

Environmental Assessment and Risk Analysis Element



Research Project Summary

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Emergency Room Visits and Hospital Admissions of Asthmatics in NJ as an Indicator of Ozone Exposure

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Abstract

The goal of air pollution reduction strategies in NJ is not merely to achieve regulatory compliance, but also to protect the public health of its citizens. It is therefore important to evaluate progress in ozone reduction by examining the extent to which health effects associated with ozone are being reduced. Previous studies have established an association between atmospheric ozone concentrations and severe asthma symptoms (those resulting in emergency room (ER) visits or hospital admissions for asthma). Daily ER visit and hospital admissions data for asthma are compared to NJ maximum daily 8-hour ozone concentrations while also accounting for daily temperature, pollen, and spore data to determine the extent of association between ozone and asthma and to investigate possible trends in ozone-related asthma for the period 1995-1999. During this period no consistent trend is evident. In some years, ozone accounted for 1-10% of ER visits or hospital admissions for asthma. In some years, however, no significant association was observed. A statistical model incorporating data for all years during this period indicates a significant association between ER visits for asthma and the previous 24 hour maximum 8-hour ozone concentrations, and between hospital admissions for asthma, and previous 24, and 48 hour maximum 8-hour ozone concentrations. In both cases ozone accounted for about 1% of ER visits or hospital admissions for asthma. These data further suggest the existence of a threshold for severe asthma symptoms related to ozone in NJ in the range of 60-80 ppb. The upper end of this range is consistent with the current USEPA 8-hour ozone standard. These results suggest that, in general, current ozone levels in NJ are close to the threshold for detecting an association with severe asthma symptoms. Continued reductions in ozone levels can further reduce the remaining associations. Further prospective and retrospective analysis can clarify the nature of the ozone-asthma relationship in NJ and can help determine when ozone levels are sufficiently low to eliminate all detectable associations.

Introduction

Ozone has long been known to cause and/or exacerbate various adverse respiratory health effects including asthma. The current USEPA 8-hour standard for ozone (80 ppb) under the Clean Air Act is based, in part, on maintaining ground-level ozone at concentrations that are unlikely to result in significant symptoms among sensitive individuals. EPA acknowledges, however, that such standards will not necessarily eliminate all adverse health effects (including asthma) associated with ozone for all individuals. Ultimately, the goal of pollution reduction strategies in New Jersey is not merely to achieve regulatory compliance, but to also protect the health of its citizens. The success of ozone reduction strategies should, therefore, be judged not only with respect to ongoing measurement of ozone concentration in air, but also with respect to the reduction of adverse health effects

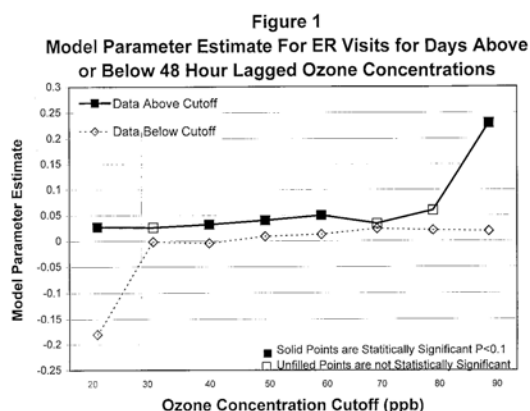
associated with ozone exposure. Furthermore, progress toward regulatory compliance may not directly parallel progress in reduction of related health effects as the two may not be tightly linked. It is, therefore, useful to assess progress toward reduction of ozone-related health effects alongside progress in reducing atmospheric ozone levels. By evaluating the strength and significance of the relationship between measured ozone levels in NJ and asthma incidence, it should be possible to follow the extent of progress in reducing ozone-related health effects as ozone levels are reduced through regulatory controls.

NJ maintains an extensive ozone monitoring network. State-wide hospital admissions data as well as partial state coverage in emergency room (ER) data are also available. It should therefore be possible to link daily measurements of ozone concentration in air to data on hospital admissions and ER

vists to examine whether short-term changes in ozone levels in ambient NJ air are associated with severe, acute symptoms of asthma. These short term observations could then be aggregated over the course of a year, and over the course of several years to assess possible associations and trends. The current report represents the results of a two-year study examining the association between ozone levels and hospital admissions/ER visits for asthma in NJ for the period 1995-1999.

Methods

ER data were available for the northern and central portions of NJ through Emergency Medical Associates (there is no systematic digitized ER visit data for the southern portion of NJ). Statewide hospital admission data was obtained from the database maintained by the NJ Department of Health and Senior Services. Hourly ozone concentration data are



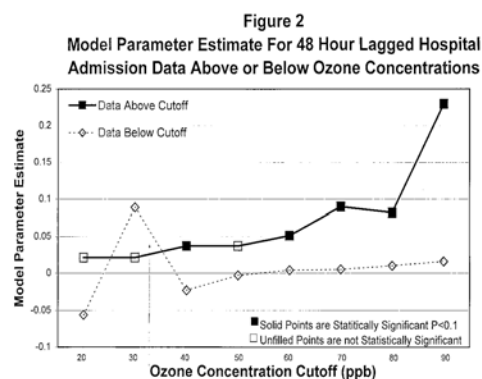
collected by the NJDEP, and are compiled by the USEPA within the Aerometric Information Retrieval System (AIRS) database from which they were retrieved for all NJ monitoring sites.

