HEI Publishes New Review of Asian Literature on Air Pollution and Health

HEI has just published Special Report 18, *Outdoor Air Pollution and Health in the Developing Countries of Asia: A Comprehensive Review*. This benchmark publication for policy makers, stakeholders, and scientists assesses the latest science on air pollution and health from nations in East, South, and Southeast Asia. Although these countries have demonstrated promising successes in pollution reduction, the unprecedented growth in energy consumption, vehicle sales, and urbanization in this region underscores the importance of understanding the impact of air pollution on local populations and international transport in the world’s most rapidly expanding marketplace.


HEI to Issue Report on Emerging Fuels and Technologies

A host of new automotive fuels and technologies are in the works or will emerge over the coming decade, according to a new report to be issued soon by HEI’s Special Committee on Emerging Technologies (SCET). The HEI Board of Directors formed this distinguished advisory body to aid the institute in identifying fuels and technologies with a high likelihood of coming to market so that HEI can effectively evaluate their potential intended and unintended consequences for health and, where needed, initiate timely research to inform the next round of fuel and technology development.

The variety of vehicle fuels and technologies is expanding at an unprecedented rate. In its report, SCET notes that these developments are being “driven by a need for energy independence, increased fuel efficiency, reduction in pollutant emissions, and concern about climate change.” The report (HEI Communication 16) focuses on technologies and fuels likely to be commercially available within the next 10 years. It includes chapters about technological changes for both gasoline- and diesel-powered vehicles, the trend toward power-train electrification, new fuels derived from biomass and nontraditional sources, and non-fuel emissions, such as dust from brake and tire wear and combustion of lubricating oil. Continued on page 5.

Members of the Special Committee on Emerging Technologies met last spring in Sacramento, California, with HEI President Daniel Greenbaum, Director of Science Rashid Shaikh, and Vice President Robert O’Keefe, along with Joseph Somers of the U.S. Environmental Protection Agency. From left: Greenbaum, Thomas Cackette, Somers, Shaikh, Norbert Pelz, Christine Vujovich, Steve Cadle, Alan Lloyd, Robert Sawyer, Wayne Eckerle, O’Keefe, and David Kittelson. PHOTO BY DHITI STEMACH

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Studies of Particulate Matter Exposure

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summarized here are three recently published or forthcoming HEI Research Reports. Each contains a Critique by HEI’s Review Committee.

Effects of Exposure to Diesel Exhaust on Young and Old Mice

Epidemiologic studies generally indicate that people over the age of 55 years are more sensitive than younger people to exposure to airborne particulate matter (PM). What is the physiologic basis for this increased sensitivity in older people? Debra Laskin and her colleagues at Rutgers University (New Brunswick, New Jersey) and its Environmental and Occupational Health Sciences Institute (Piscataway) address this question in HEI Research Report 151, Pulmonary Effects of Inhaled Diesel Exhaust in Young and Old Mice: A Pilot Project.

The report, part of HEI’s program to investigate the health effects of PM and its various components, describes a one-year study in which Laskin’s team examined the effects of inhalation of diesel exhaust — a compo-


nt of urban air pollution — in young mice (2 months of age) and old mice (18 months) as a model of the effects of air pollution in humans. In preparation for testing, Laskin and her colleagues built a diesel exhaust exposure chamber and characterized the physical properties of the diesel emissions they generated. The investigators originally hypothesized that exposure to diesel exhaust would result in lower-level production of the cytokine tumor necrosis factor by the lung macrophages of old mice than by those of young mice. The investigators extended their analyses to evaluate the airways and blood of the diesel-exposed mice for several markers of inflammation, injury, and oxidative stress and antioxidant defense mechanisms.

Fine-Tuning Methods for Predicting Exposure

HEI will soon publish Research Report 152, Evaluating Heterogeneity in Indoor and Outdoor Air Pollution Using Land-Use Regression and Constrained Factor Analysis, by Jonathan Levy of the Harvard School of Public Health and colleagues. Levy was a recipient of HEI’s Walter A. Rosenblith New Investigator Award for this work in 2005.

