be exposed as well. To protect workers in these industries, the Occupational Safety and Health Administration (OSHA) sets strict guidelines pertaining to how much workers are allowed to be exposed to SO₂.



NITROGEN OXIDES

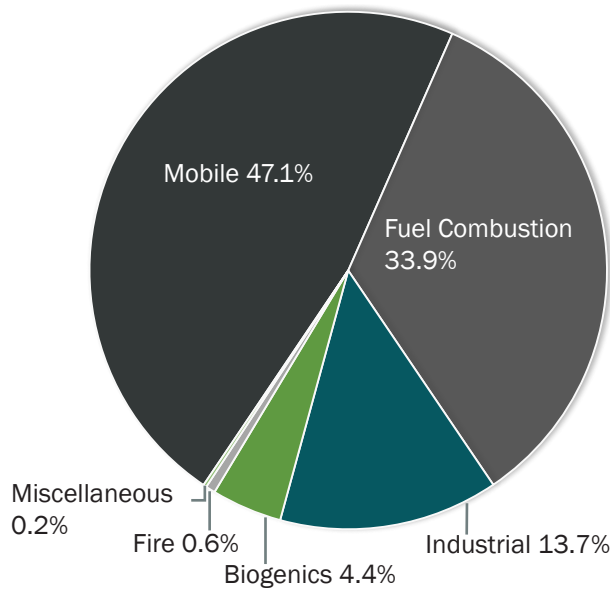
Nitrogen oxides (NO_x) are a group of highly reactive gases that include nitrogen dioxide (NO₂), nitric oxide, and nitrous oxide. NO₂ is the most common of the nitrogen oxides that contributes to the formation of ground-level ozone.^[1] NO₂ is one of the major components of smog because it absorbs light and leads to the yellow-brown haze sometimes seen over cities. NO₂ is a reddish-brown gas with a strong odor and remains in the environment up to seven days.^[2] The Environmental Protection Agency (EPA) monitors the air quality and the concentrations of NO₂ throughout the country to ensure that levels protect the public and the environment. The EPA has documented a significant national trend of decreasing NO₂ concentrations.^[3]

Nitric oxide has no color, odor, or taste and is not as toxic as NO₂. Once nitric oxide is released into the air, it quickly combines with oxygen to form NO₂. Nitrous oxide is a colorless gas that has a slightly sweet smell. It is nontoxic and occurs naturally in the air. The man-made version of nitrous oxide is used as an anesthetic known as laughing gas. Of all the nitrogen oxides emitted into the air, the majority is nitric oxide and some is nitrous oxide. A very small percentage is NO₂.^[2]

SOURCES OF NITROGEN OXIDES

Nitrogen oxide emissions occur naturally through the growth and decay of plants and animals, lightning, and forest and grassland fires. However, the primary source of nitrogen oxides is produced by man's activities from the burning of fossil fuels. NO₂ varies in amount emitted with the temperature of combustion; as temperature increases so does the level of NO₂.^[2] NO₂ forms quickly from emissions from cars, trucks, buses, power plants, and off-road equipment. NO₂ can be found in the home through fuel combustion, like wood burning and natural gas.^[4] Agriculture plays a role in the emission of nitrogen oxides because fertilizers emit nitrous oxide into the atmosphere.^[2]

Figure 1. Nitrogen Oxides Emissions Sources, Utah, 2011



Source: U.S. Environmental Protection Agency. (2014, March 18). Air Emission Sources. Retrieved on February 12, 2015 from <http://epa.gov/air/emissions/>

Figure 1.

NO_x is a precursor gas to ozone. This figure shows a breakdown of all sources of the pollutant grouped into seven major categories. *Mobile* sources refer to highway automobiles and trucks, locomotives, and aircraft. *Fuel Combustion* sources refer to the burning of oil, natural gas, wood, and coal. *Industrial* sources refer to activities such as oil and gas production, cement manufacturing, chemical manufacturing, petroleum refineries, and mining. *Biogenics* refers to emissions that come from living sources, like vegetation and soil. *Fires* refer to emissions that come from wildfires, controlled burns, and agricultural burning. *Miscellaneous* refers to emissions from waste disposal, gas stations, and other activities.

HEALTH EFFECTS OF NO_x

Nitrogen oxides react with ammonia, moisture, and other compounds in the air to form small particles that penetrate deeply into sensitive parts of the lungs. This can cause or respiratory disease or worsen existing conditions such as emphysema and bronchitis. Nitrogen oxides can make existing heart disease worse.^[5] People most at risk are the elderly, children, people with lung disease, and people who are often around roadways. The negative health effects include a decrease in lung function and an increase in respiratory symptoms and respiratory-related emergency department visits, hospital admissions, and possibly premature death.^[5]

Studies show scientific evidence that links short term NO₂ exposures to negative respiratory effects, such as inflammation of the airways in healthy people and increased respiratory symptoms in people with asthma.^[5, 6] The short term exposure to NO₂ can range from 30 minutes to 24 hours.^[5] NO₂ causes irritation to the eyes, nose, and throat. Long term exposure to NO₂ can contribute to the development of acute or chronic bronchitis.^[6]

PREVENTION OF EXPOSURE

A single person cannot entirely eliminate the risk of exposure to NO_x; however, there are several ways to limit one's exposure to NO_x. When at the home, individuals can use low-nitrogen fuels such as natural gas, which can emit 60% less NO_x than coal.^[7] Gas stoves, heaters, and dryers should be properly vented to the outside. Individuals should avoid breathing in air near high traffic areas with idling vehicles.^[8]



LEAD POISONING

Lead is a metal that was once used in paint, gasoline, water pipes, and many other products. Lead was removed from these products once it was discovered to be very dangerous.^[1] In 1978, lead-based paint was banned for use in housing.^[2] However, there are still a number of ways to be exposed to lead. Even though lead is no longer added to these products, the removal of lead did not eliminate the hazard that is still at risk with the existing paint, plumbing systems, and lead contaminated soil and dust.^[3] Lead is still considered a criteria pollutant because there are still emissions from lead smelters and aircraft operating on leaded aviation gasoline.^[4]

SOURCES OF LEAD

People are exposed to lead from lead-based paint, contaminated soil, dust, drinking water, and contaminated air.^[1] All houses built before 1978 are expected to contain some lead-based paint.^[2] The most common source of lead exposure occurs at the home when lead-based paint begins to deteriorate, peel, or is disturbed by either scraping or sanding. When this happens, it produces dust containing lead. If inhaled or swallowed, even the smallest particle can be dangerous. Exterior paint used on houses is higher in lead content than paint used inside. Exterior paint can become accessible indoors through windowsills. The lead particles from the paint flake off and settle on the windowsills and people are poisoned by inhaling and ingesting these particles.^[3]

Lead is found in outdoor air from vehicles containing leaded gasoline or industrial sources such as smelters, waste incinerators, and lead-acid battery manufacturers. Once it is released into the air, lead can travel long distances before settling on the ground and sticking to soil particles. Depending on the type of lead compound, lead can enter into groundwater from the soil.^[5]

PREVENTION OF LEAD POISONING

Lead poisoning is most common in children and people exposed to lead at their job. Determine when your house was built; where your child spends most of their time is important. If your house was built before 1978, talk to your local health department about testing paint and dust for lead. If the house tests positive for lead, there are some things you can do to decrease exposure to lead:

- Make sure your child does not have access to paint that is peeling or surfaces they can reach with lead-based paint.
- If your house is being renovated, make sure pregnant women and children are not present.
- Wash children's hands and toys often.
- Regularly wet-mop floors and wet-wipe window sills instead of sweeping or dusting because dust is a major source of lead.^[2]
- Do not remove lead by yourself. Instead, find a qualified lead abatement professional to come and remove it.^[3]

Another form of prevention is to eat right. Children who get enough iron and calcium will absorb less lead. Foods that are high in iron include eggs, red meats, and beans. Foods that are high in calcium are dairy products, dark green vegetables, seeds, and nuts.^[4]



HEALTH EFFECTS IN CHILDREN

Lead poisoning was once focused on adults exposed to high doses while working in industrial settings. Now, the focus on lead poisoning has shifted to children who are exposed to low doses who experience no symptoms.^[7] Lead poisoning is known for mainly affecting children's development. However, lead can affect virtually all systems within the body. Blood lead levels at low levels can harm mental and physical development, lowering IQ levels, shortening attention spans, and increasing behavioral problems. At high levels, lead can cause convulsions, coma, and even death.^[1]

Typically, low doses of lead have no symptoms. The highest accepted threshold for lead in children is 60 micrograms per deciliter ($\mu\text{g}/\text{dl}$). If there are blood lead levels greater than 60 $\mu\text{g}/\text{dl}$, symptoms become more noticeable in children. Common early complaints are abdominal pain, joint pain, clumsiness, headaches, and behavioral changes.^[7]

Children are more prone to lead poisoning than adults for many reasons. First of all, their exposure is increased because they are more likely to put lead-contaminated objects, including their own hands after handling lead dust, into their mouths.^[1, 7] Second, children's intestinal tracts absorb lead easier than the intestinal tracts of adults. Finally, a child's central nervous system is still developing, making it more susceptible to toxins than a mature central nervous system.^[7]

HEALTH EFFECTS IN ADULTS

Although children seem to be the main focus with lead poisoning, adults can be affected as well. Lead can affect the peripheral and central nervous systems, the kidneys, and blood pressure.^[7] People who are experiencing peripheral and central nervous system issues have symptoms such as motor clumsiness, clouded consciousness, weakness, and paralysis. Those effects are typically caused from an occupational exposure to lead.

