

lungs, exacerbation and causation of asthma, respiratory illness-related school absence, hospital and emergency room visits for asthma and other respiratory causes, and premature mortality. EPA is currently in the process of evaluating these and other studies as part of the ongoing review of the air quality criteria and NAAQS for ozone. A revised Air Quality Criteria Document for Ozone and Other Photochemical Oxidants will be prepared in consultation with EPA's Clean Air Science Advisory Committee (CASAC). Key new health information falls into four general areas: development of new-onset asthma, hospital admissions for young children, school absence rate, and premature mortality.

Aggravation of existing asthma resulting from short-term ambient ozone exposure was reported prior to the 1997 decision and has been observed in studies published subsequently.^{58,59} In particular, a relationship between long-term ambient ozone concentrations and the incidence of new-onset asthma in adult males (but not in females) was reported by McDonnell *et al.* (1999).⁶⁰ Subsequently, an additional study suggests that incidence of new diagnoses of asthma in children is associated with heavy exercise in communities with high concentrations (*i.e.*, mean 8-hour concentration of 59.6 ppb) of ozone.⁶¹ This relationship was documented in children who played 3 or more sports and thus had higher exposures and was not documented in those children who played one or two sports. The larger effect of high activity sports than low activity sports and an independent effect of time spent outdoors also in the higher ozone communities strengthened the inference that exposure to ozone may modify the effect of sports on the development of asthma in some children.

Previous studies have shown relationships between ozone and hospital admissions in the general

population. A study in Toronto reported a significant relationship between 1-hour maximum ozone concentrations and respiratory hospital admissions in children under the age of two.⁶² Given the relative vulnerability of children in this age category, we are particularly concerned about the findings.

Increased respiratory disease that are serious enough to cause school absences have been associated with 1-hour daily maximum and 8-hour average ozone concentrations in studies conducted in Nevada⁶³ in kindergarten to 6th grade and in Southern California in grades 4 through 6.⁶⁴ These studies suggest that higher ambient ozone levels may result in increased school absenteeism.

The air pollutant most clearly associated with premature mortality is PM, with dozens of studies reporting such an association. However, repeated ozone exposure is a possible contributing factor for premature mortality, causing an inflammatory response in the lungs which may predispose elderly and other sensitive individuals to become more susceptible to other stressors, such as PM.^{65,66,67} Although the findings have been mixed, the findings of three recent analyses suggest that ozone exposure is associated with increased mortality. Although the National Morbidity, Mortality, and Air Pollution Study (NMMAPS) did not report an effect of ozone on total mortality across the full year, the investigators who conducted the NMMAPS study did observe an effect after limiting the analysis to

summer when ozone levels are highest.^{68,69} Similarly, other studies have shown associations between ozone and mortality.^{70,71} Specifically, Touloumi *et al.* (1997) found that 1-hour maximum ozone levels were associated with daily numbers of deaths in 4 cities (London, Athens, Barcelona, and Paris), and a quantitatively similar effect was found in a group of four additional cities (Amsterdam, Basel, Geneva, and Zurich).

In all, the new studies that have become available since the 8-hour ozone standard was adopted in 1997 continue to demonstrate the harmful effects of ozone on public health, and the need to attain and maintain the NAAQS.

b. Current and projected 8-hour ozone levels

As shown earlier (Figure II-1), unhealthy ozone concentrations exceeding the level of the 8-hour standard (*i.e.*, not requisite to protect the public health with an adequate margin of safety) occur over wide geographic areas, including most of the nation's major population centers. These monitored areas include much of the eastern half of the U.S. and large areas of California.

Based upon data from 1999–2001, there are 291 counties where 111 million people live that are measuring values that violate the 8-hour ozone NAAQS.⁷² An additional 37 million people live in 155 counties that have air quality measurements within 10 percent of the level of the standard. These areas, though currently not violating the standard, will also benefit from the additional emission reductions from this rule.

From our air quality modeling for this proposal, we anticipate that without emission reductions beyond those

⁶² Burnett, R.T.; Smith, Doiron, M.; Stieb, D.; Raizenne, M.E.; Brook, J.R.; Dales, R.E.; Leech, J.A.; Cakmak, S.; Krewski, D. (2001) Association between ozone and hospitalization for acute respiratory diseases in children less than 2 years of age. *Am. J. Epidemiol.* 153: 444–452.