Using a creative combination of land-use regression and source-apportionment techniques, Levy (now at the Boston University School of Public Health) and his co-investigators sought to improve upon the data and methods used to predict individual-level exposures to indoor and outdoor concentrations of PM_{2.5} (PM with an aerodynamic diameter of 2.5 µm or smaller), elemental carbon, and nitrogen dioxide and to better understand their indoor and outdoor sources, including traffic. The team obtained health and air monitoring data on individuals and their homes from an ongoing prospective birth-cohort study of factors contributing to the development of asthma — the Asthma Center for Community, Environment, and Social Stress (ACCESS) study, in Boston, Massachusetts. An underlying goal of the study was to evaluate how their approaches might reduce the amount of error in the levels of exposure assigned to individuals and thereby improve epidemiologic estimates of the effects of traffic-related air pollution on health.

Improved Analysis of PM Composition

Particulate air pollution has been increasingly associated with adverse health effects, and interest has been growing in the chemical composition of PM as a key step in understanding whether some PM components have greater or lesser toxicity. Studies of PM composition have focused on particulates from high-volume samplers, which do not necessarily represent human exposures, and personal sampling does not collect enough particulate for traditional analysis of chemical composition. In the upcoming HEI Research Report 153, Improved Source Apportionment and Speciation of Low-Volume Particulate Matter Samples, James Schauer of the University of Wisconsin–Madison and his colleagues detail research on methods with the high sensitivity and low limits of detection needed to analyze a wide range of chemical species in personal-scale particulate samples. Schauer was a recipient of HEI’s Walter A. Rosenblith New Investigator Award for this work in 2002.

For the analysis of trace metals in PM_{2.5}, the research team used a novel process to concentrate the samples for improved detection; the investigators also further adapted their method for analysis of non-polar organic compounds. Additionally, they adapted inexpensive wet-chemical methods for analysis of iron, manganese, and chromium in various oxidation states. In validation studies, the investigators found that most of their methods were sensitive enough to detect the chemicals of interest in small PM samples. Schauer’s team then analyzed particulates from low-volume samplers used in two health studies; the subjects were workers at a trucking terminal and residents of a retirement community located in a high-traffic area.

The methods described by Schauer and colleagues extend PM composition research to the personal scale. Their low-volume methods may be used by researchers to gain greater insight into the relationships between the composition of inhalable particulates and their health effects.

These Research Reports will be available for downloading, free of charge, at http://pubs.healthteffects.org; printed copies can be purchased from HEI.

For more information on Research Report 151, contact Geoffrey Sunshine (+1-617-488-2303; sunshine@healthteffects.org); for Research Report 152, Katherine Walker (+1-617-488-2310; kwalker@healthteffects.org); and for Research Report 153, Kate Adams (+1-617-488-2330; kadams@healthteffects.org).

MARK YOUR CALENDAR

HEI Annual Conference
May 1–3, 2011
Park Plaza Hotel
Boston, Massachusetts
Keeping an “Eye on the Sky” on the HEI Research Committee

The HEI Board of Directors recently announced the appointment of David T. Allen, the Gertz Regents Professor in Chemical Engineering and director of the Center for Energy and Environmental Resources at the University of Texas–Austin, to the HEI Research Committee. Allen was appointed to fill the seat held with distinction for the past eight years by Kenneth Demerjian, professor in the Department of Atmospheric and Environmental Sciences at the University at Albany, State University of New York.

