Study shows long term exposure to air pollution is associated with emphysema development and changes in lung function

**Background and Methods**

Emphysema is a result of thinning and damage to alveoli or air sacs.

Emphysema is primarily caused by smoking. Emphysema is part of chronic obstructive pulmonary disease, or COPD. Not only is emphysema caused by cigarette smoke, it has also been found that just slightly elevated levels of air pollution could lead to the disease.

This study found that an increase of three parts per billion of ozone (O₃) outside an individual’s house was as harmful to the lungs as smoking a pack of cigarettes each day for 29 years.
There were 7,071 participants aged 45-84 years that did not have cardiovascular disease in six metropolitan cities between 2000 and 2018.

Study participants were tested to see if long term exposure to O₃, fine particulate matter (PM₂.₅), nitrogen oxide (NOₓ) and black carbon would alter percent emphysema tested with computed tomographic (CT Scans) imaging and lung function.

CT scans provide more detail than a regular X-Ray as it provides pictures of organs and tissues. The participants lung function was tested by a Spirometer.

Researchers collected a baseline of a person’s lung health and during follow up.

What did the Researchers Find?

Researchers found that PM₂.₅ and NOₓ concentrations declined.

During the study time, O₃ concentrations increased during follow up. Increased exposure to O₃, PM₂.₅, and NOₓ were associated with increased progression of percent emphysema.

Participants who had airflow obstruction at the start of the study, had percentage points of emphysema increase by 0.35 when ozone levels increased during follow up.

Those who were healthy at the start of the study, had only an increase by 0.15 percentage points. Meaning that those with airflow obstruction are more negatively affected by air pollution.

What did the Researchers Conclude?

Although, there have been regulations to work to reduce O₃ levels, it was observed that the O₃ levels did not decline. O₃ was associated with altering lung structure and function. It was observed that PM₂.₅ and NOₓ concentrations decreased due to improved regulations.

This supports numerous of other studies that showed that those with lung disease suffer more due to air pollution.

Smokers had the greatest amount of emphysema progression.

Meaning that O₃ is associated with altered lung function and structure and damage.

More regulation is recommended for reduction of O₃.

Emphysema Cont.

This study provided additional evidence that air pollution contributes to worsening lung health.

Ozone is associated with altered lung function and structure damage.
You read in the Emphysema article about spirometry. But what exactly is spirometry? The spirometer is a device that measures the lungs performance by determining how fast your lungs can fill and empty air. Spirometry is used to diagnose diseases like COPD, which is the narrowing of the airways, resulting in difficult breathing.

The patient first begins by taking in a huge breath and blows out into a tube that is connected to the spirometer to test lung function. The spirometer provides a ratio of the expiratory forced vital capacity (FVC) and the forced expiratory volume in one second (FEV1), also known as the FEV1/FVC ratio.

FVC measures the greatest amount of air you can forcefully breathe. If the FVC score is lower than normal, then it may be that a restrictive or obstructive lung disease is restricting your breathing. FEV1 measures the amount of air you can force out of your lungs in one second.

The FEV1/FVC ratio provides information on the percentage of your lung capacity you are able to exhale in one second. The higher the percentage, the healthier the lungs are. With poorer lung function, it would affect the amount of air you are able to quickly blow out, resulting in a lower FEV1 score, thus a lowered FEV1/FVC ratio.

Would you like to van pool or car pool to work?
http://pcgov/devserv/airquality/Pages/AlternativeTransportation.aspx
What is Nitrogen Dioxide (NO\textsubscript{2})?
It is released from burning fuel. It is found in emissions from vehicles, power plants, and off-road equipment.

How does it harm our environment?
When NO\textsubscript{2} and NO\textsubscript{X} react with oxygen, water, and other compounds in the air, it produces acid rain. The acid rain then harms lakes and forests. It is also responsible for the decline of fish and shellfish populations.

In addition, haze could result when sunlight encounters NO\textsubscript{2}, limiting visibility.

How does it harm you and your loved ones?
Asthmatics, children, and elderly are most susceptible to health effects of NO\textsubscript{2}. High levels of NO\textsubscript{2} in the air irritate airways. Even short exposure periods can aggravate susceptible people such as asthmatics that can experience coughing, wheezing, or difficulty breathing. Long exposure time can result in asthma development and increasing the risk to respiratory infections.
What is Particulate Matter (PM)?

Solid particles and liquid droplets mixed in the air.

