HEI

STATEMENT

Synopsis of Research Report 196

HEALTH EFFECTS INSTITUTE

Exposure to Traffic-Related Air Pollution in a Panel of Students Living in Dormitories

INTRODUCTION

Exposure to traffic-related air pollution has been associated with various adverse health effects. However, exposure assessment is challenging because traffic-related air pollution is a complex mixture of many particulate and gaseous pollutants and is characterized by high variability by location and by time of day or season. Approaches to assess exposure to traffic-related air pollution have included measurements made at fixed sites at various distances from busy roads or with a mobile platform and via models such as land-use regression and dispersion models. Sarnat and colleagues proposed to evaluate two multipollutant air pollutant metrics that had not previously been considered as metrics of exposure to traffic-related air pollution, by collecting measurements in and around two student dormitories in Atlanta that were located at different distances from a major highway. They also proposed a small panel study to compare the indoor and outdoor pollutant concentrations to personal exposures experienced by students who lived in the two dormitories. They intended to explore the use of metabolomics to identify possible biological markers that varied with exposure to traffic-related air pollution in those students. With the encouragement of HEI, they also colocated several low-cost sensors with monitors using more established methods to test the reliability of the new sensors.

APPROACH

The investigators conducted their study on the campus of the Georgia Institute of Technology in Atlanta, Georgia, near the downtown Connector where I-75 and I-85 merge, one of the most heavily trafficked highway arteries in the United States (~300,000 vehicles per day with little diesel traffic). The investigators conducted an extensive field campaign to measure levels of a number of air pollutants — including fine particulate matter, nitrogen dioxide (NO_2), and black carbon — at six outdoor sites and inside two student dormitories at different distances from the highway. They also measured

What This Study Adds

- This study evaluated exposure to traffic-related air pollutants measured outside, inside, and by personal monitors. It also evaluated metabolomics profiles in students living in dormitories close to or away from a traffic hotspot.
- It had many strong aspects — a large number of measurements at a site next to one of the busiest highways in the United States, a multipollutant approach, various exposure metrics, and concurrent evaluation of low-cost sensors.
- Lower-than-expected air pollutant concentrations and less-steep gradients reported in this and other recent studies provide evidence that the near-road environment is improving, likely a consequence of air quality regulations and related improvements in vehicle emission control technologies.
- The multipollutant exposure metrics explored in the study did not appear to be useful to capture traffic-related air pollution in the near-road environment, and the low-cost sensors tested did not perform well.
- Because of the low exposure contrast and other differences between the dormitory populations, a metabolomics study to explore differences among residents of two dormitories — one close to and the other farther from the roadway — was not informative.

This Statement, prepared by the Health Effects Institute, summarizes a research project funded by HEI and conducted by Dr. Jeremy Sarnat, Emory University Rollins School of Public Health, Atlanta, Georgia, and colleagues. The complete report, *Developing Multipollutant Exposure Indicators of Traffic Pollution: The Dorm Room Inhalation to Vehicle Emissions (DRIVE) Study* (© 2018 Health Effects Institute), can be obtained from HEI or our website (see next page).

personal air pollutant exposures to NO_2 and black carbon with monitors carried by a panel of student participants, as well as biological markers in the study participants.

The study focused on evaluating two multipollutant metrics of exposure to traffic-related air pollution. The first, the integrated mobile source indicator (IMSI), combines measurements of several different pollutants (elemental carbon, carbon monoxide, and nitrogen oxides) into a single metric of the mixture of traffic-related air pollutants. The second, the oxidative potential of fine particulate matter (FPMOP), was considered a potential metric of exposure to traffic-related air pollution because it was associated with both mobile source emissions and cytotoxicity and heart- and lung-related emergency department visits in some earlier studies. Although it is a single measurement, FPMOP is considered a multipollutant metric because it is affected (albeit unpredictably) by many particle properties, including size, surface properties, and chemical composition.

First, Sarnat and colleagues evaluated how pollutant levels changed with weather and time of day or week at an air pollutant monitor located 10 m from the highway. Second, they compared the air pollutant levels at their other monitors with the levels at the highway monitor. Third, they tested which outdoor and indoor measurements were most strongly correlated with measurements made by monitors carried by the participants. Fourth, they measured metabolomics profiles in the study participants' blood and saliva to see if there were differences among the participants that lived in the two dormitories.

MAIN RESULTS AND INTERPRETATION

In its independent review of the study, the HEI Review Committee noted that Sarnat and colleagues conducted a comprehensive study to evaluate single-pollutant and multipollutant metrics of exposure to traffic-related air pollution. The large number of detailed measurements — including outdoor and indoor air pollutant levels, personal exposure to air pollutants, and measurements in blood and saliva — the multipollutant approach, the low participant drop-out rate, and the concurrent evaluation of low-cost sensors were strengths of the study.

The results did not provide strong evidence of the utility of the IMSI or FPMOP as multipollutant metrics of exposure to traffic-related air pollution for use in health studies in the near-road environment. There was limited variation in these proposed metrics over the study area on average, although the different sites did have some differences in air pollutant levels when stratified by time of day. In addition, NO_2 did not seem to be a good metric of exposure to traffic-related air pollution in this study, because NO_2 levels were not substantially higher near the highway than they were farther away, and indoor sources contributed to the NO_2 levels inside the dormitories. The Committee noted that the investigators had not adopted an a priori criterion by which to assess the suitability of candidate metrics of exposure to traffic-related air pollution; when the Committee did apply its own criteria, they concurred with the conclusion that the multipollutant metrics were not useful for this application.

An interesting approach in this study was that it included a panel study with biological sampling for metabolomics analyses, rather than stopping at assessment of exposure to air pollution; however, the usefulness of the panel study results was limited. Despite their locations at different distances from the roadways, the personal exposures measured among residents of the two dormitories were very similar. The Committee thought the reported metabolomics differences were likely a consequence of factors other than exposure to traffic pollution. Though more extensive analyses are under way, an expanded study design that included more dormitories with carefully controlled building and population characteristics to allow separation of metabolomic differences related to the dormitory from those related to traffic-related air pollution would have been preferable.

The overall lower-than-expected air pollutant concentrations and less-steep gradients reported in this and other recent studies provide evidence that the near-road environment is improving. This result was likely a consequence of air quality regulations and related improvements in vehicle emission control technologies. The changing near-road environment has important consequences for the design of new research assessing the adverse health effects of traffic-related air pollution because larger study populations will be needed to measure potential effects of smaller exposure contrasts. In addition, past near-road air pollution and health studies may become less relevant to the current and future near-road environment given the fast-paced changes in engine and fuel technologies and electrification of the fleet.

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