Since its inception, HEI has relied on top atmospheric chemists on its Research Committee to inform its health research programs, ensuring proper collection and use of air quality information and careful assessment of exposure. Allen brings substantial experience and expertise to this role: he is the author of six books and more than 180 papers, primarily in the areas of air quality and prevention of pollution, and he was a lead investigator for the Texas Air Quality Studies, which have had a substantial impact on the direction of air quality policies in Texas. The caliber of his work has been recognized by the National Science Foundation, the AT&T Foundation, the American Institute of Chemical Engineers, the State of Texas, and the Association of Environmental and Engineering Science Professors.

Allen serves on state and national committees that advise government agencies, including the National Research Council’s Board of Environmental Studies and Toxicology, the U.S. Environmental Protection Agency’s Science Advisory Board, and the Texas Council on Environmental Technology (which he chaired). He received his bachelor’s degree in chemical engineering, with distinction, from Cornell University and his master’s and doctoral degrees in chemical engineering from the California Institute of Technology.

As Allen joins the committee, Demerjian steps down after serving two four-year terms. He has been a significant contributor to the work of HEI in many ways. On the committee, he has played a central role in ensuring the quality of air pollution data for HEI’s National Particle Component Toxicity initiative and of the emissions characterization for new diesel engines in HEI’s Advanced Collaborative Emissions Study. As a “father” of health outcomes research, he has been an essential part of shaping HEI’s program to assess the impact of regulations intended to reduce air pollution and improve human health. In addition, he has served on HEI’s International Scientific Oversight Committee and was an important contributor to the recent review of the literature on traffic exposure and health (Special Report 17). Though he has left the committee, Demerjian has agreed to continue assisting HEI in its oversight of several major programs he helped launch.

“We are sad to see Ken leave the committee,” said Rashid Shaikh, HEI’s director of science, “and we thank him for his extraordinary service. But we are very pleased that a scientist of David Allen’s knowledge and skill has agreed to step in and help move HEI’s research forward.”

Interest High in HEI’s Traffic Review

HEI Special Report 17, Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects, has spurred strong interest among major constituencies around the world since its publication last January. As reported in the spring 2010 issue of HEI Update, this review of the scientific literature considered more than 700 studies on relevant topics ranging from emissions to exposure and health; its purpose is to provide thoughtful synthesis of a difficult and sometimes conflicting science base.

The key conclusion that exposure to traffic-related air pollutants, particularly in densely populated urban areas, can be widespread, combined with a careful assessment of sufficient or suggestive evidence for causal associations with a number of health end points, has helped clarify what is known and what remains to be understood about this important topic. The review has captured the attention of sponsors, policy makers, scientists, and stakeholders alike.

Prominent coverage of the Special Report in the New York Times has generated numerous invitations to HEI to present the findings. These engagements have included bipartisan briefings for congressional staff from committees on transportation, commerce, environment, and public works, and other committees with relevant jurisdiction. In addition, HEI staff have made presentations to the Transportation Research Board, the Air and Waste Management Association, and the International Society of Environmental Epidemiology, as well as at high-level Chinese and Indian forums.

“As is often observed, one important measure of the impact of HEI — effective and balanced communication of results to all important parties — begins with the publication of a major review or study,” said HEI President Daniel Greenbaum. “Our recent and continuing efforts to communicate about our Traffic Review build on that tradition.”

Special Report 17 is available at http://pubs.healtheffects.org; printed copies can be purchased from HEI. For more information, contact Maria Costantini (+1-617-488-2302; mcostantini@healtheffects.org).
A Literature Review, was published by HEI in 2004, at the inception of its PAPA research program.

The current review, prepared by HEI’s International Scientific Oversight Committee, begins with a broad overview of status and trends in air pollution sources, emissions, concentrations, and exposure, as well as factors related to urban development, population health, and public policy. The picture it paints is complex. Although air quality has improved in many urban centers despite increased combustion of fossil fuels, many cities remain highly polluted. Economic development has led to increased life expectancy, but the region may face larger health impacts of air pollution owing to chronic cardiovascular and respiratory disease as populations age and as other risk factors, such as smoking and obesity, increase in prevalence.