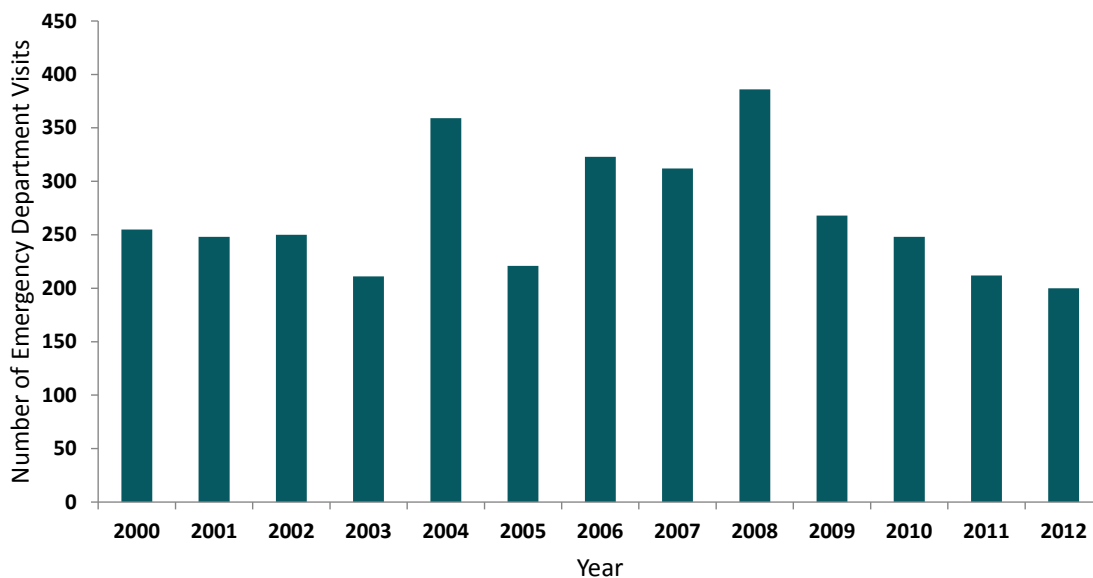
Acute lead poisoning has been known to be associated with hypertension, heart disease, and renal failure.^[7, 8] Lead has adverse effects on the male and female reproductive systems. In males, lead can decrease sperm counts. Studies have proven that lead can increase the risk of stillbirths, neonatal deaths, and decrease the fertility rate in women.^[7] Keep in mind; those studies were done in the 19th century with factory workers in the ceramic industry. The majority of women are not exposed to such high levels of lead except for in certain occupational settings.^[7]



CARBON MONOXIDE

Carbon monoxide (CO) is a colorless, odorless and tasteless gas.^[1] The term “CO poisoning” refers to inhaling CO. While CO poisoning poses its greatest threat when it gets trapped inside homes or other enclosed spaces, under certain circumstances, CO poisoning can also happen outside if a person is near a strong source of CO.^[2]

Figure 1. Number of Emergency Department Visits due to Carbon Monoxide Poisoning, by Year, Utah, 2000-2012



Source: Utah Department of Health, Bureau of Emergency Medical Services, Emergency Department Encounter Database. (2015, January 22). Retrieved on April 22, 2015 from Utah Department of Health, Center for Health Data, Indicator-Based Information System for Public Health website at <http://ibis.health.utah.gov>

HEALTH EFFECTS OF CARBON MONOXIDE

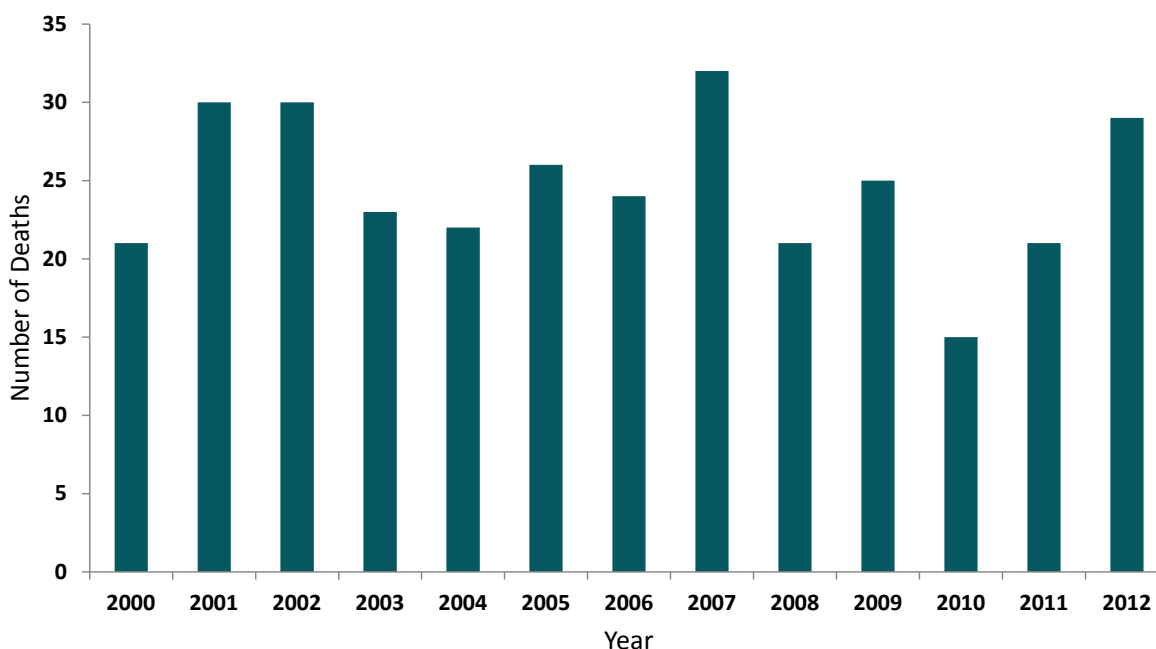
When you breathe, oxygen in the air binds to red blood cells, which then transport the oxygen around the body. However, when CO is present in the air, the CO binds to the red blood cells much faster than oxygen. When high levels of CO are inhaled, there are fewer red blood cells that are able to transport oxygen to the body. When the body does not receive enough oxygen, cells and body tissue begin to die.^[3]

The severity of symptoms depends on how much CO a person is exposed to and how long that exposure lasts. Low levels of CO exposure can result in headaches, nausea, vomiting, dizziness, fatigue, and shortness of breath. Because the symptoms are similar to other illnesses, such as the flu, it is possible to misdiagnose CO poisoning.^[1, 4] Medium levels of exposure can result in vision impairment, confusion, and loss of consciousness.^[1, 4] At high levels of exposure, CO poisoning can rapidly lead to death.^[3, 4] Nobody is immune to CO poisoning, but certain people, such as infants and people with heart disease, respiratory problems, or **anemia**, are more vulnerable to its effects.^[3] Figure 1 shows an average of 317 people who visited the emergency department due to CO poisoning during the years 2000 to 2012. Figure 2 shows an average of 24 people who died from CO poisoning every year from 2000 to 2012.^[5, 6]

SOURCES OF CARBON MONOXIDE

CO is produced when fuels that contain carbon are not completely burned, such as coal, natural gas, charcoal, kerosene, and propane.^[1, 3] Any appliance that requires fuel to operate can release CO, and many of those appliances are common household items: furnaces, water heaters, portable generators, automobiles, gas space heaters, lawn mowers, fireplaces, gas ranges, and wood stoves.^[1, 3] If those types of appliances are not properly used, maintained, or vented, CO levels can rise.^[4]

Figure 2. Number of Deaths due to Carbon Monoxide Poisoning, by Year, Utah, 2000-2012



Source: Utah Department of Health, Bureau of Emergency Medical Services, Emergency Department Encounter Database. (2015, April 8). Retrieved on June 22, 2015 from Utah Department of Health, Center for Health Data, Indicator-Based Information System for Public Health website at <http://ibis.health.utah.gov>

PREVENTION OF EXPOSURE

The best way to prevent CO poisoning is to properly use appliances that burn fuel. Those appliances should be examined every year by a qualified professional to make sure they are working properly and are not leaking CO.^[4, 7] Do not use portable fuel-burning appliances in enclosed spaces, such as a garage, shed, tent, or home.^[4] Even if you are using an appliance for a short period of time, CO can build up in the enclosed space and harm your health.

