What are the links between exhaust fumes and heart disease?

Several major studies around the globe show that people living in areas with air pollution are more likely to develop cardiovascular disease. Norwegian researchers have examined potential causes.

Air pollution can have deadly effects: an estimated 6 million people worldwide die prematurely due to harmful air pollution. The majority of these deaths appear to be due to cardiovascular disease.

"The association between air pollution and cardiovascular disease is well documented at the population level," says Bendik Brinchmann, a PhD candidate at the Norwegian Institute of Public Health.

Brinchmann is the first author of a new study that has been published under the auspices of the institute.

His work shows that relatively small changes in the amount of harmful particles in the air can increase the risk of developing disease.

"One of the big questions we had is how the exhaust we breathe can cause cardiovascular disease, he said.

Experiments with cell cultures

Diesel exhaust contains tiny particles that can penetrate deep into the lungs. Incomplete combustion of diesel fuel creates harmful substances that stick to the particles in the exhaust and are carried into the lungs.

“These substances are organic chemicals found in diesel, which include PAHs, or polycyclic aromatic hydrocarbons. But there are many different substances — a cocktail — in the mix of chemicals in diesel exhaust,” says Brinchmann.

The small particles in diesel exhaust can cause inflammatory reactions and oxidative stress in the lungs, but researchers still don’t know quite how they manage to affect the heart and the cardiovascular system.

“Our hypothesis was that these chemicals could penetrate lung cells, cross into the bloodstream and directly damage the cells lining blood vessel walls,” Brinchmann said.

The researchers examined this hypothesis by experimenting with cell cultures in collaboration with the Luxembourg Institute of Science and Technology.

The researchers made a model of the barrier between the lungs and the bloodstream by growing lung cells with macrophages (which remove bacteria and particles in the lungs) on a permeable membrane in a petri dish. Blood vessel cells were grown on the underside of the same membrane.

"We added diesel particles to the top of the ‘lung side’,” Brinchmann said. “The particles not only affected the lung cells, but also the cells on the walls of the blood vessels.”
Brinchmann said that the particulate matter in diesel particles mainly consists of fat-soluble chemicals. “The cells have a membrane that is fat based, so we thought that these substances would be able to pass through the membranes of the lung cells, where they could then be transported to the blood vessel cells, and then into the bloodstream,” he said.

**Chemicals “cross over” lung cells**

The researchers conducted a series of tests to verify their results. They specifically tested whether it was actually the inflammatory reaction of the lung cells that had a negative effect on the blood vessel cells.

To ensure that it wasn’t the lung cells themselves that were the cause of what they had observed, the researchers tested a different kind particle that can cause inflammation but which did not contain the diesel substances. When they conducted these tests, they found no reaction in the blood vessel cells. “This indicates that it is the actual substances in the incompletely burned diesel that cause the impact,” Brinchmann said.

The researchers sent samples of the particles that caused reactions to chemists in the United States. There, the harmful substances were isolated and extracted from the samples, and then sent back to Norway.

“We worked with the Norwegian Center for Stem Cell Research to expose fresh blood vessel cells from four healthy individuals to the extracts we got from the US. We then got the same type of inflammatory reaction at very low concentrations,” Brinchmann said. “This may suggest that cells in the blood vessel walls are very vulnerable to these substances. It strengthens our results and shows that these chemicals are a problem for blood vessel cells.”

Brinchmann said that big cities in countries such as China and India face a huge health problem with their existing pollution levels. But he added that pollutant levels measured in cities in Europe and the United States are also high enough to increase the risk for cardiovascular disease.

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**Nancy Bazilchuk** [12] based on an article by Elise Kjørstad [13]

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