

# Asthma and the Role of Air Pollution

## What the Primary Care Physician Should Know

**A**sthma, once considered a minor ailment, has become an urgent health problem affecting 14 to 15 million Americans. Particularly prevalent in urban areas, asthma is now the number one childhood illness in the United States. As asthma rates rise, the medical community, along with the public and the media, are focusing increased attention on ways to prevent this growing epidemic.

By many measures, asthma poses a significant health and economic burden:

- Prevalence of asthma (cases per 1,000 people) rose 61 percent from 1982 to 1994 — from 34.8 to 56.1, according to the American Lung Association. The rise in pediatric asthma (under age 18) was even more dramatic — from 40.1 to 69.1 during that period. (American Lung Association, Epidemiology & Statistics Unit, *Trends in Asthma Morbidity and Mortality*, 1996; p. 2)

- More than 5,100 Americans died from asthma in 1993, up from approximately 2,600 in 1979 (American Lung Association, *Lung Disease Data 1996*; p. 4).

- Physician office visits for asthma rose 50 percent from 1980-81 to 1993-94, according to the National Center for Health Statistics (National Center for Health Statistics, *Ambulatory Care Visits for Asthma: United States, 1993-94*, Advance Data No. 277, 1996; p. 1).

- Asthma accounts for one in six of all pediatric emergency room visits in the U.S. (ALA *Lung Disease Data 1996*; p. 3).

- An astonishing 100 million days of restricted activity each year in the U.S. are attributed to asthma (National Heart, Lung and Blood Institute *Data Fact Sheet, Asthma*, 1995).

- The financial burden of asthma, including both direct medical costs and indirect costs, such as lost work time, is expected to rise from \$6 billion in 1990 to more than \$14 billion by the year 2000 (National Center for Environmental Health, *CDC's Asthma Prevention Program*).

The dramatic increase in asthma has been documented not only in our own country, but around the globe, from Brazil and Mexico City to Sweden, Denmark, Great Britain, the Austrian alps, New Zealand and Australia, among other countries (Saldiva et al. *Environ Res* 1994;65:218-25; Friebele, *Env Health Perspect* 1996;104:22-25; Romieu et al. *Am J Epidemiol* 1995;141:546-553; Schmitzberger et al. *Pediatr Pulmonol* 1993; 15:68-74; Wilkie et al. *NZ Med J* 1995;108:188-90; Abramson et al. *Med J Aust* 1995;163:542-545).

Paradoxically, treatment for asthma has improved during this time. Yet asthma incidence, prevalence, morbidity and mortality continue to increase. Why asthma is rising, why more people are dying from the condition and why it affects some groups more than others remains a mystery.

### What is Asthma?

Asthma — derived from the ancient Greek word for “panting” — has been described in medical literature since the time of Hippocrates. It is a chronic condition in which the airways temporarily become impeded, causing labored breathing, wheezing or coughing. During an asthma attack, the muscles tighten around the airways, constricting the free exchange of air. The lining of the airways becomes inflamed and swollen.

Asthma is a much more complex condition than was once believed, with multiple inter-related causes. Some asthma attacks have an allergic basis, such as cockroaches, cat dander or pollen. Other attacks are not allergic reactions, but are caused by stimuli such as ozone,

particulates, cold air and tobacco smoke.

One important piece of the asthma puzzle is air pollution, both outdoor and indoor. According to researchers, “Levels of pollutants which may not interfere with normal breathing affect people with asthma in more profound ways, causing greater inflammation or constriction of airways” (Boushey et al. *Env Health Perspec* 1995; 103, Suppl 6: 229-33). While air pollution is not believed to be the single underlying cause of the asthma epidemic, there is strong evidence that it exacerbates the illness and that cleaner air would help prevent a significant number of asthma attacks. The U.S. Environmental Protection Agency (EPA) estimates 250,000 cases of aggravated asthma per year could be eliminated if the agency’s proposed new standards for ozone and particulates were implemented (U.S. EPA proposal on National Ambient Air Quality Standards, Nov. 27, 1996).