Even with the best prevention efforts, sometimes CO can still leak into your house. To further prevent CO poisoning, install CO detectors in your home. The detector will sound an alarm if CO levels get too high, which is especially important if you are sleeping. Place one detector outside each sleeping area.^[4] In Utah, one in five households report that they do not have a CO detector. CO detectors are an inexpensive way to save lives. When selecting a detector for purchase, choose one that can run on backup battery power.^[7] If the power in your house goes out, the detector becomes useless unless there is another source of power. Do not use a CO detector as an excuse to not properly maintain fuel-burning appliances.^[4, 7]

If there is a possibility of CO poisoning or a CO detector alarm sounds, and anyone in your home ever experiences headaches, nausea, vomiting, dizziness, fatigue, or shortness of breath, move to fresh air immediately. Once everyone has safely moved to fresh air, make sure no one is experiencing symptoms of CO poisoning. If there are any symptoms, call 911 to seek urgent medical attention. If everyone is okay, ventilate the house and turn off any fuel-burning appliances. Call a qualified technician to inspect and correct the CO leak.^[4, 7]



RADON

Radon is a colorless, odorless, and radioactive gas. Radon breaks down and can attach to dust and other particles that can be breathed into the lungs. Radon gives off a form of high-energy radiation that can damage DNA inside the cells of the body as it breaks down.^[1]

SOURCES OF RADON

Uranium is a radioactive element that occurs naturally in the soil. When uranium decays, it produces a radioactive gas called radon. Outside air naturally has small amounts of radon, but its biggest threat is when radon gets trapped inside homes and buildings. As radon gets trapped inside, radon air concentration increases, increasing the risk of lung cancer.^[2, 3]

Radon is not a region-specific or state-specific problem (see Figure 1). The best way to prevent exposure to radon is to properly test your home or building. Even though underlying geologic factors play a role in radon risk, an individual's home plays the greatest role in radon exposure. People living in a basement, an older home, or homes with a walk-in or encapsulated basement have a higher risk of radon exposure.^[4]

HEALTH EFFECTS OF RADON

Radon is the leading cause of lung cancer in nonsmokers; about 15,000 to 22,000 deaths of radon-induced lung cancer occur each year in the United States.^[5, 6] People who smoke and who are exposed to radon face an even higher risk of lung cancer than from either radon or smoking alone. If you do smoke, you can reduce your risk of lung cancer from radon by quitting.^[6, 7]

PREVENTION OF EXPOSURE

Because radon has no color, odor, or taste, the only way to be certain of its presence in your home or building is through proper testing. In Utah, 80% of people reported that they have never tested their home for radon.^[4] The most common way to test for radon is the short-term, self-administered test. The test lasts between 48 to 96 hours and tests results are returned within one to two weeks. Test kits can be purchased through the Utah Department of Environmental Quality Radon website (www.radon.utah.gov) or at home improvement stores. After properly following the test instructions, the kit is sent to a laboratory for analysis. Long-term tests (90 to 365 days) provide a more complete view of radon levels in your home or building.

The U.S. Environmental Protection Agency (EPA) established 4 picocuries per liter (pCi/L) as the action threshold for radon levels in homes. If your home or building measures 4 pCi/L or above, you should take prompt action to lower radon levels.^[8] Even though 4 pCi/L is the common action threshold, any radon level is harmful to human health.^[7] If test results are above 4 pCi/L, take action to reduce the problem. Taking action usually requires making some sort of home renovation to remove radon before it can get into your home. A common method is a vent pipe system and a fan. As radon rises beneath the foundation of a house, the pipe and fan expel the radon outside the house before it gets trapped inside. Contact a certified radon mitigator in your area to discuss options and to ensure quality work. The Utah Department of Radiation Control provides a list and other information on their website at www.radon.utah.gov.

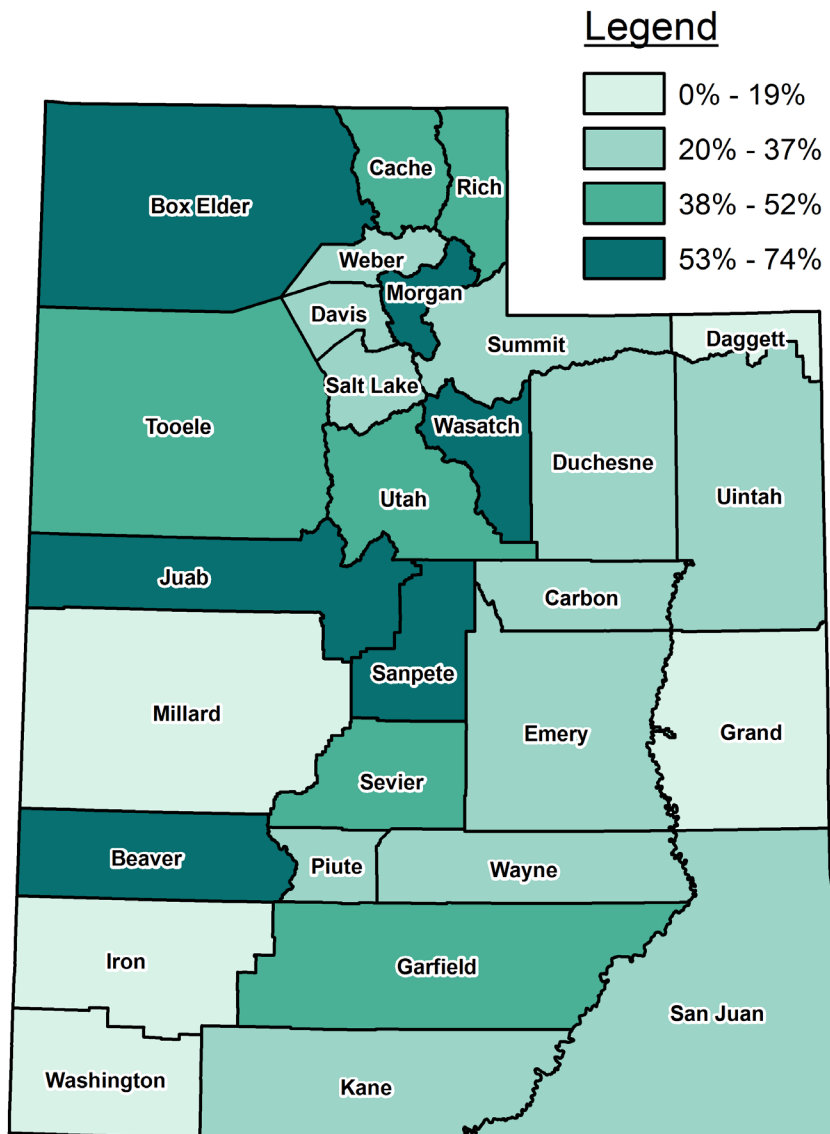


Figure 1. Percent of all Radon Home Tests above 4.0 pCi/L, by County, Utah, 1992-2013

Figure 1.

This map shows the percentage of tests for Radon where the results were above 4 pCi/L.

Source: Utah Department of Environmental Quality, Utah Radon Program. (2015). Test Results by ZIP Code. Retrieved on March 6, 2015 from <http://radon.utah.gov>



ASBESTOS

Asbestos is a fibrous mineral that is naturally found in rock and soil. It is great for sound absorption and can resist heat and corrosion. It is known for its strength and affordability.^[1] Asbestos can come in different shapes and colors. Because it is known to cause cancer, the commercial use of asbestos has significantly declined since the late 1970's. In 1989, the Environmental Protection Agency (EPA) banned most asbestos-containing products.^[2]

SOURCES OF ASBESTOS

Asbestos has been used in over 3,000 different products like roofing materials, attic and wall insulation, floor tiles, brake pads, and cement water pipes.^[1, 3] Once the asbestos-containing material is disturbed, it releases airborne asbestos fibers making it dangerous for people who live or work in those buildings; especially if inhaled over a period of time.^[1] The majority of the people affected by asbestos are construction insulation workers, miners, millers, and factory workers.^[4]

Exposure to asbestos can also come from drinking water. Cement water pipes that contain asbestos can decay and release asbestos into the public's drinking water. Fortunately, the Safe Drinking Water Act "requires the Environmental Protection Agency (EPA) to determine the level of contaminants in drinking water at which no adverse health effects are likely to occur."^[4] Routine public water well monitoring helps identify high levels of asbestos. Water suppliers must now take steps to decrease the amount of asbestos to acceptable levels.^[4]

Having experts regularly check the water's source and quality before the water is consumed is important for people who get their drinking water from a private well. Contact your local health department or public water system for more information.^[4]

HEALTH EFFECTS OF ASBESTOS

Exposure to asbestos fibers has the potential to cause cancer and asbestosis.^[5] These diseases can take several years to develop, even after the exposure has been removed. Diagnosis of asbestos-caused diseases can be very difficult. Health care providers often have to look into the person's medical, work, cultural and environmental history. Once an asbestos-related health condition is identified, usually a physical examination, chest x-ray, or pulmonary function test is done in order to confirm it was caused by exposure to asbestos.^[3]

The EPA has stated that asbestos is a proven human **carcinogen**, meaning it can cause cancer. There are several different types of cancer that can be caused by asbestos; however, the two most common cancers are **mesothelioma** and lung cancer. Mesothelioma is a tumor that occurs in the pleura, which is the space between the outside of the lungs and the chest cavity.^[6] Symptoms of mesothelioma include difficulty breathing or shortness of breath and chest pain. The fatality rate is extremely high.^[4]

Other types of cancer that are caused from exposure to asbestos are cancer of the larynx, gastrointestinal tract, and kidney. It is difficult to differentiate between lung cancers caused by asbestos or lung cancers caused by cigarette smoking or other agents. That being said, lung cancer is the most common type of cancer that causes death.^[5]

Another health effect from asbestos is called asbestosis. This is a long-term lung disease that is not a cancer.^[3] Asbestosis is scarring or thickening of the lungs caused by asbestos dust.^[5] The symptoms include shortness of breath and dry cough. Studies show that asbestosis is developed after long exposure to asbestos. Asbestosis is usually seen in workers who are exposed to high levels of asbestos for many years.^[7] Asbestos fibers can remain in the lungs for a long time and the thickening of the lungs can continue to develop for several years after exposure stops.^[5] Furthermore, cigarette smoke has been proven to increase the progression of asbestosis.^[7]

ASBESTOS IN THE HOME

Unless the material in your home is labeled, you cannot tell whether it contains asbestos or not. If you are unsure, it is best to leave the material alone and have a trained, accredited asbestos professional inspect and test the material before disturbing it. This applies to any remodeling or damaged material in the home. If there are asbestos-containing materials inside the home that are not damaged or won't be disturbed, then they are safe to remain in the home.^[8]