Following this overview is an expanded assessment of the Asian literature on the health effects of outdoor air pollution, which begins with a systematic review of 82 Asian time-series studies published through August 2007, three times as many studies as were available for HEI’s earlier review. These results, which now include estimates from the recently completed coordinated multicity PAPA project in China and Thailand, provide the basis for a unique regional estimate of the magnitude of the effects of exposure on daily mortality and hospital admissions and allow more definitive comparisons of Asian evidence with results from other regions. A meta-analysis of the 28 studies of all-natural-cause mortality estimated that short-term exposure to particulate matter with an aerodynamic diameter of 10 µm or smaller (PM10) increased daily mortality from all natural causes by 0.27% per 10 µg/m³ (95% confidence interval, 0.12–0.42). This increase is similar to that reported in meta-analyses and multicity studies in Europe, North America, and Latin America. Recent studies have observed adverse effects at lower levels of air pollution in cities in Thailand and Japan, where air quality has improved, as well as in heavily polluted Chinese and Indian cities.

In addition, in the first-ever critical review of Asian studies of selected chronic effects of long-term exposure to air pollution, Special Report 18 reviews studies of chronic respiratory disease, lung cancer, and adverse reproductive outcomes, such as low birth weight. Consistent with evidence from the West, the Asian studies suggest that long-term exposure to air pollution is associated with increased occurrence of these adverse health outcomes. The review notes, however, that these studies are more susceptible than the time-series studies to uncontrolled confounding by strong risk factors, such as tobacco smoking, and factors related to socioeconomic status, such as diet and indoor air pollution from the burning of solid fuels. Such factors may also modify the effect of air pollution, leading to larger effects in some population groups and smaller effects in others, and may be particularly important in developing countries of Asia.

The review also identifies important gaps in scientific knowledge, noting that the effects of air pollution in major population centers in South and Southeast Asia still have not been investigated owing to the absence of data on exposure and health outcomes. There is also little knowledge about the components of air pollution mixtures from diverse sources in rapidly growing urban areas or about their health effects. To date, there are no published studies of the effects of long-term exposure to air pollution on mortality from cardiovascular and respiratory disease in Asian populations; in such studies, cohorts of individuals exposed to different levels of air pollution would be observed for extended periods of time and their mortality rates would be compared.

The information on the health effects of air pollution in Asia reviewed in Special Report 18 provides a substantial basis for policies designed to improve the health of Asian populations. Nonetheless, the need for high-quality research in this field will only grow as attention increasingly focuses on issues of regional importance, such as climate change and transboundary air pollution. This HEI Special Report, along with continued funding of a targeted program of research in Asia under the PAPA program, is intended to improve understanding of the problems posed by air pollution in Asia and to help build the capacity of Asian scientists to conduct scientific research toward solutions.

HEI Special Report 18 is available at http://pubs.healtheffects.org; printed copies can be purchased from HEI. For more information, contact Aaron Cohen (+1-617-488-2325; acohen@healtheffects.org).

Walter A. Rosenblith New Investigator Award

Jun Wu is an assistant professor in the Public Health and Epidemiology Program at the University of California—Irvine. She received the 2010 Walter A. Rosenblith New Investigator Award for her project “Adverse Reproductive Health Outcomes and Exposures to Gaseous and Particulate Matter Air Pollution in Pregnant Women.” She plans to develop four different ways to estimate exposure to air pollutants and investigate the association of air pollution exposure with specific birth outcomes in California from 2001 through 2008.

