



Does Your Commute Impact Your Health?

By Michaela Burns and Ann Cornelius Brown

People are increasingly spending more time commuting to and from work each day. According to the U.S. Census Bureau, over 10 million Americans have a commute longer than two hours.

Studies by the U.S. Environmental Protection Agency (EPA) and others have provided insights into how air pollution emitted from vehicles can potentially impact cardiovascular health of commuters. Early exposure studies have measured both real-world exposures and the health response of individuals, with results showing some associations between commuting and health effects.

Michaela Burns is an Oak Ridge Associated Universities Contractor in Science Communications with the U.S. Environmental Protection Agency's Office of Research and Development (ORD). **Ann Cornelius Brown** is a Communications Lead in ORD.

A 2004 study of highway patrolmen in North Carolina observed associations between in-vehicle exposures to particulate matter (PM) over eight-hour shifts and acute changes in systemic inflammation biomarkers and cardiac autonomic function. In other research, scientists found biological changes in cardiorespiratory response in young, healthy active adults following exposures to PM levels typically experienced during commutes.

While research has raised concerns about possible health issues that might occur during a commute, results from commuter studies have been inconsistent.

"A greater understanding of in-vehicle exposures and health for commuters is necessary and can be used to explore ways to reduce health issues with driving," says Bob Devlin, a researcher at EPA who has studied near highway health effects on the cardiovascular system for several decades.

Research is further exploring the relationship between air pollution and commuter health. EPA supported the landmark commuter studies by Emory University and the Georgia Institute of Technology with a Clean Air Research Center grant. The National Institutes of Health and Centers for Disease Control and Prevention also contributed funding. In two large exposure and health assessment studies in the Atlanta metropolitan area, researchers examined commuters with asthma and those without to investigate pollutant exposures among daily car commuters and corresponding health effects. In 2014, they published findings from one of the studies, known as the Atlanta Commuters Exposures (ACE-1) Study.¹

Researchers measured air quality conditions in participant vehicles by using specific biomarkers to assess acute response consistent with oxidative stress and inflammation pathways and lung function and heart rate variability parameters. They also measured

pollutants such as fine and ultrafine PM, black carbon, polycyclic aromatic hydrocarbons (PAHs), and in-cabin noise levels. Blood plasma samples were collected before, during, and immediately after the commutes, as well as in three hourly intervals after the commutes.

The study found substantially elevated concentrations of particulate pollutants inside the vehicle. After a two-hour highway commute, participants with or without asthma demonstrated measurable increases in pulmonary inflammation and reductions in heart rate variability. The researchers saw no difference in the response to traffic pollution between those with or without asthma. To better understand the nature of in-vehicle exposures and acute response in daily car commuters, researchers also designed and conducted a second commuter study known as the Atlanta Commuters Exposure-2 (ACE-2) Study.²

ACE-2 examined whether in-vehicle exposure during a scripted highway commute differed from exposure during a side street commute or exposure to indoor air in a clinic, which could potentially lead to different acute inflammatory and cardiorespiratory responses. This study involved 60 young adult participants with or without asthma in Atlanta.

The findings of the study showed that, in general, in-vehicle pollutant exposures were higher during the highway commuting sessions compared to side street commutes or clinic visits. This points to the uniqueness of the car commuter microenvironment and the

potential risk to commuters. Researchers also observed short-term increases in systemic inflammatory and acute respiratory responses associated with in-vehicle concentrations of several primary traffic pollutants. They believe that these changes may be indicative of exposure to traffic pollution.

Researchers from Emory University and the Georgia Institute of Technology have used the data from the studies to explore additional concerns about the impact of short-term traffic-related pollution exposure on commuters. In one of these studies, they used metabolomics to better investigate potential effects of air pollution on commuters.

Metabolomics is the study of small metabolites, which play an important role in sustaining life through metabolic reactions at the molecular level. Metabolic pathways can be altered by disease, infections, or exposure to environmental chemicals such as air pollutants. High-resolution metabolomics can be used to successfully measure thousands of metabolites and may help identify pathophysiological changes in pathways associated with different types of pollutant exposure.

In a paper published in 2018, researchers from the two institutions used data from one of their studies and high-resolution metabolomics to investigate potential changes of metabolite levels in blood plasma samples from daily commuters in Atlanta, following their exposure to traffic pollution.³

“High-resolution metabolomics is a really powerful tool for capturing a

holistic picture of changes at the cellular level that might be occurring as a result of exposure to complex mixtures like what we see in vehicles,” says Jeremy Sarnat, associate professor of Environmental Health at Emory’s Rollins School of Public Health and a lead investigator.

Results showed an association between particulate metal exposures, especially lead, with metabolic changes in targeted inflammatory markers seen two hours after exposure to traffic-related pollution. Researchers also saw an association between exposure to particulate metal pollution and changes in pathways associated with fatty acid and amino acid metabolism ten hours after exposure. This is one of the first indications of a directly-measured traffic pollutant associated with changes in human metabolomic profiles. The study also demonstrated that high-resolution metabolomics can be used as a tool to detect changes in key metabolic pathways in response to traffic-related pollution.

As research continues to fill knowledge gaps on the potential biological effects linked to spending many hours driving, it is important to take steps to determine how people can protect themselves from air pollution, including traffic-related pollution. EPA researchers are investigating possible strategies to reduce the effect of air pollution on health. **em**

References

1. Sarnat, J.A.; Golan, R.; Greenwald, R.; Raysoni, A.U.; Kewada, P.; Winquist, A.; Sarnat, S.E.; Flanders, W.D.; Mirabelli, M.C.; Zora, J.E.; Bergin, M.H.; Yip, F. Exposure to traffic pollution, acute inflammation and autonomic response in a panel of car commuters; *Environ. Res.* 2014, 133, 66-76; doi: 10.1016/j.envres.2014.05.004.
2. Golan, R.; Ladva, C.N.; Greenwald, R.; Krall, J.R.; Raysoni, A.U.; Kewada, P.; Winquist, A.; Flanders, W.D.; Liang, D.; Sarnat, J.A. Acute Pulmonary and inflammatory response in young adults following a scripted car commute; *Air Quality Atmosphere & Health* 2017, 11 (2), 123; doi:10.1007/s11869-017-0530-8.
3. Ladva, C.N.; Golan, R.; Liang, D.; Greenwald, R.; Walker, D.J.; Uppal, K.; Raysoni, A.U.; Tran, V.; Yu, T.; Flanders, W.D.; Miller, G.W.; Jones, D.P.; Sarnat, J.A. Particulate metal exposures induce plasma metabolome changes in a commuter panel study; *PLoS One* 2018, 13 (9), e0203468; doi:10.1371/journal.pone.0203468.

More Information

Learn more about ways that you can protect yourself from air pollution on EPA’s Healthy Heart web page (<https://www.epa.gov/air-research/healthy-heart-toolkit-and-research>).

Additional Resources:

- Research on Near Roadway and Other Near-Source Air Pollution (<https://www.epa.gov/air-research/research-near-roadway-and-other-near-source-air-pollution>)
- How Can You Protect Your Heart from Air Pollution (<https://www.epa.gov/science/health/how-can-you-protect-your-heart-air-pollution>)

For more information about the **EPA Research Highlights** column, contact Ann Cornelius Brown, U.S. Environmental Protection Agency (EPA), Office of Research and Development, Research Triangle Park, NC; phone: 1-919-541-7818; e-mail: brown.ann@epa.gov.

Disclaimer: The views and opinions expressed in this article are those of the author and do not represent the official views of the U.S. Environmental Protection Agency (EPA).