HEALTH EFFECTS INSTITUTE

STATEMENT

Synopsis of Research Report 169

Air Pollution and Ho Chi Minh City Pediatric Hospital Admissions for Acute Lower Respiratory Infections

BACKGROUND

In the past decade HEI has made a substantial commitment to furthering air pollution science in Asia by funding studies that provide science for decision making as they develop the abilities of local scientists to conduct research on air pollution and public health. This report describes a study by the HEI Collaborative Working Group on Air Pollution, Poverty, and Health in Ho Chi Minh City, Vietnam, that was financed by HEI, the Poverty Reduction Cooperation Fund of the Asian Development Bank, and in-kind support from the government of Vietnam. The study was led by Dr. Le Truong Giang of the Ho Chi Minh City Department of Public Health; Dr. Long Ngo, a biostatistician at Beth Israel Deaconess Medical Center in Boston, Massachusetts; and Dr. Sumi Mehta, who was at HEI during the study and currently is director of programs at the Global Alliance for Clean Cookstoves. It focused on associations between pediatric hospital admissions for acute lower respiratory infection (ALRI) and air pollution levels. This is the first study of health and air pollution conducted in Vietnam and one of the first studies in the region to focus on the important question of air pollution and children's health.

HEI directed this study under its Public Health and Air Pollution in Asia (PAPA) Program, which supports new science in understudied areas in the developing countries of Asia, in combination with technical capacity building for local investigators. The model for this study was also based on the Asian Development Bank's model of supporting collaborative research through technical-assistance grants. Capacity-building projects develop the abilities of new investigators and train local personnel to organize and conduct future studies. Such projects are designed to answer scientific questions that are relevant to regional decisions about air quality, health, and related issues. Although the studies are designed to be achievable within the constraints of data and technical capacity often found in developing countries, they are subject to the full peer-review procedures of HEI, which are intended to assess the quality and utility of the study.

The HEI International Scientific Oversight Committee (ISOC) reviewed the Collaborative Working Group's original proposal and provided technical expertise and oversight for this project. In typical HEI-funded studies, investigators identify and propose projects that are carried out with supervision by the HEI Health Research Committee and HEI staff. The Ho Chi Minh City projects involved deeper participation by ISOC and HEI staff in the design and conduct of the research.

ALRI, a disease category comprising bronchiolitis and pneumonia, is the chief cause of death among children under the age of 5 years worldwide. Pediatric ALRI cases in developing countries are often bacterial, and without antibiotic therapy they can progress rapidly, sometimes leading to death. Poverty is associated with the incidence of ALRI and with mortality from the disease; malnutrition is the primary risk factor for ALRI.

Although exposure to indoor air pollution from burning solid fuel has been shown to increase the risk of ALRI, the relationship of outdoor air pollution to ALRI has not been widely studied in the developing world. In the developed world, the U.S. Environmental Protection Agency has determined that there is some evidence that exposure to nitrogen dioxide (NO_2) reduces resistance to respiratory infection. The current study in Ho Chi Minh City

This Statement, prepared by the Health Effects Institute, summarizes an HEI project conducted by the HEI Collaborative Working Group on Air Pollution, Poverty, and Health in Ho Chi Minh City. The complete report, *Effects of Short-Term Exposure to Air Pollution on Hospital Admissions of Young Children for Acute Lower Respiratory Infections in Ho Chi Minh City, Vietnam* (© 2012 Health Effects Institute), can be obtained from HEI or our Web site (see last page).

attempted to explore relationships among outdoor air pollution, hospital admissions of young children with ALRI, and poverty in a developing Asian country.

APPROACH

The study focused on the short-term effects of daily average exposure to NO_2, particulate matter (PM) $\leq$ 10 µg/m^3 (PM_{10}), sulfur dioxide (SO_2), and ozone (O_3) in Ho Chi Minh City. Its specific aims were to assess the effects of such exposure on the hospitalization of young children for ALRI and to compare these effects in poor children with those in other children.

The investigators collected data on admissions for ALRI to Ho Chi Minh City's two major pediatric hospitals in 2003, 2004, and 2005. Their analysis focused on admissions of children who were between 28 days and 5 years of age and resided in an urban district. Because hospital staff did not always distinguish between bronchiolitis and pneumonia, the investigators created a single category for both diagnoses. ALRI cases were identified by the child's hospital identification (ID) number and by the case ID number, admission date, discharge date, and discharge diagnosis.

Air pollution data were obtained from four of the air quality monitoring stations that the Ho Chi Minh City Environmental Protection Agency operates with assistance from the Norwegian Institute for Air Research. These four stations, considered to monitor residential levels of air pollution, measured levels of NO_2, SO_2, and O_3 every 5 minutes and collected 24-hour filter samples for PM_{10}. The investigators then calculated mean daily levels for NO_2, SO_2, and PM_{10} and daily 8-hour maximum mean levels for O_3. Hourly weather data from a local forecasting center were used to calculate mean daily temperature and humidity and to track rainfall.