ENVIRONMENTAL TOBACCO SMOKE

Environmental tobacco smoke, or secondhand smoke, is the inhalation of tobacco smoke by nonsmokers. In addition to the smoke inhaled by the smoker, the burning cigarette emits smoke as well as smoke exhaled from the smoker.^[1] This includes smoke from regular cigarettes, hand-rolled cigarettes, marijuana, pipes, and cigars. It is the most hazardous form of indoor air pollution and is the third leading cause of preventable deaths.^[2] Secondhand smoke is a cancer-causing agent that may be twice as dangerous as radon gas and more than a hundred times as hazardous as outdoor air pollutants which are regulated by federal law.^[2] All secondhand smoke is bad; there is no risk-free level of exposure to secondhand smoke.^[3]

Most exposure to secondhand smoke happens in homes and workplaces. It can occur in places like multiunit housing, personal vehicles, bars, and casinos.^[4] The particles in the air from secondhand smoke can linger in the air for hours exposing more people. Another health concern is the smoke residue that sticks to a smoker's hair, clothing, carpet, and cushions. The residue can pose health risks as well and is known as thirdhand smoke.^[5] Thirdhand smoke can combine with common indoor pollutants to create cancer-causing elements that aren't found in fresh smoke from the cigarette. Researchers are still studying the possible dangers of thirdhand smoke.^[6]

SOURCES OF SECONDHAND SMOKE

A smoker inhales mainstream smoke, which is the smoke directly inhaled from the cigarette. Sidestream smoke is the smoke that is emitted from a burning cigarette and breathed in by everyone else, including the smoker. This sidestream smoke is dirtier and contains more tar and nicotine than the mainstream smoke.^[2] It contains hundreds of chemicals known to be toxic or cause cancer. Some of those toxins include formaldehyde, benzene, vinyl chloride, arsenic ammonia, lead, and carbon monoxide.^[2, 5, 7] Because sidestream smoke contains particles that are small, the air pollutant can reach deeper into the lungs.

HEALTH EFFECTS OF SECONDHAND SMOKE

There are over 4,000 chemicals in secondhand smoke and more than 50 of these chemicals can cause cancer.^[8] According to the Centers for Disease Control and Prevention (CDC), secondhand smoke causes about 34,000 heart disease deaths and 7,300 lung cancer deaths every year.^[9] Secondhand smoke can cause cardiovascular disease and lung cancer in adults who have never smoked before.^[2, 4] As for pregnant women, secondhand smoke increases the risk of low birth weight.^[10]

Children are more at risk for the effects of secondhand smoke because their bodies are still growing and they breathe at a faster rate than adults.^[9] Some possible health effects for children include ear infections, chronic cough, more severe and frequent asthma attacks, respiratory symptoms, respiratory infections, and sudden infant death syndrome (SIDS).^[2, 4, 9] Older children who live with parents who smoke have less developed lungs and get more bronchitis and pneumonia than children who do not breathe secondhand smoke.^[10] In Utah, 98% of children live in smoke-free homes; however, almost 14,800 of those children still breathe secondhand smoke in their homes.^[8]

PREVENTION OF EXPOSURE

For many, avoiding secondhand smoke is as simple as avoiding people who smoke. However, this may not be so simple for those who live or work with people who smoke. Trying to convince or help someone quit smoking can definitely aid in the prevention of secondhand smoke exposure. The home is the most important place to keep smoke free, especially if there are children present. Anyone who decides to smoke should smoke outside and far away from people.^[9] Other ways to prevent secondhand smoke exposure include choosing smoke-free facilities or insisting that smoking restrictions be enforced at work.^[5]



HEALTH EFFECTS

The environment affects our health both directly and indirectly. No one is resistant to environmental health threats. Individual health cannot be separated from that of the environment in which we live. Exposure to air pollution can have an impact on many different aspects of health. Affected systems include the respiratory, pulmonary, cardiovascular and reproductive systems. This section will discuss the negative health effects associated with air pollution and ways to help prevent adverse health effects.

This section provides information about the following health effects:

- ✓ Asthma
- ✓ Chronic Obstructive Pulmonary Disease
- ✓ Bronchitis
- ✓ Emphysema
- ✓ Cardiovascular Disease
- ✓ Renal Disease
- ✓ Birth Outcomes



ASTHMA

Asthma is a common disease that affects the airways. When a person with asthma is exposed to a trigger, which is anything that can cause them to have an asthma attack or symptom, the airways inflame and excess mucus is released.^[1] The results are lung irritation, coughing, wheezing, chest tightness, and difficulty breathing.^[1, 2] Some other triggers include cigarette smoke, air pollution, vapors, fumes, medications, emotions, upper respiratory tract infections, the weather and physical activity. A trigger can be an allergen that irritates the lungs and causes a person to have an allergic reaction. The most common allergen triggers are pollen, grass, mold, secondhand smoke, and animal dander.^[2, 3]

During an asthma attack, it takes a lot more effort to push air through the airways because they are inflamed and swollen. It requires the use of different muscles surrounding the neck, shoulders, and ribs. With all this extra work, it can cause exhaustion and irritation to the airways. It is common to hear wheezing or whistling sounds as the person breathes. If left untreated, the airways will continue to constrict and reduce the amount of oxygen a person receives. When that happens, a person may become anxious, have difficulty in speaking full sentences, and possibly become unconscious. In more serious cases, death can occur.^[2]

The number of people diagnosed with asthma and the number of deaths due to asthma have been increasing over the past 40 years.^[4] There are about 25 million people who have asthma in the United States, seven million of whom are children.^[3] In 2013, 9.1% of adults in Utah had asthma.^[5] Between 2012 and 2013, 7.5% of Utah children had asthma.^[6] Asthma is the most common chronic disease in children.^[7]

PREVENTION OF ASTHMA

There is no cure for asthma, but the symptoms can be controlled. By controlling symptoms, you can prevent death, emergency room visits, and hospital stays.^[10] Recognizing the early signs and symptoms of an attack before it becomes too serious is important. Learning what your triggers are and keeping track of your breathing patterns can also help.^[13] As a result, a person with asthma can receive treatment and prevent serious situations. Using a quick-relief inhaler can help open the airways in case of an asthma attack. Medications vary from patient to patient based on age, symptoms, and asthma triggers. Consulting with a doctor ensures that the right medication is prescribed.^[13]

LIVING WITH ASTHMA

Maintaining proper health will help reduce the health burdens of asthma. Exercise and a good diet are two important ways to decrease the negative health effects from asthma. You can still be physically active while having asthma. Exercise is actually preferred in order to strengthen the heart to help tolerate the asthma. When the upper body muscles are strengthened, it helps to move the mucus from the bottom of the lungs and prevent mucus from collecting over time.^[2]



LIVING WITH ASTHMA *CONTINUED*

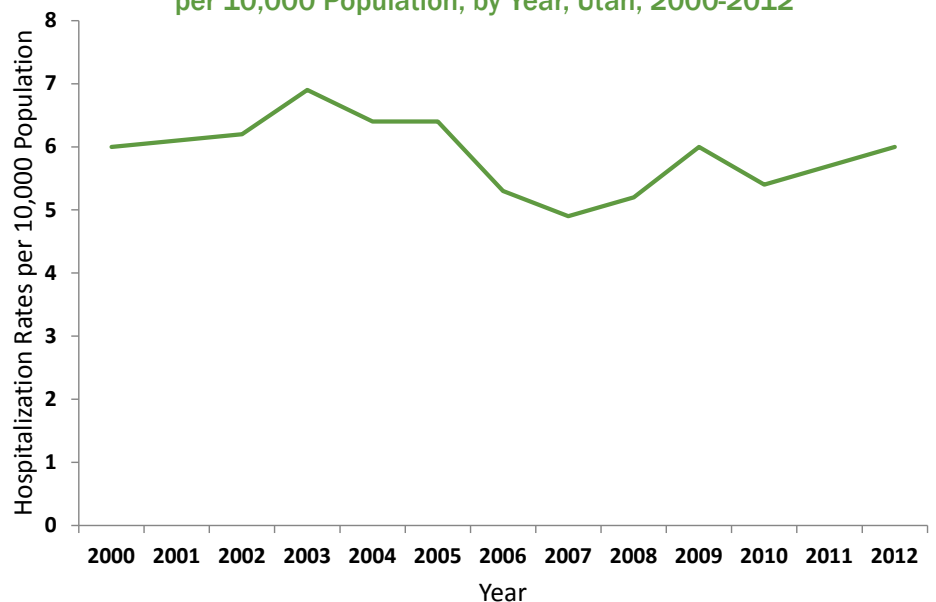
In the most recent decade, asthma rates have increased at a rate similar to obesity. The prevalence of asthma has doubled in the past 30 years in both adults and children. A scientific study found that children diagnosed with asthma would eventually have a higher body mass index (BMI) than children without asthma. This is likely because it is more difficult for one to exercise when they have asthma.^[8] In the past, people with asthma were advised to avoid physical exertion for fear of triggering an asthma attack. This included children who were told to avoid playing sports at school. However, asthma can now be managed through medication, patient education, avoiding triggers, and asthma action plans. People with asthma can live normal lives through long-term asthma management that focuses on decreasing the symptoms of asthma so people can lead normal lives.^[9]

Certain dietary factors may contribute to chronic inflammation within the lungs, which is associated with asthma. Eating a low quality diet that does not provide sufficient nutrients could lead to deficiencies that promote inflammation. Consuming too much food leads to obesity, which can make asthma symptoms worse. Another concern for people with asthma is food allergies. A well balanced and moderate diet is very important in the nutrition of all children, especially those with asthma. Getting five to nine servings a day of fruits and vegetables is recommended. Consuming whole grain foods and lean proteins are essential for healthy eating.^[2]

Body Mass Index (BMI):

A number calculated from a person's weight and height to be placed into a range of either underweight, healthy, overweight, obese, or extremely obese. The higher the BMI calculation, the closer one is toward extreme obesity.