PHOTO BY SHENG LI
Putting the Strategic Plan into Action

As soon as HEI’s Strategic Plan for Understanding the Health Effects of Air Pollution 2010–2015 hit the presses in April, the institute set to work carrying it out. The plan focuses HEI on four key science areas: multipollutant exposure and health, assessing the health outcomes of air quality actions (accountability), potential effects from the introduction of new vehicle technologies and fuels, and an international perspective. HEI began work in some of these areas in anticipation of the plan’s release. For example, studies from the National Particle Component Toxicity initiative (slated for completion in 2010–2011 and publication in 2012–2013) and animal research as part of the Advanced Collaborative Emissions Study (slated for completion in 2012 and publication in 2013) apply new and established techniques to address the health effects of air pollutant mixtures. In addition, a multicenter study to investigate the effects of near-ambient levels of ozone on the cardiovascular system in human volunteers is to begin in 2011 (see related story). HEI will soon reissue a request for applications (RFA) that will focus on the effects on the human cardiovascular system of exposure to ambient levels of ozone in the presence of other pollutants, a good example of HEI seeking new multipollutant approaches.

Meanwhile, the new report of the Special Committee on Emerging Technologies (see related story) provides an excellent starting point for consideration of high-priority areas for research into the health effects of potential new emissions, and initial steps to closely examine such recommendations by this committee are already being taken. For example, HEI is currently planning a review of the literature on ultrafine particles, with publication expected in 2012, and is scheduling a workshop on emissions from vehicles using biofuels in 2011.

In the area of health outcomes research, HEI is preparing to issue an RFA in January. In December 2009, HEI held a workshop to review past activities and discuss avenues for further investigation; the proceedings of this workshop were recently published as HEI Communication 15. The RFA is based on recommendations made during the workshop.

In the international arena, HEI has just published five studies from its Public Health and Air Pollution in Asia (PAPA) program and a comprehensive review of the literature on air pollution and health in Asian countries (see related stories). Two additional PAPA studies conducted in India, as well as studies in Vietnam and in South America, are scheduled to be published in 2011. Finally, HEI has just initiated two studies of reproductive health outcomes in developing countries.

HEI welcomes comments and suggestions from update readers on these or other topics for consideration for future research. For more information, contact Rashid Shaikh (+1-617-488-2301; rsaikh@healtheffects.org).

SCET REPORT (Continued from page 1)

The committee is cochaired by Christine Vujovich, formerly of Cummins, and Alan Lloyd, president of the International Council on Clean Transportation. Its members, recruited from academia, industry, and nongovernmental organizations, have expertise in technologies, fuels, regulatory issues, life-cycle questions, emissions, and other relevant areas (see member list). Earlier drafts of the report were reviewed extensively by a diverse group of outside experts who had not been involved in the development of the report.

HEI plans to release the report broadly, given its comprehensiveness and the importance of the issues it raises. Within HEI, the report will be used by the Research Committee in setting priorities for future research and review activities. Given the probability of continuing changes in fuels and technologies in the coming years, SCET will continue to meet periodically to advise HEI about important ongoing trends in these areas.

For more information, contact Rashid Shaikh (+1-617-488-2301; rsaikh@healtheffects.org).

Special Committee on Emerging Technologies

Christine Vujovich (cochair) formerly of Cummins
Alan Lloyd (cochair) president, International Council on Clean Transportation
Thomas Cackette (chair, Technologies Subcommittee) chief deputy executive officer, California Air Resources Board
Albert Hochhauser (chair, Fuels Subcommittee) senior engineering adviser, ExxonMobil Research and Engineering Company
Steve Cadle principal scientist, Air Improvement Resource; formerly at General Motors Research and Design Center
Wayne Eckerle vice president, Corporate Research and Technology, Cummins Technical Center
Helmut Greim former chair and director, Institute of Toxicology and Environmental Hygiene, Technical University of Munich
John Heywood, director of the Sloan Automotive Laboratory and Sun Yat Professor of Mechanical Engineering, Massachusetts Institute of Technology
Roland Hwang, vehicles policy director, Energy Program, Natural Resources Defense Council
David Kittelson professor of mechanical engineering, University of Minnesota–Minneapolis
C. Andy Miller, Atmospheric Protection Branch, National Risk Management Research Laboratory, U.S. Environmental Protection Agency
Norbert Pelz former senior manager, Fuels and Lubricants, Daimler Chrysler AG
Kathryn Sargeant director, Air Toxics Center, Office of Transportation and Air Quality, U.S. Environmental Protection Agency
Robert Sawyer Class of 1935 Professor of Energy Emeritus, University of California–Berkeley
Dennis Schuetzle president, Renewable Energy Institute International
Tom Stricker vice president, Technical and Regulatory Affairs and Energy and Environmental Research, Toyota Motor North America
Michael Walsh international consultant on fuels and transportation emissions
Michael Wang vehicle and fuel systems analyst and manager, Systems Assessment Section, Center for Transportation Research, Argonne National Laboratory
O’Keefe Appointed Chair of CAI-Asia Board