⁶³ Chen, L.; Jennison, B.L.; Yang, W.; Omaye, S.T. (2000) Elementary school absenteeism and air pollution. *Inhalation Toxicol.* 12: 997–1016.

⁶⁴ Gilliland, F.D., K. Berhane, E.B. Rappaport, D.C. Thomas, E. Avol, W.J. Gauderman, S.J. London, H.G. Margolis, R. McConnell, K.T. Islam, J.M. Peters (2001) The effects of ambient air pollution on school absenteeism due to respiratory illnesses. *Epidemiology* 12:43–54.

⁶⁵ Samet JM, Zeger SL, Dominici F, Currier F, Coursac I, Dockery DW, Schwartz J, Zanobetti A. 2000. The National Morbidity, Mortality and Air Pollution Study: Part II: Morbidity, Mortality and Air Pollution in the United States. Research Report No. 94, Part II. Health Effects Institute, Cambridge MA, June 2000. (Docket Number A-2000-01, Document Nos. IV-A-208 and 209).

⁶⁶ Devlin, R.B.; Folinsbee, L.J.; Biscardi, F.; Hatch, G.; Becker, S.; Madden, M.C.; Robbins, M.; Koren, H. S. (1997) Inflammation and cell damage induced by repeated exposure of humans to ozone. *Inhalation Toxicol.* 9: 211–235.

⁶⁷ Koren HS, Devlin RB, Graham DE, Mann R, McGee MP, Horstman DH, Kozumbo WJ, Becker S, House DE, McDonnell SF, Bromberg, PA. 1989. Ozone-induced inflammation in the lower airways of human subjects. *Am. Rev. Respir. Dis.* 139: 407–415.

⁵⁸ Thurston, G.D., M.L. Lippman, M.B. Scott, and J.M. Fine. 1997. Summertime Haze Air Pollution and Children with Asthma. *American Journal of Respiratory Critical Care Medicine*, 155: 654–660.

⁵⁹ Ostro, B., M. Lipsett, J. Mann, H. Braxton-Owens, and M. White (2001) Air pollution and exacerbation of asthma in African-American children in Los Angeles. *Epidemiology* 12(2): 200–208.

⁶⁰ McDonnell, W.F., D.E. Abbey, N. Nishino and M.D. Lebowitz. 1999. "Long-term ambient ozone concentration and the incidence of asthma in nonsmoking adults: the ahsmog study." *Environmental Research*. 80(2 Pt 1): 110–121.

⁶¹ McConnell, R.; Berhane, K.; Gilliland, F.; London, S.J.; Islam, T.; Gauderman, W.J.; Avol, E.; Margolis, H.G.; Peters, J.M. (2002) Asthma in exercising children exposed to ozone: a cohort study. *Lancet* 359: 386–391.

⁶⁸ Samet JM, Zeger SL, Dominici F, Currier F, Coursac I, Dockery DW, Schwartz J, Zanobetti A. 2000. The National Morbidity, Mortality and Air Pollution Study: Part II: Morbidity, Mortality and Air Pollution in the United States. Research Report No. 94, Part II. Health Effects Institute, Cambridge MA, June 2000. (Docket Number A-2000-01, Documents No. IV-A-208 and 209).

⁶⁹ Samet JM, Zeger SL, Dominici F, Currier F, Coursac I, Zeger, S. Fine Particulate Air Pollution and Mortality in 20 U.S. Cities, 1987–1994. *The New England Journal of Medicine*. Vol. 343, No. 24, December 14, 2000. P. 1742–1749.

⁷⁰ Thurston, G.D.; Ito, K. (2001) Epidemiological studies of acute ozone exposures and mortality. *J. Exposure Anal. Environ. Epidemiol.* 11: 286–294.

⁷¹ Touloumi, G.; Katsouyanni, K.; Zmirou, D.; Schwartz, J.; Spix, C.; Ponce de Leon, A.; Tobias, A.; Quenel, P.; Rabchenko, D.; Bacharova, L.; Bisanti, L.; Vonk, J.M.; Ponka, A. (1997) Short-term effects of ambient oxidant exposure on mortality: a combined analysis within the APHEA project. *Am. J. Epidemiol.* 146: 177–185.

⁷² Additional counties may have levels above the NAAQS but do not currently have monitors.