Statistical regression models were constructed using either hospital admissions or ER visits for asthma as the dependent variable, and maximum daily temperature, spores, pollen, and the maximum 8-hour ozone concentration (same day, as well as previous 24 and 48 hour 8-hour maximum concentrations – i.e., “lagged”) as possible independent variables. In addition, the possible influence of different patterns of weekend and weekday ER and hospital visits was also considered. For the all-years-combined analysis, the potential influence of year-to-year differences in reporting (e.g., number of ER facilities participating) was also addressed. For each year, and for all-years-combined, the strongest overall regression model was generated, and the contribution of ozone to the model (i.e., the parameter estimate) as well as the statistical significance of ozone in the model (i.e., the p-value) were evaluated. The all-years-combined model was used to investigate possible ozone concentration thresholds for ozone-related asthma.

Discussion

The first year of the study, which focused on the data from 1995, demonstrated that the approach was feasible and delineated the appropriate model. The second year of the study expanded the analysis to cover the entire period of 1995-1999.

Ozone was not always a significant predictor of ER visits or hospital admissions for asthma. This suggests that ozone



concentrations in NJ air are generally close to the threshold for detecting a relationship with asthma. Over this relatively limited span of years, no trend is evident. For those years in which a significant association was observed, ozone accounted for between about 1 and 10% of ER visits or hospital admissions. In some years, elevated ozone levels, as reflected in the number of days in that year on which the ozone standard was exceeded (e.g., 1995, 14 days; 1997, 10 days) may explain the observed relationship. However, other years with few exceedences (e.g., 1998, 4 days) also showed significant associations, while 1999 with 10 days exceeding the standard showed little association. The relationship between ozone and asthma may not be simple, and may depend on several factors, not all of which are identified in the model. The all-years-combined model contains the most data, and is, therefore, the most robust. For ER visits, it identifies ozone levels during the previous 24 hours as significantly associated with asthma. For hospital admissions, it identifies ozone levels during the previous 24 and 48 hours as significantly associated with the asthma. These relationships seem reasonable since ER visits would be expected to reflect relatively acute asthma responses, while hospital admissions would reflect acute responses as well as those that took longer to develop, or that did not

respond first to home treatment or physician's office visits. For both ER visits and hospital admissions, the all-years-combined model estimated that ozone was associated with about 1% of these cases of severe asthma symptoms.

While the fraction of ER visits or hospital admissions for asthma that is associated with ozone is relatively modest, it should be remembered that these represent the most severe occurrences of asthma that are not treatable with self administered medication or in physician's offices. It is reasonable to assume that the incidence of milder occurrences of asthma that are associated with ozone will be greater than that seen for ER visits or hospital admissions. It is encouraging that associations between ozone and severe asthma occurrences are not consistently observed. This suggests that continued ozone reduction efforts can further reduce the remaining associations.

The all-years-combined models with ozone concentrations 24 and 48 hours previous were used to investigate the existence of a practical ozone concentration threshold for association with severe asthma symptoms. If a threshold exists, then the relationship between ozone and asthma should be statistically significant only when data above the threshold are included. Therefore, the days examined in this analysis were divided into those with ozone concentrations above and below discrete "cutoff" values between 20 and 90 ppb. Thus, for a cutoff value of 50 ppb for example, the data were divided into those days in which ozone concentrations were all 50 ppb or larger, and those in which ozone concentrations were all less than 50 ppb. As larger cutoff values are considered, the strength of the relationship between ozone concentration and asthma (i.e., the value of the parameter estimate) for the days with ozone concentration above the cutoff should increase because the number of days included in the analysis that are below the threshold is consequently decreased, and there is therefore less dilution of the observable ozone-asthma relationship. When the cutoff includes the threshold value, the value of the parameter estimate should begin to increase rapidly. On the other hand, as the cutoff value increases, the strength of the relationship between ozone concentration and asthma for the days below the cutoff should remain relatively constant because the number of days included in the analysis which are below the threshold, and therefore do not add to the strength of the relationship, increases or remains constant while the days above the threshold which are included in the analysis will increase slowly, if at all. Figures 1 and 2 present such an analysis for ER visits and hospital admissions for ozone concentration 48 hours previous as this measure of asthma was most consistently statistically significant in this analysis.

The threshold analyses show that, as expected, the parameter estimates increase with increasing ozone cutoff concentrations for days above the cutoff, but not for days below the cutoff. There is a clear increase above 80 ppb, and a suggestion of an increase for hospital admissions above 60 ppb. This analysis suggests that a threshold for the occurrence of severe asthma from ozone effects exists in this range. The current 8-hour ozone standard is 80 ppb. This analysis thus suggests that this standard is, indeed, protective for severe symptoms of asthma.

Recommendations

If, as suggested by these analyses, ozone concentrations in NJ are close to the threshold for the occurrence of severe asthma symptoms, a clear trend may only be discernable if years when ozone concentrations were characteristically much larger (such as the 1970s and 1980s) are included in such analysis. Ozone monitoring data exist for that period. If appropriate hospital admissions data are also available, it should be possible to detect a clear trend in ozone-associated asthma in conjunction with the decrease in ozone concentration. In addition, the inclusion of those data in the threshold analysis should allow a more precise estimate of threshold concentrations.

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