or placebo, the subjects had preventative therapy suspended and were monitored for 28 to 112 days while using only albuterol as needed and orally administered prednisone for treatment of severe exacerbations.

Methods. The children and their caregivers completed daily diary cards for an average of 58 days, recording medication use and asthma severity. Air pollution and temperature data were collected by the Puget Sound Clean Air Agency (Seattle, WA). Particulate matter (PM) and carbon monoxide (CO) were measured. PM is a complex aerosol of solid and liquid, organic and inorganic materials, including dust, soot, smoke, pollen, acid droplets, and secondary aerosols. PM with an aerodynamic diameter of \( \leq 10 \mu m \) (PM\(_{10}\)) and with an aerodynamic diameter of \( \leq 2.5 \mu m \) (PM\(_{2.5}\)) were measured. Recent research has indicated that PM\(_{2.5}\) may be more strongly associated with asthma than larger particles. PM\(_{2.5}\) and PM\(_{10}\) concentrations were measured nephelometrically. CO monitoring sites were located in areas of high traffic volume. CO data were averaged, to diminish the influence of random sources of air pollution on any given day.

Results. Asthma severity and medication use were both associated with elevated PM\(_{2.5}\), PM\(_{10}\), and CO concentrations. Increasing asthma severity was most significantly seen 1 day after pollution exposure. With adjustment for confounders, 1 day after a 10 \( \mu g/m^3 \) increase in PM\(_{2.5}\) levels, there was a 12-fold increase in the odds of having a serious asthma attack and a 1.08-fold increase in \( \beta \)-receptor agonist use. The association of air pollutants with medication use was weaker than that with asthma severity. Stronger associations with asthma severity and rescue inhaler use were found with CO levels than with PM levels.

Conclusions. Increases in PM and CO levels were associated with higher risks of increasing asthma severity and rescue medication use among children with moderate/severe asthma in the Seattle area.

Reviewer’s Comments. The authors noted that there is no biological plausibility of a direct association between CO levels and asthma exacerbations. The primary effect of CO exposure is anoxia, which results in confusion, headache, and nausea. The authors speculated that CO levels may serve as a marker for exposure to combustion byproducts, particularly diesel and gasoline exhaust particles.

ALAN B. GOLDSOBEI, MD
San Jose, CA

PROSPECTIVE STUDY OF AIR POLLUTION AND BRONCHITIC SYMPTOMS IN CHILDREN WITH ASTHMA


Purpose of the Study. To examine the effects of air pollutants, including particulate matter (PM), organic carbon (OC), elemental carbon, and other traffic-related pollutants, on bronchitic symptoms among children with asthma.

Study Population. Twelve Southern California communities were studied. In 1993, fourth graders and seventh graders were recruited from schools in 12 neighborhoods. Children with a history of asthma who completed \( \geq 2 \) years of study questionnaires (1996–1999) were included in the analysis. There were 475 children in the study.

Methods. Questions regarding bronchitic symptoms were asked each year. Positive responses included daily cough for 3 consecutive months, 3 consecutive months of congestion or phlegm, or the occurrence of bronchitis.

Other questions addressed smoke exposure and participation in team sports. A number of demographic questions were also asked. Air pollution monitoring stations were established in the 12 neighborhoods. The following were measured: ozone, PM of \(<10 \mu m\), nitrogen dioxide (NO\(_2\)), PM of \(<2.5 \mu m\) (PM\(_{2.5}\)), OC, and elemental carbon. Annual averages for these pollutants were calculated, and 4-year mean levels (1996–1999) for each community were established.

Results. Of the 475 children in the study with asthma, 184 (38.7%) experienced bronchitic symptoms during the first year. Children with a history of wheezing in the year before the study or with allergy were significantly more likely to report symptoms. During the 4 years of the study, the average pollutant concentrations varied 4- to 10-fold among the communities. There was very little variation within each community from year to year. The odds ratio (OR) for bronchitic symptoms among children with asthma varied from 0.80 for ozone to 1.81 for PM\(_{2.5}\) among the communities. Within communities, the ORs were \( >1 \) for every pollutant. In special models for 2 pollutants, ie, OC and NO\(_2\), ORs were only modestly decreased when other pollutants were controlled for and the effects of OC and NO\(_2\) were not altered by other pollutants. NO\(_2\) effects were modified by participation in team sports, with an increase in the OR for bronchitic symptoms among participating children.

Conclusions. Among children with asthma, there were associations of bronchitic symptoms with PM\(_{2.5}\), OC, NO\(_2\), and ozone levels. Importantly, OC and NO\(_2\) effects were not confounded by other pollutants. These 2 pollutants deserve greater attention with respect to bronchitic symptoms associated with air pollution among patients with asthma.

Reviewer’s Comments. This is another important study that helps to establish the effects of air pollution on children with asthma. The study was conducted in California, and the air pollution components that were investigated were derived from vehicular traffic more than industry. This article also demonstrates the need to investigate more extensively the effects of NO\(_2\) and OC among children with asthma.

FREDERICK E. LEICKLY, MD
Indianapolis, IN

RELATIONSHIP OF OUTDOOR AIR QUALITY TO PEDIATRIC ASTHMA EXACERBATION


Purpose of the Study. To determine the relationship of outdoor air quality parameters to asthma exacerbations among children.

Study Population. Pediatric patients who had experienced an emergency department visit or an inpatient hospitalization at Cincinnati Children’s Hospital for treatment of acute asthma were studied.

Methods. The number of emergency department visits and hospitalizations for treatment of asthma were determined by review of emergency department logs and a hospital computer database. Air quality data were obtained from a centrally located monitoring station. Ozone concentrations were continuously monitored, and data were recorded as daily averages and the highest 1-hour average concentration for each day. Concentrations of airborne particulates <10 \( \mu m\) in diameter were obtained by using a volumetric air sampler with a size-selective inlet, and 24-hour average values were calculated. Pollen and
PROSPECTIVE STUDY OF AIR POLLUTION AND BRONCHITIC SYMPTOMS IN CHILDREN WITH ASTHMA
Frederick E. Leickly
*Pediatrics* 2004;114;536

Updated Information & Services
including high resolution figures, can be found at:
/content/114/Supplement_1/536.1.full.html

Subspecialty Collections
This article, along with others on similar topics, appears in the following collection(s):

**Environmental Health**
/cgi/collection/environmental_health_sub

**Allergy/Immunology**
/cgi/collection/allergy:immunology_sub

**Asthma**
/cgi/collection/asthma_sub

Permissions & Licensing
Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:
/site/misc/Permissions.xhtml

Reprints
Information about ordering reprints can be found online:
/site/misc/reprints.xhtml

PEDIATRICS is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. PEDIATRICS is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2004 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 0031-4005. Online ISSN: 1098-4275.
PROSPECTIVE STUDY OF AIR POLLUTION AND BRONCHITIC SYMPTOMS IN CHILDREN WITH ASTHMA
Frederick E. Leickly
Pediatrics 2004;114;536

The online version of this article, along with updated information and services, is located on the World Wide Web at:
/content/114/Supplement_1/536.1.full.html