Figure 1. Age-Adjusted Rates of Asthma Hospitalizations per 10,000 Population, by Year, Utah, 2000-2012



Source: Utah Department of Health, Office of Health Care Statistics, Utah Inpatient Hospital Discharge Data. (2015, March 3). Retrieved on June 22, 2015 from Utah Department of Health, Center for Health Data, Indicator-Based Information System for Public Health website at <http://ibis.health.utah.gov>

ASTHMA AND AIR POLLUTION

People with asthma tend to be more sensitive to air pollution which is a common asthma attack trigger.^[10] Children are more sensitive to pollutants for several reasons: increased respiration in comparison to body size; undeveloped respiratory and immunologic systems; low metabolic capacity; and longer life expectancy.^[11]

Outdoor pollutants such as ozone, particulate matter (PM), nitrogen oxides, carbon monoxide, carbon dioxide, and sulfur dioxide can irritate and damage airways.^[11] Ozone can be found in smog and PM can be found in haze, smoke, and dust. Ozone is usually worse during the hot summer days, whereas PM can be high any time of the year. The symptoms of these pollutants irritating the lungs are wheezing, chest tightness, and coughing. Long term exposure has been shown to increase the risk of asthma in children.^[10]

In addition, indoor pollution is dangerous for children and adolescents because they typically spend most of their time in small spaces. Indoor pollutants such as tobacco smoke, wood burning, carbon monoxide, carbon dioxide, pet dander, mite allergens, and mold are the most important indoor pollutants.^[11] To help children have less asthma symptoms or attacks, try to control dust, remove pets from the home, and avoid environmental tobacco smoke.^[12]



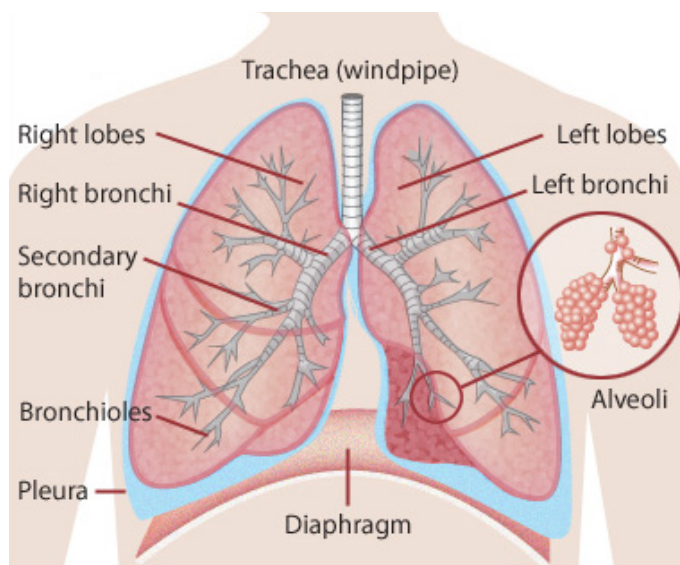
CHRONIC OBSTRUCTIVE PULMONARY DISEASE

Chronic obstructive pulmonary disease (COPD) is a broad term used to describe the progression of certain lung diseases such as asthma, chronic bronchitis, and emphysema.^[1] COPD is a disease of the lungs that makes it hard to breathe and gets worse over time.^[2] COPD is the third leading cause of death in the U.S. and there is currently no cure for this disease.^[3]

As people age, many mistakenly believe that increased breathlessness and coughing are normal. COPD can begin to develop over several years without any symptoms. Symptoms typically start to show after COPD is in the more advanced stages.^[4] Make sure to call your doctor as soon as you notice any of the following symptoms: increased breathlessness, frequent coughing (with or without mucus), wheezing, and tightness in the chest.

COPD causes less air to flow in and out of the airways. Understanding how the lungs work in order to recognize the effect COPD has on a person's lungs can help. Air that you breathe in travels down your windpipe, called the trachea, and enters the airways in your lungs, which are called bronchial tubes. The bronchial tubes branch out into smaller, thinner tubes called bronchioles. At the end of the bronchioles, are the alveoli, which are tiny round air sacs. COPD has a few different effects on the lungs: the alveoli lose their elasticity; the walls between the alveoli are destroyed; the walls of the alveoli become thick and inflamed; and the alveoli make more mucus than normal, which can clog them.^[2]

Figure 1. Diagram of the Lungs



Source: ABC Health and Wellbeing. Retrieved on April 20, 2015 from <http://www.abc.net.au/health/library/stories/2010/07/29/2967396.htm>

CAUSES OF COPD

The main cause of COPD is smoking.^[4] This can be from individuals who are current or former smokers. Another cause is from inhaling air pollutants such as fumes, chemicals, and dust.^[1] People who are at a higher risk are those who work in mining, agriculture and other industries. Genetics is another factor that contributes to COPD.^[4] In Utah, only about 4% of all adults have ever been diagnosed with COPD.^[5] Of those who smoke in Utah, 12.5% of adults have ever been diagnosed with COPD. Of the people who don't smoke in Utah, 3.28% of adults have ever been diagnosed with COPD.^[6]

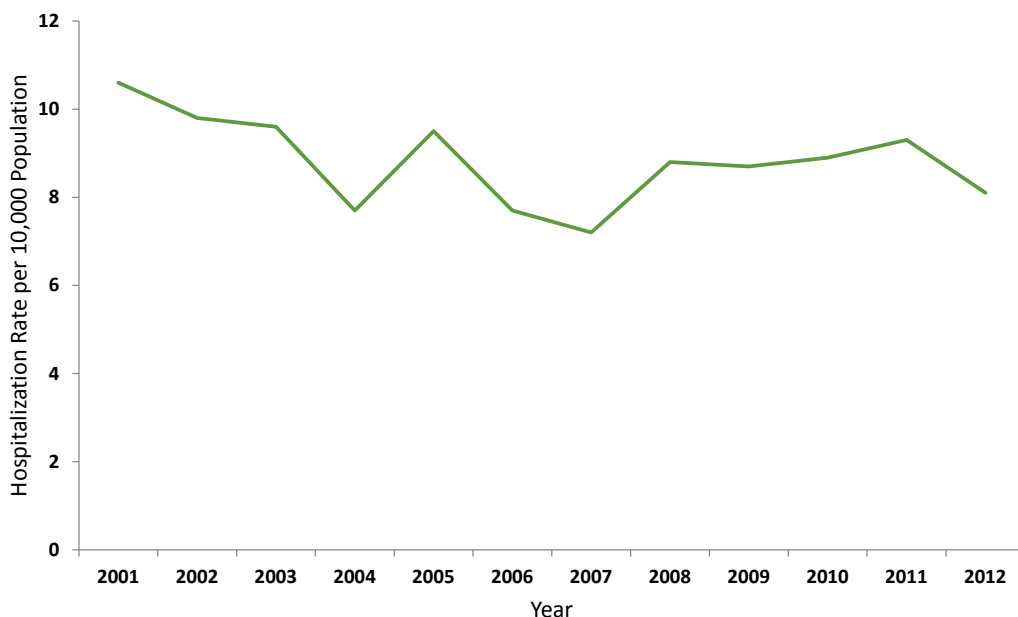
LIVING WITH COPD

To increase your quality of life and reduce the symptoms when living with COPD, there are several options. Quitting smoking, staying healthy, and exercising can all help improve life when suffering from COPD.

Because smoking is the main cause of COPD, the most important thing you can do is quit smoking. COPD progresses faster in people who smoke than in those who do not smoke. Avoiding secondhand smoke is important as well.^[7] For more information on taking steps to quit smoking, visit www.tobaccofreeutah.org.

People with COPD will often experience an acute exacerbation, which is a temporary increase in the severity of the disease. Staying healthy by avoiding things that cause exacerbations can help slow down the progression of COPD. In order to do this, recognizing early warning signs of acute exacerbations is important. By paying attention to early warning signs, you can avoid the things that cause the exacerbation. Some warning signs of exacerbations are the worsening of symptoms such as wheezing, coughing, shortness of breath, increase of mucus or change in color of mucus, rapid breathing, and fever. Some ways to help avoid acute exacerbations include washing hands often, avoid touching your face in public to prevent germs from entering your body, staying away from crowds during flu and cold season, getting plenty of sleep, and drinking plenty of water.^[8]

Figure 2. Age-Adjusted Rates of COPD Hospitalizations per 10,000 Population, by Year, Utah, 2001-2012



Source: Utah Department of Health, Office of Health Care Statistics, Utah Inpatient Hospital Discharge Data. (2015, May 5). Retrieved on May 5, 2015 from Utah Department of Health, Center for Health Data and Informatics, Indicator-Based Information System for Public Health Website at <http://ibis.health.utah.gov>

Exercise can be very difficult to do when you have COPD, especially when feeling short of breath. However, exercise can have a positive impact in helping you feel less short of breath when done correctly and safely. To start, your exercise should be slow and easy. Over time, you can steadily increase your exercise time and efforts. Eventually, you should reach a point where you feel better and breathe better while exercising. It is important to not stop at this point and stay consistent with exercising regularly. Exercise does not reverse lung disease but it can improve your quality of life and help ease symptoms.^[9] Seek help from an exercise specialist if exercising is too difficult.

