STATEMENT

Synopsis of Research Report 160

HEALTH EFFECTS INSTITUTE

Air Toxics Exposures in a Potential Hot Spot in New Jersey

INTRODUCTION

Air toxics comprise a large and diverse group of air pollutants that, with sufficient exposure, are known or suspected to cause adverse effects on human health. The Clean Air Act requires the U.S. Environmental Protection Agency to characterize, prioritize, and address the effects of air toxics on public health and the environment.

Although ambient concentrations of some of these air toxics have been monitored by state or local agencies in some areas, the characterization of personal exposures to air toxics has been limited. And although ambient concentrations are generally low, so-called hot spots might exist where concentrations of one or more air toxics, and consequent exposures of area populations, could be elevated. In 2003, HEI targeted research to identify and characterize potential air toxics hot spots, with the aim of conducting future health studies in these locations.

APPROACH

Dr. Paul J. Lioy of the Environmental and Occupational Health Sciences Institute of Piscataway, New Jersey, and colleagues evaluated ambient and personal exposures to particulate matter with aerodynamic diameter ≤ 2.5 µm ($PM_{2.5}$) and several air toxics in 107 nonsmoking residents of two neighborhoods in Camden, New Jersey. Residents of both neighborhoods were predominantly low-income. The investigators hypothesized that one neighborhood, Waterfront South, was an air toxics hot spot, defined as having elevated concentrations of air toxics compared with those of a nearby area. Waterfront South has numerous industrial sites serviced by heavy truck traffic and is close to major roads; its residents were thus likely to be exposed to air toxics from multiple sources. The other neighborhood, Copewood–Davis, was selected as the control, or comparison, site for the pollutant measurements. It was near Waterfront South and had no industrial sites.

Between June 2004 and July 2006 the investigators collected four sets of 24-hour personal air samples from the study subjects and made simultaneous measurements of ambient pollutant concentrations at a fixed monitoring site in each neighborhood. To assess how pollutant concentrations varied by season, they collected personal and ambient samples in summer and in winter. To assess how mobile sources (particularly truck traffic) contributed to pollutant concentrations, they collected personal and ambient samples on weekdays and weekend days (anticipating that concentrations would be higher on weekdays). To assess finer spatial variability in air toxics concentrations, they also conducted a saturation-sampling substudy in which pollutant measurements were made at 38 monitoring sites in the two neighborhoods.

Lioy and colleagues measured concentrations of multiple air toxics, including volatile organic compounds (VOCs) (especially benzene, toluene, ethylbenzene, *m*- & *p*-xylenes, *o*-xylenes, methyl *tert*-butyl ether [MTBE], chloroform, carbon tetrachloride, and hexane); aldehydes (especially formaldehyde and acetaldehyde); and polycyclic aromatic hydrocarbons (PAHs) (especially naphthalene, phenanthrene, pyrene, and benzo[*a*]pyrene as representatives of compounds with two to five benzene rings). They also measured $PM_{2.5}$ concentrations.

In addition to comparing concentrations of air pollutants in Waterfront South with those in Copewood–Davis, the investigators used an alternative definition of a hot spot — i.e., having elevated concentrations of air toxics compared with those of other, more distant areas in New Jersey and across

This Statement, prepared by the Health Effects Institute, summarizes a research project funded by HEI and conducted by Dr. Paul J. Lioy of the Environmental and Occupational Health Sciences Institute, Piscataway, New Jersey, and colleagues. The complete report, *Personal and Ambient Exposures to Air Toxics in Camden, New Jersey* (© 2011 Health Effects Institute), can be obtained from HEI or its Web site (see next page).

the United States — to compare concentrations of air pollutants in Waterfront South and Copewood–Davis with concentrations at other locations.

KEY FINDINGS AND CONCLUSIONS

HEI's Health Review Committee, which undertook an independent review of the study, thought the study had made an important contribution to the characterization of possible air toxics hot spots.