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El Vice President Robert O’Keefe has been named the new chair of the board of the Clean Air Initiative for Asian Cities (CAI-Asia).

Established in 2001 by the Asian Development Bank, the World Bank, and the U.S. Agency for International Development, CAI-Asia has grown to become Asia’s premier source of information on air quality and effective approaches to air quality management. It is a partnership composed of more than 200 organizations from across the Asian continent and around the world, representing government, the private sector, cities, international lending agencies, other stakeholders, and academia. Its mission is to promote better air quality and more livable cities by translating knowledge into policies and actions that reduce air pollution.

HEI’s Public Health and Air Pollution in Asia (PAPA) program of research has served as an important part of the science base for CAI-Asia from the time the initiative was launched. The PAPA program specializes in providing and interpreting science to inform regional decisions in what are currently the most rapidly growing markets for vehicles and other products in the world.

In accepting the position, O’Keefe noted: “CAI-Asia has made remarkable progress, becoming a key hub of knowledge on air quality and climate across the region. As chair of the board, I hope to strengthen the link between science and air quality decisions and foster the ability of CAI-Asia to analyze and interpret its wealth of technical information, to help ensure clean air for Asia’s citizens and reduce transport of pollution to other countries.”

Richard Celeste, chair of the HEI board, welcomed O’Keefe’s appointment, noting the importance of HEI science in informing CAI-Asia’s work. “CAI-Asia has been a model multi-stakeholder partnership to foster improved air quality in the developing countries of Asia,” Celeste said. “I am pleased that through Bob’s appointment as chair of the CAI-Asia board, HEI science will better support this important mission.”

O’Keefe succeeds Jiming Hao, dean of the Institute of Environmental Science and Engineering at Tsinghua University and director of its Tsinghua-Toyota Research Center.

ACES Health Testing Under Way

Testing of 2010 Engines in Planning Stage

Toxicity testing is well under way for the Advanced Collaborative Emissions Study (ACES), following the most rigorous emissions testing ever done for new heavy-duty diesel engines — which power virtually every new large truck and bus sold in the United States.

In late 2009 through early 2010, emissions from one of four 2010-compliant engines tested were characterized in the exposure chambers at the Lovelace Respiratory Research Institute (LRRI) in Albuquerque, New Mexico, in advance of the start of animal exposures and toxicity testing. After the engine was found to be operating within the expected parameters, the targeted dilution ratios were achieved, and concentrations of key pollutants in the chambers were shown to be reproducible, the ACES Oversight Committee authorized the start of exposures of mice last April.

The three-month mouse exposures were completed in June. Tissue samples were distributed among the LRRI investigators and the five investigators conducting ancillary studies of genotoxic and cardiovascular outcomes. After the first month of mouse exposures was completed, the Oversight Committee again reviewed the exposure atmosphere and the reliability of the engine system; subsequently, in May, they authorized the start of the two-year rat exposures; one- and three-month exposures have now been completed, and analysis of samples is also under way.