COPD AND AIR POLLUTION

COPD is a significant disease worldwide because of how common it is. While genetics play a big part in the development of COPD, air pollution is closely linked to the increase of the disease with prolonged exposure to harmful particles and gases in the environment. Studies have been done to prove that outdoor air pollution has a negative effect on lung development in children aged 10-18 years, but is unclear for adults.^[10]

Air pollution can cause symptoms to become worse for days or weeks at a time. This is acute exacerbation and it is important to seek treatment right away to avoid lung failure.^[11] Additional medications may be needed to help treat the coughing or difficulty breathing. Once symptoms begin to improve, it is important to take measures to prevent future exacerbations. Not only does this include seeking help through a doctor with medications, but also lessening exposure to air pollution when possible.



BRONCHITIS

Bronchitis is a respiratory disease where the mucus membranes in the lining of the bronchial tubes become inflamed. Difficulty in breathing is common when the bronchial tubes become inflamed. The bronchial tubes are responsible for carrying air to and from the lungs. The symptoms can last for a short or long time. Symptoms of bronchitis include cough; production of mucus that can either be clear, white, green or yellowish gray; fatigue; shortness of breath; slight fever; and chest discomfort.^[1]

Acute bronchitis is common, often developing from a cold or other viral respiratory infection. However, bronchitis can result from a bacterial infection in the lungs as well. Symptoms of acute bronchitis include a hacking cough and phlegm production that can last for several weeks even if the bronchial tubes are no longer inflamed.^[1, 2] Once you are recovered from the initial lung infection, the mucus membrane should return back to good health again. The lung infection can often be treated effectively without professional medical help.^[2] If you are a smoker and you contract acute bronchitis, the recovery process will take much longer. The lungs have tiny hair like configurations that line the bronchial tubes, called cilia. The cilia are responsible for filtering out debris, irritants, and excess mucus. Every cigarette smoked damages the cilia; therefore, preventing them from working properly and ultimately increasing your chances of developing chronic bronchitis.^[2]

Chronic bronchitis is a more serious long term disease that usually requires regular medical treatment.^[2] The constant irritation or inflammation of the mucus membranes in the bronchial tubes result in a cough that can last for at least three months.^[1]

CAUSES OF BRONCHITIS

As previously mentioned, acute bronchitis is typically caused by a virus such as the common cold or the flu. However, the most common cause of chronic bronchitis is from smoking. Other causes are air pollution and dust or toxic gases in the environment or workplace.^[1] Chronic bronchitis is commonly found among coal miners, grain handlers, metal molders, and people who are frequently exposed to dust and fumes. High concentrations of smoke, fog, and sulfur dioxide can make the symptoms of chronic bronchitis even worse.^[2, 3]



EMPHYSEMA

Emphysema is a lung disease that slowly damages the air sacs, known as alveoli, in your lungs. The purpose of the alveoli is to allow oxygen and carbon dioxide to move between the bloodstream and lungs. When the air sacs are damaged, it gradually makes it harder to breathe.^[1]

In your lungs, the alveoli are bundled together like bunches of grapes. Emphysema damages the inner walls of the air sac to the point where many of the inner walls break, producing larger spaces for air instead of several small ones.^[1] Since the walls of the alveoli are where the exchange of oxygen occurs to the bloodstream, reduction in the amount of oxygen in the bloodstream is caused due to a smaller surface area. Instead of being able to exhale all of the internal air, damaged alveoli leave behind old air that becomes trapped making less room for fresh air to enter.

Often, emphysema develops over several years without any symptoms; however, the main symptom is shortness of breath.^[1] Shortness of breath begins gradually when you start to avoid activities where it is difficult to breathe. The point where emphysema becomes a problem is when it starts to restrict daily activities.

CAUSES OF EMPHYSEMA

There are a few causes of emphysema including smoke, air pollution, and manufacturing fumes.^[1] Smoking or being exposed to secondhand smoke is a major risk factor. Likewise, exposure to fumes or dust in the workplace and indoor or outdoor pollution exposures are risk factors. Fumes from heating fuel or car exhaust are examples of air pollution exposure that can cause emphysema. Smoking, or frequently being around secondhand smoke, increases the risk for emphysema along with the exposure to the air pollutants. In an occupational setting, breathing in fumes from certain chemicals or dust from grain, cotton, wood, or mining products can increase the rate of emphysema.^[1]

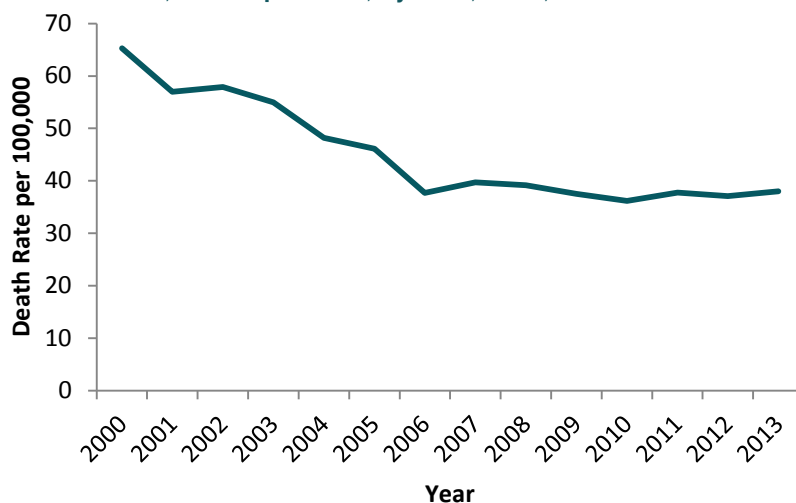
CARDIOVASCULAR DISEASE

Cardiovascular disease, or heart disease, is a broad term that describes several conditions that affect your heart. This refers to conditions that include constricted or blocked blood vessels that can lead to chest pain, stroke, or a heart attack. It includes conditions that affect the muscles, valves, and rhythm of the heart.^[1] Symptoms depend on which type of heart disease you have.

CAUSES OF HEART DISEASE

Heart disease has several different causes; some causes are more specific to a certain type of heart disease. The most common cause of heart disease is atherosclerosis. Atherosclerosis can be caused by correctable problems such as an unhealthy diet, lack of exercise, being overweight, or smoking.^[2] An unhealthy diet that contributes to heart disease typically consists of high amounts of saturated and trans fats, cholesterol, and sugar in the blood stream.^[3] Other symptoms include genetics (born with heart defects), high blood pressure, diabetes, excessive use of alcohol or caffeine, drug abuse, and stress.^[2] In Utah, about 26% of adults have ever been diagnosed with high blood pressure.^[4]

Figure 1. Age-Adjusted Rates of Stroke Deaths per 100,000 Population, by Year, Utah, 2000-2013



Source: Utah Department of Health, Office of Vital Records and Statistics, Utah Death Certificate Database; Utah Governor's Office of Planning and Budget; National Center for Health Statistics. (2014, October 23). Retrieved on March 9, 2015 from Utah Department of Health, Center for Health Data, Indicator-Based Information System for Public Health website at <http://ibis.health.utah.gov>

HEART DISEASE AND AIR POLLUTION

Heart disease can be prevented by making numerous healthy choices; however, what is not commonly known is that air pollution can play a part in heart disease as well. There is evidence that suggest pollutants in the air can increase the risk of heart disease.^[5] People who are at the most risk of air pollution increasing their risk of heart disease are the elderly, those with preexisting cardio-respiratory diseases, those of lower socioeconomic status, and diabetics.^[5, 6]

All six criteria air pollutants which include carbon monoxide, nitrogen oxides, sulfur dioxide, ozone, lead, and particulate matter (PM), are associated with increased hospitalization and death due to heart disease. Once inhaled, the air pollutants can cause inflammation and an imbalance of pro- and anti-oxidants in cell functions called **oxidative stress**.^[7] Oxidative stress and inflammation can then lead to arrhythmia or a heart attack.^[5]

PM is more common in causing adverse health effects leading toward heart disease. The smaller the PM is in diameter, the more serious the health effect. When the particle is very small, the particle can travel really deep into the lungs reaching the alveoli (see Figure 1. Diagram of the Lung on page 41).^[6] The alveoli are where oxygen and carbon dioxide move in and out of the bloodstream and lungs.^[8] Once the fine particle reaches the alveoli, it's easier for it to travel into the bloodstream and have a direct effect on people with heart illnesses. The effects can occur during short-term or long-term exposure to PM pollution. PM has also been found to increase one's blood pressure.^[6]

In 2012, the World Health Organization (WHO) reported that air pollution was responsible for 3.7 million deaths; one million of which were related to heart disease. Air pollution can double the risk for obesity, hypertension, chronic pulmonary disease, and cardiovascular disease in older people.^[6]

PREVENTION OF HEART DISEASE AND AIR POLLUTION

The main ways to lower the risk of heart disease are to eat a healthy diet and get sufficient exercise. Eating a diet that is rich in fruits, vegetables, and whole grains can help protect your heart. Low-fat sources of protein, beans, and certain types of fish can also help protect your heart.^[9] Limiting certain fats such as saturated fat and trans fat as well as limiting sodium and cholesterol is very important.^[9, 10] If you choose to drink alcohol, drink in moderation. Exercising for 30 minutes on most days of the week and controlling your weight can reduce your risk for heart disease.^[9]

Smoking can greatly increase the risk of heart disease. Quitting smoking or the use of tobacco can decrease your risk significantly. Any amount of smoking is dangerous and contributes to heart disease. Even using smokeless tobacco and low tar or low nicotine cigarettes are risky, as well as secondhand smoke.^[9]

Avoiding unnecessary exposures to air pollution following diagnosis of cardiovascular disease is recommended. You can avoid exposure by reducing non-mandatory travel in high polluted areas, avoiding outdoor activities during times of elevated pollution, and using good filtering systems. Good filtering systems include air conditioning, and keeping indoor windows and car windows closed.^[14] Educating people with heart disease about the risks posed by air pollution can help decrease the negative health effects from air pollution. When people implement heart disease prevention strategies, it helps them be less susceptible to the effects of air pollution.