### Who Is Affected?

Asthma has been on the rise throughout the population, but some groups are more vulnerable than others:

Children are particularly at risk. Nearly 5 million children in the U.S. have asthma, and the death rate from the disease for youngsters 19 years and under increased by 78 percent from 1980 to 1993 (National Center for



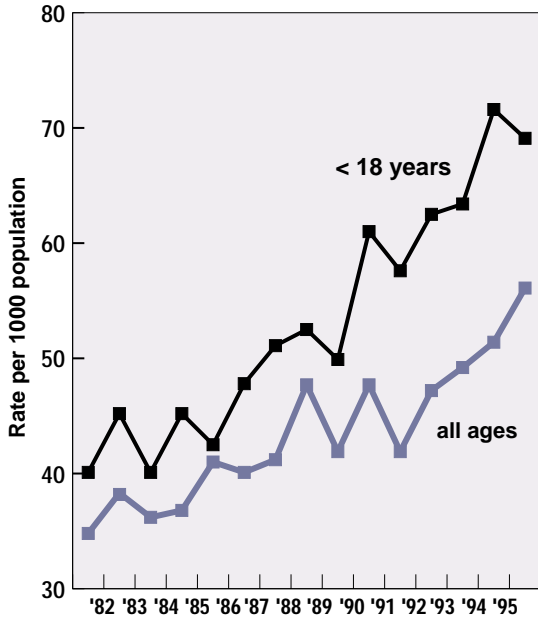
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### Prevalence Rates for Asthma by Age and Year, United States, 1984-1994



Source: Centers for Disease Control & Prevention

Environmental Health). Children also pay a heavy price for asthma in the form of restricted activity: an estimated 10 million school days are lost each year, according to the American Public Health Association.

Air pollution is believed to be an important contributing factor in pediatric asthma. One reason is that children’s airways are narrower than those of adults, “thus, irritation caused by air pollution that would produce only a slight response in an adult can result in potentially significant obstruction in the airways of a young child,” according to the American Academy of Pediatrics. “They breathe more rapidly and inhale more pollutant per pound of body weight than do adults.” In addition, children are more likely to play, exercise and spend time outdoors (American Academy of Pediatrics Committee on Environmental Health, *Pediatrics* 1993; 91:1212).

Indoor pollution is also more of a problem for children, who play on the floor where they are exposed to cockroach and dust mite allergens. Both of these allergens are triggers for asthma.

Older people are experiencing higher mortality rates (number of deaths per 100,000 people) from asthma than other age groups. In 1970, the asthma mortality rate for people 70-74 years old was 3.5. By 1993, the rate had more

than doubled to 7.4. During that time, the very old — those 85 and over — experienced the sharpest rise in mortality rate from asthma — from 5.0 to 18.3. This compares to 2.0 for the population overall in 1993 (ALA Trends, Table 3).

African Americans suffer from asthma more frequently than white Americans. Again, young people are especially vulnerable. Asthma is 26 percent more prevalent in black children than white, according to the National Institute of Allergy and Infectious Diseases (NIAID, *Asthma and Allergy Statistics* 1996).

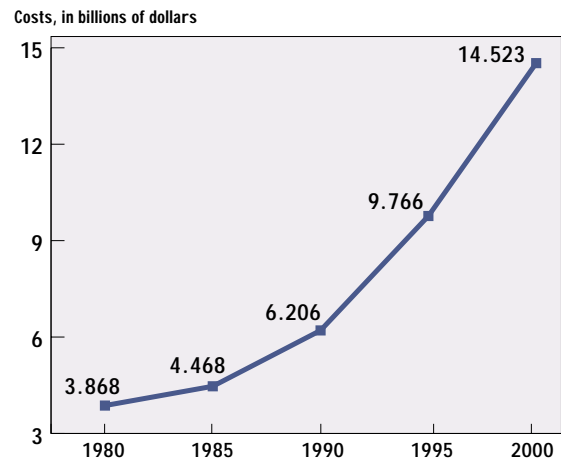
African Americans are three times as likely to die from asthma. Among young people the differential is even more stark: African Americans ages 15-24 were six times more likely to die from asthma than white Americans that age (Centers for Disease Control and Prevention, *J Am Med Assoc* 1996;275: 1536-7). The same was true for the very young, ages 0-4.