Results from the characterization of engine emissions at LRRI and preliminary results on the overall health of the mice were presented at the Directions in Engine Efficiency and Emissions Research (DEER) conference in Detroit, Michigan, in late September. A report presenting the full results from the emissions characterization is currently under review and is expected to be published this winter. The first analyses from the three-month exposures in mice and rats are expected in early 2011 and will subsequently enter HEI’s review process.

In the meantime, planning for the emissions characterization of 2010-compliant heavy-duty diesel engines has started. These engines have been designed to meet stricter federal standards for emissions of nitrogen oxides, in addition to the recent tighter standard for particulate matter emissions that had to be met by the 2007-compliant engines already tested as part of ACES.

For more information on ACES, contact Maria Costantini (+1-617-488-2302; mcostantini@healtheffects.org) or Annemoon van Erp (+1-617-488-2346; avanerp@healtheffects.org).
As Asia continues to experience rapid increases in industrial production, urbanization, and motor vehicle traffic, government decision makers, the private sector, and other local stakeholders are increasingly raising concerns about the health impacts of urban air pollution. HEI has recently published a coordinated set of time-series studies of the health effects of air pollution in four Asian cities, as well as a combined analysis that incorporates data from all of them. These five components appear in a single volume as HEI Research Report 154, *Public Health and Air Pollution in Asia (PAPA): Coordinated Studies of Short-Term Exposure to Air Pollution and Daily Mortality in Four Cities*.

The research was conducted in Bangkok, Thailand (principal investigator, Nuntavarn Vichit-Vadakan of Thammasat University), Hong Kong (Chit-Ming Wong, of the University of Hong Kong), Shanghai (Haidong Kan, from the Fudan University School of Public Health), and Wuhan, China (Zhengmin Qian, from Pennsylvania State College of Medicine, Hershey, Pennsylvania).

Coordinated multicity studies, when rigorously done, can provide valuable epidemiologic evidence of the effects of short-term exposure to air pollution and thus play an important role in the assessment of health impacts and environmental policy. The recent Asian studies were designed and conducted by local investigators and officials in concert with international experts on air pollution and public health. They explore major aspects of the epidemiology of exposure to air pollution in each location — issues of local as well as global relevance — including the effects of exposure at high concentrations and at high temperatures, the potential influence of influenza epidemics on the relationships between air pollution and health, and the ways in which socioeconomic status might modify the risks associated with air pollution. The principal investigators agreed upon a common set of criteria for data on health outcomes, air quality measurements, and meteorologic factors, as well as a general approach to the analysis of time-series data that was on a par methodologically with the most recent U.S. and European analyses.

Although pollution concentrations in these four cities are dramatically different from those in most Western cities, effect estimates are broadly consistent with those from the United States and Europe; the similarity implies that the combination of differences — in concentrations, pollutant sources and mixtures, the susceptibility of the population, and people’s time–activity patterns — does not substantially modify the relationship between changes in mortality risk and changes in absolute pollutant concentrations. In the combined analysis, increases in daily mortality rates from all causes (excluding accidental deaths) and cause-specific rates were associated with four different air pollutants in each of the four cities. A 10 µg/m³ increase in PM₁₀ (particulate matter with an aerodynamic diameter of 10 µm or smaller) was associated with a 0.6% increase (95% confidence interval, 0.3%–0.9%) in deaths from all causes. Effects on cardiovascular and respiratory mortality were generally higher than for all-cause mortality.

Effect estimates varied across cities, however. For example, the effects of PM₁₀ and ozone on all-cause mortality were generally greater in Bangkok than in the three Chinese cities. In Hong Kong, Shanghai, and Wuhan, the effects of nitrogen dioxide (NO₂) were more robust in multipollutant models than were the effects of other pollutants, including PM₁₀. In Bangkok, however, effects of PM₁₀ were less sensitive to the inclusion of other pollutants. Thus, although there were reasonably consistent findings of associations with air pollution exposure across the studies, the potential for residual confounding and other sources of bias suggests that the complex patterns found in these studies should be interpreted cautiously.