BRIEF DEFINITION OF VARIOUS TYPES OF HEART DISEASE

Atherosclerosis: A condition where plaque builds up in the walls of the arteries making it narrow and difficult for blood to flow through. A heart attack or stroke can happen if a blood clot gets stuck in the narrow passage and stops the blood flow.^[12] Symptoms include pain, numbness, weakness or coldness in your limbs; pain in the neck, jaw, throat, upper abdomen or back; chest pain, or shortness of breath.^[13]

Heart Attack: Occurs when a blood clot blocks the blood flow to part of the heart. If the blood flow is blocked completely, part of the heart muscle can begin to die.^[12] Symptoms are similar to those of atherosclerosis.

Ischemic Stroke: The most common type of stroke happens when there is a blockage in a blood vessel that provides blood to the brain. Blockage can cause part of the brain to shut off and kill off brain cells. Some effects of stroke are permanent due to lack of blood and oxygen to the brain.^[12] Symptoms include numbness on one side of the face, arm, leg; difficulty speaking, seeing walking or staying balanced; confusion, dizziness, or severe headache.^[14]

Heart Failure: A condition where the heart isn't pumping blood as well as it should. The heart is still working; however, it is not properly supplying the body with an adequate amount of blood and oxygen.^[12] Symptoms include swelling of the legs, ankles and feet; breathlessness even at rest, fatigue, irregular heartbeats, dizziness, lightheadedness, and fainting.^[13]

Arrhythmia: An abnormal rhythm of the heart. The heart can either beat too slow, too fast, or irregularly. This can affect how well the heart functions by not pumping enough blood to meet the body's needs.^[12] Symptoms include fluttering in your chest, fast heartbeat, slow heartbeat, chest pain, shortness of breath, lightheadedness, dizziness, or fainting.^[13]

Hypertension: Having a blood pressure of 140/90 millimeters of mercury (mmHg) or higher majority of the time.^[15] High blood pressure causes extreme pressure on the artery walls which can damage blood vessels and organs in the body.^[16] There are no symptoms for hypertension.



RENAL DISEASE

Renal disease is a chronic condition that describes the gradual loss of kidney function. Renal disease is the 14th highest cause of death in Utah.^[1] The primary functions of the kidney are to filter wastes and excess fluids from your body that are then excreted through urine.^[2] Signs and symptoms at the early stages of kidney disease can be hard to recognize because they are non-specific and can be confused with other types of diseases.^[3] Some of these symptoms include nausea, vomiting, loss of appetite, fatigue, changes in urine output, muscle twitches and cramps, swelling of feet and ankles, hiccups, and persistent itching.^[4] Typically, when kidney disease has become more advanced is when symptoms are noticed. This is because the kidneys are extremely adaptable and are able to compensate for lost function.

CAUSES OF KIDNEY DISEASE

The most common causes of kidney disease are from diabetes and high blood pressure. Prolonged high blood pressure can damage capillaries in the kidneys. If severe enough, the damage can lead to kidney failure and even death.^[5] Kidney disease can be caused by toxic heavy metals such as lead. The contribution of lead in the progression of kidney disease is gradually being recognized in more recent times.^[6] Studies have shown that low-level environmental lead exposure is associated with heightened deterioration of long-term kidney failure.^[7]



RENAL DISEASE AND LEAD POISONING

Lead is absorbed by the gastrointestinal tract when consumed, and the lungs when inhaled. From there, lead enters into the bloodstream and attaches to proteins in the blood where it is carried to different organ systems in the body. Lead interferes with kidney functions. If the lead levels are reduced, the kidney is able to return to its normal function. However, if a high amount of lead exposure continues over a long period of time for a child, kidney disease may appear later in life as an adult.^[8]

The toxicity of lead can either be acute and dramatic or chronic and subtle.^[3] Lead cannot be destroyed or changed in the body; lead is simply just stored away in the body where it can accumulate over time. However, a majority of people are unable to get rid of all the lead that they take in, especially when they are constantly exposed to it.^[8]

PREVENTION OF RENAL DISEASE AND LEAD POISONING

Early detection is the key to preventing or delaying severe kidney disease. Once kidney disease is detected, be involved with seeking treatment. This can help slow down the progression to kidney failure.^[9] The incidence of lead poisoning has decreased significantly over the last twenty years due to screening and education about lead exposure.^[3] In 1970, legislative regulation was enacted to regulate the industrial production, dispersion and uses of lead.^[6]

Even small concentrations of lead have been associated with negative health effects. Long term low level lead poisoning is related to the rate of hypertension and progressive kidney disease. This is why physicians need to be attentive in detecting early lead poisoning. Beginning treatment has been shown to limit or reverse lead toxicity.^[6]

BIRTH OUTCOMES

Even with advances in medicine, adverse birth outcomes are increasing in the United States. An adverse birth outcome is any event that reduces the chance of having a healthy baby.^[1] The most well-known adverse birth outcomes are preterm births, low birth weight (LBW), birth defects, pregnancy loss, and neurodevelopmental defects.^[2]

The two most important indicators of infant health are a newborn's gestational age and birth weight. Those conditions may increase the child's risk for several other health complications throughout their life.^[2, 3] Normal pregnancies last between 37 and 41 weeks allowing the complete development of the baby's organs and systems to be complete. If a baby is born before 37 weeks of gestation, the baby is considered preterm. A baby born with a low birth weight means they weigh less than 5 pounds, 8 ounces at birth. Birth weight alone does not always indicate whether a baby's fetal growth has been restricted. Other measurements such as length at birth, head circumference, and abdominal circumference are used.^[3, 4]

BIRTH OUTCOMES AND AIR POLLUTION

Some of the most dangerous air pollutants are particulate matter (PM), ozone, carbon monoxide (CO), nitrogen oxides, sulfur dioxide, secondhand smoke, fumes from paint and household cleaners, and lead.^[2, 7] Particle pollution includes gaseous emissions such as PM, sulfur dioxide, and nitrogen oxides. Particle exposure is linked to a greater risk of LBW and infant mortality. However, outcome can vary greatly based on the time the mother was exposed during pregnancy, duration of exposure, and the size of the particles.^[7]

Ozone exposure has been linked to LBW babies as well. Researchers found that women who are exposed to high levels of ozone are particularly at risk for having babies suffering with **intrauterine growth retardation**, which is poor growth of the baby while in the womb. The association was even stronger during the second and third trimester if exposed to ozone.^[7]

CO reduces the capacity of a mother's blood to carry oxygen to the developing baby. Studies suggest that long term exposure to ambient CO may increase the risk for a preterm birth, reduce fetal growth, and increase certain birth defects such as cardiac birth defects. Exposure to CO is especially hazardous during the first trimester. Many times, the amount and length of exposure, as well as the gestational age during the exposure can determine the severity of CO poisoning for the fetus. Generally, if a pregnant woman experiences very mild symptoms or no symptoms at all of CO poisoning, it is unlikely that the fetus is at a significant risk. On the other hand, detecting CO poisoning in expectant mothers can be very difficult because the symptoms are similar to those of pregnancy such as nausea, vomiting, and sleepiness. Symptoms of high exposure to CO are serious and potentially life threatening.^[7]

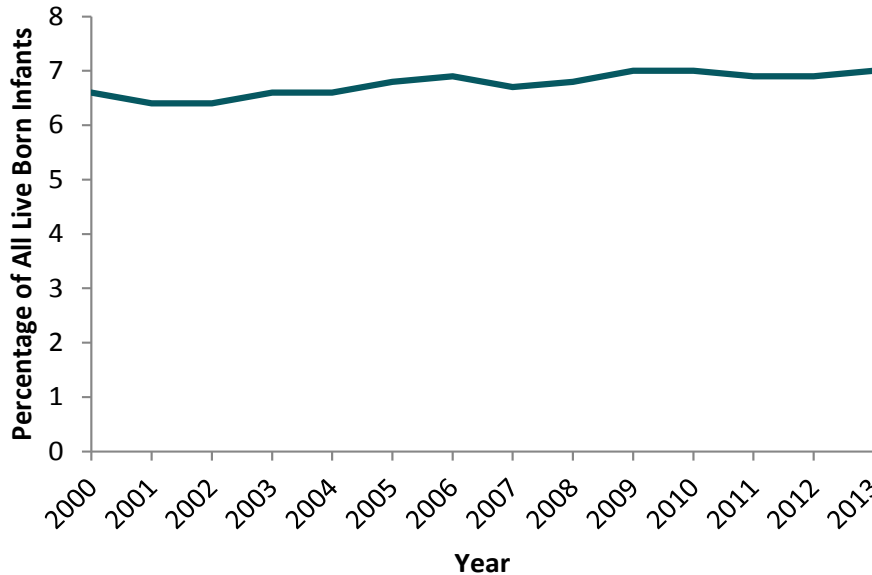
While smoking during pregnancy is well known to be associated with adverse birth outcomes, exposure to secondhand smoke during pregnancy results in a high risk for a variety of poor fetal development. These risks range from reduced birth weight and length, reduced lung function, respiratory illnesses such as asthma, and cognitive deficits such as impaired speech and intelligence. Some of the toxic chemicals can cross the placenta to the developing fetus causing an increase in adverse birth outcomes.^[7]