Puerto Ricans, of all ethnic groups in the U.S., may suffer the most from asthma. Among children age 6 months to 11 years, one in five had asthma in 1982-84 compared to 9 percent of black and 6.5 percent of white youngsters that age. More recent studies conducted among ethnic groups in New York City confirm that Puerto Ricans have unusually high rates of asthma (Crain et al. *Pediatrics* 1994; 94:356-62; De Palo et al *Chest* 1994;106:447-51).

### Air Pollutants That Trigger Asthma

The relationship between asthma and air pollution, especially out of doors, is complicated and is the subject of

### Estimated Costs of Asthma, United States 1980-1995 and projection for year 2000



Source: Centers for Disease Control & Prevention

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## Faces Behind the Statistics

**A**sthma is the most common illness among children [in the South Bronx]. Many have to struggle to take in a good deep breath. Some mothers keep oxygen tanks, which children describe as 'breathing machines,' next to their children's beds...

"The longer I talk with children here, and then with doctors who work with asthmatics, the more I am convinced that what I first thought might be anecdotal accident, the sheer coincidence that writers learn to view with a degree of caution, is not mere coincidence but something painfully widespread. I can't remember ever being in another place in the United States in which so many children spoke of having difficulty breathing...."

"According to a zip code breakdown of New York shown to me by Dr. Robert Massad, a family-practice specialist at Montefiore Medical Center in the Bronx, the rate of hospital admissions for asthma statewide in New York is 1.8 per 1,000 people. In New York City, it is 2.5 per 1,000, but in Mott Haven [in the poorest congressional district in the nation] the rate rises to 6.0 and 6.9 in the adjacent zip code...The asthma mortality rate for people in the Bronx, the borough with the highest concentration of black and Hispanic residents, is nearly nine times that of Staten Island, which is the whitest borough in the city."

Jonathan Kozol

*Amazing Grace — the Lives of Children and the Conscience of a Nation*  
Crown Publishers, © 1995

ongoing research. Industry critics of tougher pollution control maintain that mandating higher air quality standards wouldn't affect the increase in asthma rates. They point out that during the last 20 years, air quality has been improving, while asthma has been on the rise. But it's not that simple.

Based on national averages, air quality has indeed improved. But according to monitoring data compiled by EPA, more than half the population lives in areas that exceed federal standards for many pollutants, including ozone, sulfur dioxide and particulates — all of which are associated with asthma (Peden, *Otolaryngol Head Neck Surg* 1996;114: 242-47). Low-income neighborhoods are more likely to be exposed to pollution from industry and waste.

The potent blend of chemicals and fine particles that we all inhale may not trigger acute respiratory symptoms in most of us. But certain pollutants, at the wrong levels, can have grave consequences for asthma sufferers, as explained below. Not only can individual chemicals such as ozone be dangerous, but there may well be a synergistic effect of inhaling multiple pollutants that is little understood. While air pollution may not be the major cause of the increased incidence of asthma, it significantly exacerbates the condition and contributes to costly hospital admissions and emergency room visits.

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## Ozone

Ozone, an invisible gas that is the main component of smog, is the most pervasive outdoor air pollutant in the United States. Since the 1980's more than 3,000 research studies have been conducted, aimed at bettering our understanding of the health and environmental effects of ground-level ozone (Testimony of Carol M. Browner, Administrator, U.S. EPA, before the Senate Committee on Environment and Public Works, Feb. 12, 1997, p. 5).

Ozone has been called a prime suspect in the search to understand the increased prevalence of asthma (Bates *Environ Health Perspect* 1995; 243-47). In an extensive review of the data on ozone and asthma, Jefferson H. Dickey, M.D., of New England Physicians for Social Responsibility, found: "The weight of evidence at epidemiologic, human chamber, whole animal, biochemical and genetic levels is that ozone is acutely toxic to the lung at current ambient levels" (written testimony 1997).