The investigators reported that one of the neighborhoods, Waterfront South, had consistently higher ambient concentrations than the other, Copewood–Davis, of $PM_{2.5}$, toluene, xylenes, and PAHs. Thus, by the investigators' original definition of a hot spot (i.e., having elevated concentrations compared with those of a nearby control, or comparison, area with fewer industrial sites), Waterfront South could be considered a hot spot for these pollutants. However, ambient concentrations in Copewood–Davis of several other pollutants — benzene, MTBE, chloroform, carbon tetrachloride, hexane, and acetaldehyde — were as high as or higher than those in Waterfront South. The Committee generally considered the measurements of the air pollutants to have been accurate and reliable. However, they were concerned about the validity of the absolute concentrations of benzene, formaldehyde, and acetaldehyde, because they were much higher than those reported in other studies, and there appeared to be some specific problems with the measurement method for formaldehyde.

The Committee concurred with the investigators' conclusion that, by their alternative definition of a hot spot (i.e., having elevated concentrations compared with those of other, more distant areas in New Jersey and across the United States), *both* neighborhoods could be considered hot spots for $PM_{2.5}$, benzene, toluene, xylenes, MBTE, and aldehydes. At the same time, the Committee cautioned that comparisons of pollutant concentrations across studies are difficult because studies differ in averaging periods, sampling and analysis methods, types of sampling sites, and meteorologic conditions (temperature and wind speed and direction are particularly relevant). The Committee also noted that, although ambient concentrations of PAHs were higher in Waterfront South than in Copewood–Davis, they were not higher than those measured at other urban sites in the United States and that therefore, by the alternative definition, neither neighborhood was a hot spot for PAHs.

The Committee concluded that the study had provided useful information on personal exposures in the two neighborhoods. For most of the pollutants, measured personal concentrations were higher than the respective ambient concentrations measured at the study's two fixed monitoring sites, suggesting contributions from sources other than outdoor (i.e., indoor or occupational). In general, variations in personal concentrations did not correspond with variations in ambient concentrations. The Committee considered that this highlighted an important continuing issue for policy making and future health effects studies of air toxics — namely the difficulty of relating personal exposures to ambient concentrations measured at a central monitoring site.

The Committee found that the investigators' saturation-sampling substudy, in which measurements of ambient air toxics were made in three campaigns at several monitoring sites in each neighborhood, provided valuable information about the spatial variability at small scales of pollutant concentrations that could be compared with information from each neighborhood's fixed monitoring site. The results showed that, even within a possible hot spot, spatial variability in ambient concentrations can be found, suggesting that people in some locations within a neighborhood are likely to be exposed to much higher concentrations than those recorded at a fixed monitoring site in the same neighborhood. This finding again underscores the importance of individualized personal monitoring of pollutants. Lioy and colleagues also provided useful information that showed temporal (weekday versus weekend) and seasonal (summer versus winter) variability in individual pollutant concentrations.

The Committee concluded that in retrospect choosing Copewood–Davis as the control area for the study was not ideal. Although the neighborhood was free of industrial facilities, it was subject to high concentrations of mobile-source emissions from traffic on roads in or near the area as well as of emissions transported from adjacent areas (including Waterfront South). The two neighborhoods were also subject to the same regional meteorologic conditions and the same pollutant plume from Philadelphia (some 20 miles [32 km] away), and both were topographically simple.

In summary, the current study provided valuable information about ambient and personal concentrations of $PM_{2.5}$ and a large number of air toxics and demonstrated elevated ambient concentrations (compared with other areas in New Jersey and across the United States) of some air toxics in both of these lower-socioeconomic-status neighborhoods. At the same time, the findings illustrate the difficulties of defining an area a priori as a potential hot spot — or as a control location. The design of future exposure and health effects studies in hot spots will need to take multiple pollutant sources and meteorologic factors into consideration to achieve sufficient contrasts in pollutant concentrations between appropriately chosen hot spots and background locations.

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