These five studies, part of HEI’s ongoing PAPA program of research, represent the most comprehensive and rigorous investigation of air pollution and mortality in Asia to date. Further coordinated multicity studies conducted across the region could provide more definitive answers, particularly since major population centers in South and Southeast Asia remain understudied; it is hoped that the methods applied in the PAPA time-series studies will provide a foundation for further research in the developing countries of Asia.

**Timely Science for Rapidly Developing Markets**

Asian vehicle markets are among the fastest growing in the world (see accompanying chart). In recognition of this, HEI is working actively to ensure that its science portfolio, including these new PAPA studies and “core” studies conducted in the United States and Europe, is relevant to Asian conditions when possible and that these results are available and communicated in an understandable and thoughtful way to meet the growing needs of Asian decision makers in industry and government. *HEI*

HEI Research Report 154 is available at [http://pubs.healtheffects.org](http://pubs.healtheffects.org); printed copies can be purchased from HEI. For more information, contact Sumi Mehta (+1-617-488-2306; smehta@healtheffects.org).

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**Communication 15 Now Available**

HEI Communication 15, *Proceedings of an HEI Workshop on Further Research to Assess the Health Impacts of Actions Taken to Improve Air Quality*, is available at [http://pubs.healtheffects.org](http://pubs.healtheffects.org). The document summarizes the findings of a 2009 workshop that reviewed the current state of research to evaluate the impact of air quality interventions (also known as accountability or air quality outcomes research).
HEI has selected three teams to conduct a multicenter study of the effects of human exposure to low levels of ozone as the first stage of an effort that will ultimately seek to compare the effects of ozone with those of the broader multipollutant mixture.

The effects of ozone on the respiratory system have been studied for many years, yet little is known about its cardiovascular effects, particularly at ozone levels close to the U.S. National Ambient Air Quality Standard, or about its effects in the presence or absence of other air pollutants. Early in 2010, HEI issued a request for applications (RFA 10-1) for research on the effects on the human cardiovascular system of ozone alone and in combination with other pollutants. The RFA specified that the subjects in these studies will be men and women 55 to 70 years old with no discernible cardiovascular disease, who will be exposed to near-ambient levels of ozone for two to three hours, with intermittent exercise. Evidence of cardiovascular effects will be this study’s primary focus; effects on the pulmonary system and inflammatory markers will be measured as secondary end points.

The studies will be conducted in two phases. In phase 1, subjects will be exposed to ozone alone in a controlled laboratory setting. In phase 2, subjects will be exposed in the field at locations where ambient levels of ozone are similar to those used in the laboratory studies, but where other pollutants — such as particulate matter — are also present, thus representing a real-world exposure scenario.

In response to this RFA, HEI received several applications, which were initially evaluated by a panel of experts. The panel’s comments and rankings of the proposals informed the Research Committee’s recommendation to fund three phase 1 applications; the committee decided that the phase 2 studies required more thought and that HEI should reissue the RFA next year. These recommendations were later endorsed by the HEI Board of Directors.

Leading the selected teams are John Balmes (University of California–San Francisco), Philip Bromberg (University of North Carolina–Chapel Hill), and Mark Frampton (University of Rochester, Rochester, New York). The Research Committee intends to manage the three studies as a “multicenter study.” Toward this goal, the teams have begun to work on developing common hypotheses and preparing a common protocol. There will also be common operating procedures for all parts of the study, and several end points will be measured by core laboratories.

In addition, HEI will work with a data-coordinating center whose staff will manage the data and participate in data analysis. HEI issued a request for qualifications (RFQ 2010) in August to seek a qualified statistical team for this center. Applications were due in October. For more information, contact Maria Costantini (+1-617-488-2302; mcostantini@healtheffects.org) or Rashid Shaikh (+1-617-488-2301; rshaikh@healtheffects.org).