Many epidemiological studies show a link between elevated ozone levels and increased hospital admissions and emergency room visits for asthma. The current National Ambient Air Quality Standard (NAAQS) for ozone is 120 ppb for one hour in a year. But many places in the U.S. exceed this level. Researchers are also discovering that at levels far below the federal standard, ozone causes numerous ill effects that contribute to asthma, including increased inflammation of airways, decreased lung function, heightened sensitivity to allergens and an increase in respiratory symptoms.

In another review of the medical literature (Bascom, *Toxicol Lett* 96;86: 115-30), increased emergency room visits for asthma, associated with a rise in ozone levels, were reported in cities throughout the Western Hemisphere, including Toronto, New York, Atlanta and Mexico City. For example, at a major pediatric hospital in Mexico City, "Exposure to high ozone levels for two consecutive days increased the number of asthma-related emergency visits by 68 percent" (Romieu et al).

Another study of black children in Atlanta, Georgia, examined the relationship between emergency room visits and ozone levels during the summer of 1990. The number of hospital visits for asthma or reactive airway disease increased by 37 percent on the days following high ozone levels (0.11 ppm or higher) (White, et al. *Environ Res*, 1994;65: 56-68).

According to the American Academy of Pediatrics, the federal standard for ozone “contains little or no margin of safety for children engaged in active outdoor activity.”

Studies in Canada add further confirmation of the special dangers ozone poses for people with asthma. “Studying hospital admissions in the summer in southern Ontario over a 6-year period from 1974 to 1980, we found that asthma admissions for children up to the age of 14 were invariably higher after days when the ambient ozone level had exceeded 80 ppb, compared to all days” (Bates, 49-53).

In one study of how ozone affects the respiratory system, a team of investigators exposed people with asthma to ozone and to filtered air as the subjects exercised for four hours. It was found that those with asthma developed significantly greater respiratory tract inflammation than people without asthma who underwent a similar test (Scannell et al. *Am J Respir Crit Care Med* 1996;154: 24-29).

### **Sulfur dioxide**

Sulfur dioxide (SO<sub>2</sub>), generated from oil and coal burning, is of special concern for people with asthma. While healthy subjects exposed to SO<sub>2</sub> show no ill effects, exposure to even low levels of SO<sub>2</sub> alters the lung function of asthmatics (Koren *Environ Health Perspect* 1995;103 Suppl 6: 235-41).

In controlled exposure studies, SO<sub>2</sub> caused a dramatic decrease in lung function. One clinical study challenged teenagers who have asthma with ozone, with SO<sub>2</sub> and then with both. The combination of ozone followed by sulfur dioxide — a realistic sequence of exposure, according to the investigators — produced bronchial reactions in the subjects. (Koenig et al. *Am Rev Respir Dis* 1990;141:377-80).

### **Particulates**

A growing body of research implicates particulate matter — commonly known as soot — with an increase in asthma and other respiratory ailments. The major sources of particulate matter are industrial processes, solid waste dis-

posal and fossil fuel combustion in energy production and transportation.

Thousands of deaths each year are associated with this type of pollution, even at levels well below federal standards. Many studies from around the world, using a wide variety of methodologies, link particulate matter with everything from increases in hospitalizations, emergency room visits, illness and death to decreased lung function and lost days from school and work.

Of particular concern are the tiny particles classified as PM<sub>10</sub> which can be breathed into the smallest airways and the alveoli in the lower respiratory tract. Numerous studies show an association between elevated PM<sub>10</sub> levels and asthma (Pope et al *Environ Health Perspect* 1995; 103:472-80). For example, a study in Seattle, Washington, found that emergency visits for asthma increased even at PM<sub>10</sub> levels below 100 — well below the federal standard of 150 micrometers per cubic meter (Schwartz et al. *Am Rev Resp Dis* 1993;147:826-831).

Other studies in Steubenville, Ohio; Russia, China, Victoria, Germany and Spain found a similar association between particulate air pollution and emergency room visits .

