HEI

STATEMENT

Synopsis of Research Report 143

HEALTH EFFECTS INSTITUTE

Measurement and Modeling of Exposure to Selected Air Toxics

BACKGROUND

Air toxics are a diverse group of air pollutants that are known or suspected, with sufficient exposure, to cause adverse health effects including cancer, damage to the immune, neurologic, reproductive, developmental, or respiratory systems, or other health problems. Limited monitoring has been performed by some state and local agencies, but substantial uncertainty regarding exposure to air toxics remains, largely because of their presence in the ambient environment at low concentrations. Although environmental exposures to air toxics are generally low, the potential for widespread chronic exposure and the large number of people who are exposed have led to concerns regarding their impact on public health. Estimation of the health risks of exposure to air toxics is complicated by the fact that there are multiple sources of air toxics. These may be outdoor and indoor (e.g., environmental tobacco smoke, building materials, consumer products, and cooking).

APPROACH

Dr. Roy Harrison investigated personal exposures to a broad group of air toxics, with the goal of developing detailed personal exposure models that take various microenvironments into account. In order to provide important information on personal exposures to air toxics, the study was designed to capture adequate variation in exposure concentrations. Repeated measurements of exposure to selected air toxics were made for each of 100 healthy adult nonsmoking participants residing in urban, suburban, and rural areas of the United Kingdom expected to have different traffic exposures. Measurements included five repeated 24-hour measurements of personal exposure to volatile organic compounds (VOCs; including 1,3-butadiene) per participant; five urine samples collected to test for urinary biomarkers (polycyclic aromatic hydrocarbon [PAH] metabolites, cotinine, and *trans*-3′-hydroxycotinine) per participant; and one 24-hour measurement of particle-phase PAHs per participant; plus concurrent measurement of microenvironmental exposures at participants' homes and workplaces — a total of 200 VOC, 190 1,3-butadiene, and 168 PAH samples, as well as measurements in other major microenvironments.

Dr. Harrison developed models to predict personal exposures on the basis of microenvironmental concentrations and data from time–activity diaries, and compared measured personal exposures with modeled estimates of exposure. The goal was to use these data to produce a scheme for categorizing exposure (by compound) according to the location of residence and other lifestyle and exposure factors, including environmental tobacco smoke, for use in the design of health studies of cancer incidence.

RESULTS AND IMPLICATIONS

This study serves as a rich source of recent information on personal exposures to selected air toxics across a range of residential locations and exposures to non-traffic sources, with attention to spatial variation and areas in which air toxics exposures were likely to be elevated. However, most participants in the study were young adults, thus limiting the study's generalizability to other age groups. Also, owing to challenges in recruitment, the study sample was not balanced.

This Statement, prepared by the Health Effects Institute, summarizes a research project funded by HEI and conducted by Dr. Roy M. Harrison at University of Birmingham, Division of Environmental Health and Risk Management, Birmingham, U.K., and colleagues. The complete report, *Measurement and Modeling of Exposure to Selected Air Toxics for Health Effects Studies and Verification by Biomarkers*, can be obtained from HEI or our Web site (see next page).

Personal exposures were most heavily influenced by the home microenvironment and were higher in the presence of fossil fuel combustion, environmental tobacco smoke, solvent use, use of selected consumer products, and commuting. After the home microenvironment, the workplace and commuting were the largest contributors to personal exposure. The reported concentrations of selected air toxics and levels of personal exposure were somewhat lower than those observed in other studies.

Harrison and colleagues used an innovative approach to modeling to predict personal exposures on the basis of microenvironmental concentration data and time–activity diaries, with the idea that models could inform the design of future health studies. The most predictive statistical models did only a fair-to-moderate job of predicting personal exposures, however. Statistical models based on microenvironmental factors and lifestyle were able to explain a fair amount of the variance in personal exposures for selected VOCs but were less predictive of PAH exposures. While part of the inability to effectively model exposures may be due to the lack of measured characteristics of home ventilation, particularly air exchange rates in the home, this study underscores the challenges of accurately predicting personal exposures. Personal exposure monitoring requires extensive time and equipment, but the science is not yet at a point at which exposures to VOCs and PAHs can be reliably predicted from time–activity patterns and microenvironmental concentrations alone.

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