Although lead is known to delay growth and development in children, lead still continues to exist in the environment. Lead is often found in older and lower income communities where it is present in the plumbing and in lead paint. Recently, scientists have found that low level exposures to lead can have a negative effect on the neurological development of fetuses.^[2, 8] Lead can cause LBW, **preeclampsia**, brain damage, **anemia**, developmental delays, headaches, hearing loss, stomach problems, loss of appetite, and constipation.^[8, 9] Lead can cause miscarriages, stillbirths, infertility in women, preterm delivery, and increased gestational hypertension.^[8, 10] Lead has been found in breast milk of women in certain studies; however, the risk for toxicity to the breastfeeding infant is limited.^[8]

CAUSES OF ADVERSE BIRTH OUTCOMES

There are several reasons why there are negative effects on a woman's ability to conceive, carry, and deliver a healthy baby. Some of the risks or poor outcomes include age, genetics, medical health, socioeconomic status, behaviors, access to health care, and environmental exposures.^[5] In Utah, 12% of women who smoked during pregnancy gave birth to a LBW infant. However, only 6.5% of infants born to women who did not smoke during pregnancy were LBW.^[6]

Figure 1. Percentage of Live Born Infants with Low Birth Weight, by Year, Utah, 2000-2013



Source: Utah Department of Health, Office of Vital Records and Statistics, Utah Birth Certificate Database; Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System. (2014, November 5). Retrieved on April 23, 2015 from <http://ibis.health.utah.gov>

PREVENTION OF ADVERSE BIRTH OUTCOMES AND AIR POLLUTION

The Environmental Protection Agency (EPA) uses an Air Quality Index (AQI) to report the levels of outdoor air pollution such as PM, ozone, and other particle pollution (see page 53 to view the AQI chart). Checking your local air quality before planning outdoor activities can help prevent exposure during poor air quality days. If the AQI indicates poor air quality, reduce the amount of outdoor activity or do an activity that requires less energy. Particle levels are generally higher near high traffic roads. Avoiding those areas can help decrease risk from exposure.^[7]

Installing CO detectors inside your home is a simple way given to prevent CO poisoning. Never use gas ovens or burners to heat a home, don't use charcoal grills indoors, and only use gasoline powered engines in well-ventilated spaces. This includes idling cars in the garage. Ignoring symptoms of CO poisoning when around a CO source. Doing so can cause you to lose consciousness and even die if severe enough.^[7]

Depending on your situation, preventing secondhand smoke can be difficult. Pregnant women should not smoke and should avoid public places where smoking is allowed. They should make their homes and cars smoke free.^[7] However, living with someone who smokes can make it difficult. Asking the person to smoke outside and away from the home can help reduce the risk of exposure to secondhand smoke.

As for lead, if possible, avoid living near a point source for lead, such as lead mines, smelters, or battery recycling plants. If someone you live with works in this occupational setting, avoid any dust they might bring home. Never eat or put your mouth on nonfood items that may have lead on them, such as pottery, paint chips, clay, or soil. Stay away from any repair, repainting, renovation, or remodeling work that is being done in homes built before 1978. Avoid any exposure to deteriorating lead-based paint in older homes that is deteriorating. Eating a balanced diet with adequate intake of iron and calcium can help reduce your risk of lead poisoning.^[8]

APPENDICES

This section includes the complete air quality index chart, glossary, and works cited. The glossary defines words that are highlighted in green throughout the booklet.

This section provides information about the following:

- ✓ Air Quality Index Chart
- ✓ Glossary
- ✓ Works Cited



AIR QUALITY INDEX CHART

AQI Categories	AQI Range	General Meaning	Ozone (ppm) [8-hour]	Ozone Meaning	PM2.5 (ug/m ³) [24-hour]	PM2.5 Meaning
Good	0-50	Air quality is considered satisfactory and air pollution poses little or no risk.	0.0 - 0.059	Air quality is excellent and poses little or no risk.	0.0 - 12	Air quality is excellent and poses little to no risk.
Moderate	51-100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.	0.060 - 0.075	Unusually sensitive individuals may experience respiratory symptoms.	12.1 - 35.4	Respiratory symptoms possible in unusually sensitive individuals, older adults, and possible aggravation of heart or lung disease in people with cardiovascular disease.
Unhealthy for Sensitive Groups	101 - 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected. Sensitive groups are: <ul style="list-style-type: none"> those with lung and heart disease, diabetes, or a current respiratory infection infants and children adults over 65 	0.076 - 0.095	Increasing likelihood of respiratory symptoms and breathing discomfort in active children and adults and people with respiratory disease, such as asthma.	35.5 - 55.4	Increasing likelihood of respiratory symptoms in sensitive individuals, aggravation of heart or lung disease and premature mortality in older adults and people with cardiovascular disease.
Unhealthy	151 - 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects. Sensitive groups are listed above.	0.096 - 0.115	Greater likelihood of respiratory symptoms and breathing difficulty in active children and adults and people with respiratory disease, such as asthma; possible respiratory effects in general population.	55.5 - 150.4	Increased aggravation of heart or lung disease and premature mortality in older adults and people with cardiopulmonary disease; increased respiratory effects in general population.
Very Unhealthy	201 - 300	Health alert: everyone may experience more serious health effects.	0.116 - 0.374	Increasingly severe symptoms and impaired breathing likely in active children and adults and people with respiratory disease, such as asthma; increasing likelihood of respiratory effects in general population.	150.5 - 250.4	Significant aggravation of heart or lung disease and premature mortality in older adults and people with cardiopulmonary disease; significant increase in respiratory effects in general population.
Hazardous	301 - 500	Health warnings of emergency conditions. The entire population is more likely to be affected.	Over 0.374	Severe respiratory effects and impaired breathing likely in active children and adults and people with lung disease, such as asthma; increasingly severe respiratory effects like in general population.	Over 250.4	Serious aggravation of heart or lung disease and premature mortality in older adults and people with cardiovascular disease; serious risk of respiratory effects in general population.

GLOSSARY

Anemia: a condition where there are not enough red blood cells in the blood. Red blood cells carry oxygen to tissues in the body. Some symptoms include fatigue, weakness, pale skin, irregular heartbeat, shortness of breath, chest pain, dizziness, cold hands and feet, and headaches.^[1]

Bronchoconstriction: narrowing of the airways making it difficult to breathe. Some people who do not have asthma may experience this during exercise. The symptoms are coughing, wheezing, shortness of breath, and tight chest. These symptoms can be worse in cold, dry air conditions.^[2]

Carcinogen: any substance or exposure that can lead to cancer often from environmental factors such as lifestyle causes (tobacco use, lack of physical activity, nutrition), naturally-occurring exposures (ultraviolet light, radon gas), medical treatments, workplace exposures, household exposures, and pollution.^[3]

Intrauterine growth retardation: a condition where an unborn baby is smaller than normal due to lack of growth at a normal rate inside the womb. Delayed growth increases the baby's risk for certain health problems such as low birth weight, decreased oxygen levels, low blood sugar, suppressed immune system, trouble maintaining body temperature, long-term growth problems and in severe cases, stillbirth.^[4]

Mesothelioma: when a tumor occurs on the tissue that lines the lungs, stomach, heart and other organs. It can either be cancerous or noncancerous. It is commonly caused from asbestos and is a rare but serious type of cancer. The symptoms are difficulty breathing, unknown weight loss, pain under the rib cage, and pain, swelling, or lumps in the abdomen.^[5]

Oxidative stress: an imbalance between the production of free radicals and antioxidant defenses against harmful effects of the body.^[6]

Pneumonia: a lung infection where the lungs become inflamed. It is commonly caused by a bacteria or virus and is more likely to occur after a cold or the flu. It can be contagious and symptoms include fever, coughing up mucus, fast breathing, chills, chest pain, fast heartbeat, lethargy, nausea, vomiting, and diarrhea.^[7]

Preeclampsia: a pregnancy complication where a woman's blood pressure is high during pregnancy. Blood pressure that is 140/90 millimeters of mercury (mm Hg) or higher obtained twice within 4 hours of each other is abnormal and considered preeclampsia. It usually begins after 20 weeks of pregnancy and sometimes without any symptoms. This is why monitoring blood pressure during pregnancy is important. Other symptoms may include headaches, blurred vision, nausea, vomiting, shortness of breath caused by fluid in the lungs, and decreased urine output. Sudden weight gain and swelling often occurs alongside preeclampsia.^[8]

Volatile Organic Compounds (VOCs): gases that are evaporated from a variety of liquids or solids such as cleaning supplies, pesticides, building materials and furnishings, paints, lacquers, glues and adhesives, copiers and printers. Concentration of VOCs are significantly higher indoors than outdoors.^[9]

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View from Bells Canyon, personal photograph by Katie Ostler. JPEG file.

View from Bonneville Shoreline Trail, personal photograph by Katie Ostler. JPEG file.

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Wind River Mountains, personal photograph by Jeff Lym. JPEG file.

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