Study sheds new light on the harms of air pollution

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Lina Mu, Ph.D., associate professor of epidemiology and environmental health, University at Buffalo School of Public Health and Health Professions. Credit: University at Buffalo

A new University at Buffalo study based on levels before, during and

after the Beijing Olympics reveals how air pollution affects the human body at the level of metabolites.

Researchers found that 69 metabolites changed significantly when air pollution changed. Their results were published today (May 29) in the journal *Environmental Health Perspectives*.

The study identified two major metabolic signatures, one consisting of lipids and a second that included dipeptides, polyunsaturated fatty acids, taurine, and xanthine. Many of those metabolites are involved in oxidative stress, inflammation, cardiovascular and nervous systems, researchers note.

The findings are based on the Beijing Olympics Air Pollution study, conducted during the 2008 Olympic Games in China, when temporary air pollution controls were implemented. The study was led by UB epidemiologist Lina Mu.

The study enrolled 201 adults prior to Beijing's air quality improvement initiative, when air pollution was high. Researchers followed them during the Games, when air pollution was low, and afterward, when levels returned to their usual high in the city of 21 million people. A subset of 26 non-smokers aged 30 to 65 was selected for the metabolomics analysis.

Metabolites are small molecules that are the end products of environmental exposures, such as air pollution, and body metabolism. "Think of our body as a society. These metabolites fulfill different positions, such as teacher, farmer, worker, soldier. We need each one functioning properly in order to maintain a healthy system," said Mu, Ph.D., associate professor of epidemiology and environmental health in UB's School of Public Health and Health Professions.

"Our study found that the human body had systemic changes at the metabolite level before, during and after the 2008 Beijing Olympics, when ambient air pollution changed drastically," said Zhongzheng Niu, a Ph.D. candidate and a paper co-author.

The molecules mostly belonged to the lipid and dipeptide families.

The study provides researchers with a broader view of the molecular mechanism underlying the impact of air pollution on the human body. Most previous studies only looked at a small number of molecules. However, the human body is complex and molecules affect one another.

Mu and her colleagues used the "omics" method, a new platform that can measure a whole collection of all detectable metabolites—886 in their study—simultaneously. Instead of examining these molecules one by one, Mu and her team used network analysis to analyze them all together.

"We found that these metabolites together depicted a relatively comprehensive picture of human body responses to air pollution," said paper co-author Rachael Hageman Blair, associate professor of biostatistics at UB. She and her team developed the novel analysis method used in the study

The responses include cellular stability, oxidative stress, anti-oxidation and inflammation.

Researchers measured metabolomics repeatedly when air pollution was high, low and high. Such a design mimicked a "natural experiment" while controlling for variations unrelated to air pollution changes. This provided stronger evidence than previous studies.

Air pollution is an environmental exposure that can't be avoided by people who live in places like Beijing. The World Health Organization

reports that 91 percent of the world's population lives in places where air quality exceeds WHO guidelines.

Once inhaled, air pollutants stimulate the body's respiratory system, including the nose and lungs. Some cells in the body may be directly insulted by these air pollutants, their membrane may be broken, their secretion may be disordered, and they may send out signaling molecules to other organs for subsequent responses, Mu explains. Metabolites are all these broken membranes, secreted products and signals.

"Capturing these molecules tells us what is going on when people are exposed to air pollution," Mu said.

Air pollution also induces cellular oxidative stress, which breaks cell membranes.

Researchers found that some molecules that serve as building blocks of cell membranes were elevated when air pollution levels rose. Broken cell membranes release different kinds of lipid molecules. Some of these lipid molecules, with the help of enzymes, turn to inflammatory molecules, which could be harmful to the body.

"The good thing is that we also found some protective molecules, namely antioxidants, also increased when air pollution is high, indicating our body has a defense system to reduce harm," Mu said.

Studies such as this one may help identify individuals most vulnerable to air pollution, as well as finding potential biological pathways to guide treatment that reduces harm to the body, Mu said.

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