The investigators used both time-series and case–crossover analyses to search for statistical associations between ALRI cases and pollution levels. In the time-series analyses, they used Poisson regression to assess the impact of short-term changes in pollutant levels on ALRI admissions. The daily count of admissions was modeled as a function of average pollutant concentration and meteorologic conditions for the day of admission, for each of the preceding 10 days (lags 0–10), and over the range of days (lags 1–6) they considered to include the probable time of onset of ALRI. Variables for season, holidays, and long-term time trend were included, and natural spline smoothing functions were used for temperature, relative humidity, and day, and fixed effects for weekdays and holidays.

In the case–crossover analyses the investigators linked each ALRI case to average pollutant levels for the date of admission, for individual lag days, and for the range of lags 1–6. To calculate the excess risk of ALRI associated with these pollutant levels, they compared levels on the specific lag day or the average of lags 1–6 with the mean daily pollutant levels recorded every 7th day before and after, and within the same month as, the admission date — times that would not be associated with disease onset.

Financial information from patients' hospital records was used to assign an individual-level indicator of socioeconomic position. The poverty rate for each child's district of residence, based on 2004 district estimates from a poverty mapping project by the Institute of Economic Research in HCMC, the General Statistics Office of Vietnam, and the World Bank, was used to assign a district-level indicator. The investigators explored the potential role of socioeconomic position as a modifier of the effects of pollution in separate time-series and case–crossover models using the individual-level and district-level data. They created four quartiles of socioeconomic position using the district-level data and performed analyses stratified by quartile and by season.

RESULTS AND INTERPRETATIONS

For PM_{10}, ALRI admissions were found to increase with increases of 10 µg/m^3 in pollutant levels in the case–crossover analyses, but not in the time-series analyses. In contrast, during the rainy season, increases in PM_{10} levels appeared to be associated with reduced ALRI hospitalization in both types of analyses. Full-year results were consistent with those of studies of childhood respiratory morbidity and PM_{10} from other countries.

Levels of NO_2 demonstrated the most consistent relationships to hospital admissions for ALRI, and the results were broadly consistent with results from studies of respiratory morbidity from other countries. The excess risks of hospitalization associated with an increase of 10 µg/m^3 in NO_2 concentration were significant and equivalent in magnitude for lag days 2 and 3 and in both types of analyses. Except for lag day 3, these associations were also found in the overall time-series analyses (in which rainy and dry season data were combined). In the rainy season NO_2, like PM_{10}, showed a negative association with ALRI hospitalization for some lag periods, but only in the case–crossover analyses.

ALRI admissions were not associated with increased SO_2, except for two significant findings of excess risk with a 10-μg/m^3 increase in SO_2 concentration for specific lag periods in the dry season case–crossover analysis and the overall time-series analysis. As with the other pollutants, SO_2 had significant negative associations with ALRI admissions in the rainy season case–crossover analyses.

A 10-μg/m^3 increase in the level of O_3 had no significant positive associations with the risk of ALRI admissions in any analysis, but multiple significant negative associations in the rainy season case–crossover and time-series analyses and the overall time-series analyses were found.

In two-pollutant analyses the investigators found significant excess risks of ALRI hospitalization with a 10-μg/m^3 increase in NO_2 concentration in the dry season when they controlled for SO_2, O_3, and PM_{10} levels in time-series analyses and for SO_2 and O_3 levels in case–crossover analyses. Significant excess risks were associated with a 10-μg/m^3 increase in SO_2 when the overall time-series and dry season case–crossover analyses were adjusted for PM_{10} and O_3, but not when they were adjusted for NO_2.

To investigate the confusing disparity between rainy season and dry season results, the investigators conducted a simulation using the hypothetical prevalence of respiratory syncytial virus (RSV) infection, based on known seasonal patterns, as a possible confounding variable in the PM_{10} analysis. RSV is an independent, viral cause of ALRI. Its incidence peaks during the rainy season, when air pollution levels are low in Vietnam. This simulation analysis demonstrated that the study's results for the rainy season may well have been confounded by hospital admissions due to RSV infection.

The investigators' attempts to analyze the data when stratified by an individual-level indicator of poverty were inconclusive, owing to the small proportion (1%) of patients identified as being poor. When they used the district-level indicator of poverty, they found an elevated risk of ALRI associated with 10-μg/m^3 increases in NO_2 and SO_2 levels in the dry season for patients who lived in the wealthiest districts.

CONCLUSIONS

This study of air pollution and children's health in Vietnam provides interesting information on associations between individual pollutants and hospital admissions for ALRI. Overall, the data were sound, and the study was well conducted. The associations between NO_2 concentration and hospital admissions for ALRI during the dry season, in particular, suggest a potential role of pollution exposure in the development of ALRI. Further work is needed to verify these findings in developing countries.

The lack of information recorded in individual hospital records made it difficult to study the role of socioeconomic position in ALRI hospitalization. The small number of patients identified as poor was inconsistent with the known poverty rate in Ho Chi Minh City, and the reliability of the results was not much improved by using district-level data. Furthermore, strongly seasonal and unmeasured confounding variables possibly produced some contradictory results. These difficulties underscore the need for capacity-building initiatives in developing countries, since investigators' familiarity with the environments that they study increases the likelihood that they will be able to design studies that consider local disease trends, social factors, and environmental conditions.

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