**PM**<sub>10</sub>: inhalable particles with 10 µm diameter or smaller

**PM**<sub>2.5</sub>: fine inhalable particles with 2.5 µm diameter or smaller

Larger particles pose less of a health concern, but they have the potential to irritate the eyes, nose, and throat. Smaller particles including **PM**<sub>10</sub> and **PM**<sub>2.5</sub> are more harmful as they can penetrate deep into the lungs and eventually reach the bloodstream affecting both your lungs and heart.

**How does it harm you and your loved ones?**

Those who are at greatest risk include those with heart or lung disease, elders, and children. Preexisting conditions that are most susceptible are those with high blood pressure, heart failure, asthma, and chronic obstructive pulmonary disease (COPD) as particulates can aggravate these conditions.

Children are susceptible because their lungs are still developing, in addition they are more likely to have asthma or respiratory diseases, which can be aggravated from high level particle exposure. Children also tend to spend more time outside and exert themselves at high activity levels, allowing for greater inhalation of particulates.

Individuals with high blood pressure and elevated cholesterol levels may increase risk of heart attack with high particulate exposure.

Long term exposure can result in impaired lung function and bronchitis. Short term exposure can aggravate lung disease, asthma attacks, bronchitis, and increase susceptibility to respiratory infections. In healthy individuals, it can lead to irritation, coughing, phlegm, tightness of the chest, and shortness of breath.

**How does one increase their exposure?**

Spending a lot of time outside increases your exposure to particles. With more strenuous activity, it increases inhalation rate, increasing the amount of particles inhaled, thus increased particle uptake. Plan to exert less and minimize outdoor activity when particle levels are high.

What is parts per billion (ppb)?

One ppb is one part in one billion. It is equivalent to a microgram per liter (µg/L). It is not to be confused with ppm which is one part in one million or mg/L. Ppm and ppb are used to report concentration.

1 ppm = 1 mg/L = 1/1 million = 0.0000001

1 ppb = 1 µg/L = 1/1 billion = 0.000000001

Ppb is a much lower concentration compared to ppm. These measurements are used to compare with exposure standards and guidelines used to protect the public from harmful contaminants in the water and air.

Protect yourself and your family by checking the air quality forecast and avoid exercising or working outdoors during high pollution advisories.
Unable to carpool or vanpool to work to reduce vehicle emissions? Here are some tips on how to improve fuel efficiency with your personal vehicle!

Eliminate aggressive driving
Rapid acceleration, speeding, and braking are forms of aggressive driving that can lower gas mileage by 15-30% at highway speeds and 10-40% in stop and go traffic. Eliminating aggressive driving could save you about $0.28-$1.10/gallon.

Control your speed to no more than 50 mph
Gas mileage tends to decrease at speeds above 50 mph. For every 5 mph increase above 50, it is equivalent to paying an additional $0.19/gallon for fuel.

Use cruise control
Constant speed is maintained, saving you on gas!

Avoid idling
Avoid idling and turn off your engine when the vehicle is parked whether you are waiting for the drive thru or waiting to pickup a loved one from school or work.

Avoid excessive weight
Avoid driving with unnecessary heavy items in the vehicle because excess weight affects smaller vehicles as it can reduce your MPG. This also includes avoiding carrying items over your car roof as it increases wind resistance leading to fuel inefficiency.

Economic and Health Burden of Air Pollution
According to the World Health Organization (WHO) there were approximately 7 million premature deaths in 2012 attributed to air pollution exposure from both outdoor and indoor sources in 2012. Air pollution is the world’s largest environmental health risk. Concentrations of O₃, CO₂, sulfur dioxide (SO₂), and PM₂.₅ were used to evaluate economic and health burden. It is estimated in the United States (US) that the health burden is 160,000 premature deaths, costing an estimated $145 billion in the US. If global emissions reduced by 20%, 27,500 premature deaths in the US can be avoided. If North America reduced emissions by 20%, 25,000 premature deaths in the US would be avoided.
Notice that the ozone levels increase during the hot summer months. With heat and sunlight presence, it reacts with NO\textsubscript{X} and VOCs emitted by vehicles and industrial facilities. The reaction results in "bad" or ground-level ozone. Inhaling ozone can result in health problems such as chest pain, airway irritation and inflammation, and cough. It can worsen emphysema.

Help reduce ozone by fueling after dark and being careful not to spill the fuel. Keep vehicles maintained and be sure your tires are adequately inflated.

**Sources**