To avoid the confounding factor of tobacco smoke, a known trigger for asthma, researchers studied a population of non-smoking Seventh Day Adventists. A 1995 study found a 30 percent increase in risk for developing asthma among this group after being exposed to PM<sub>10</sub> levels above 100 (Dickey).

Elderly people with chronic obstructive lung disease are at substantially increased risk of needing emergency medical care and of dying when particulate levels are high (Dickey). Other studies found a relationship between a rise in particulates and the use of inhalation medication used by people with asthma (Pope et al *Environ Health Perspect* 1996;104:414-20).

A review of the literature published in the *Medical Journal of Australia* (Abramson et al) concluded that, “Particulate air pollutants have acute deleterious effects on patients with asthma.”

## **What About Indoor Air Pollution?**

Researchers are increasingly focusing on indoor air pollution as a leading contributor to asthma, particularly among poor inner-city populations. In a recent study of children in eight inner city areas in the U.S., exposure to

*The prevalence of asthma in Western industrialized societies has doubled in the last 20 years.*

high levels of cockroach allergen was linked to asthma related health problems in children who were allergic to these pervasive insect pests (Rosenstreich et al. *N Eng J Med* 1997; 336: 1356-63). Dust mites, ubiquitous in bedding and furniture are also a suspected trigger for many asthma sufferers.

Second-hand smoke has been strongly linked to the development of pediatric asthma. Children of smokers are twice as likely to develop asthma as children of nonsmokers, and there is evidence that babies whose mothers smoke during pregnancy may be born with abnormally narrow airways. Smoking, however, has not been increasing during the period when asthma was rising, according to the American Lung Association (*ALA Lung Disease Data* 1996).

One change that corresponds to the increase in asthma, though, is building construction. Following the energy crisis of the 1970's, buildings were often better insulated, and thus more airtight. Without a free flow of air, asthma-triggering pollutants -- such as tobacco smoke, gas from open pilot lights and chemicals from cleaning solvents -- became trapped indoors.

Even ventilated homes -- such as those without air conditioning with open windows in summer -- can have indoor pollution problems. Indoor ozone levels can approach 80 percent of outdoor levels during the summer months (White et al).

## What Can Physicians Do?

**Ask the right questions.** When your patients suffer from asthma, help them determine if there are environmental triggers that might contribute to their condition.

**Inform and empower.** Teach patients to use a peak flow meter to discover which factors affect their lung function.

**Suggest ways to prevent asthma.** Researchers have found that many families are not receiving adequate counseling from health care providers about environmental interventions. Physicians need to play a more active role in asthma prevention.

Among the steps patients can take:

- Eliminate tobacco smoke from the home. Second hand smoke has been clearly associated with asthma in infants and children.

- Keep low levels of humidity in the home -- the Environmental Protection Agency suggests between 30 and 50 percent -- to reduce the growth of bacteria and other organisms that can trigger asthma.

- Fix leaks to prevent the growth of mold and bacteria.
- Reduce exposure to cockroach allergen by removing food sources for cockroaches and using nontoxic traps.
- Reduce dust mites in the home and limit exposure by covering bedding with polyurethane-coated casings.
- Replace down pillows and comforters with those made from hypoallergenic materials.
- Find out if there are chemicals at the workplace that may be triggering asthma.
- Become aware of pollution alert days in your area. If the air quality is unsafe, avoid prolonged outdoor exercise. If you do exercise outdoors, do so in the early morning. Avoid jogging or walking along busy roadways.
- During high pollution days, increase the amount of time spent indoors in air conditioned places such as libraries or malls.

**Speak out.** One of the best ways to help your patients is to lend your voice to other physicians and health groups calling for stricter air quality standards. The debate in Washington over air quality has intensified and is likely to continue, as more is learned about the harmful health and environmental effects of pollution.

Urge reductions in the sources of pollutants such as ozone by calling for increases in public transportation. Support funding for programs such as the Centers for Disease Control and Prevention's (CDC) Asthma Surveillance and Prevention Program, aimed at helping state health departments manage and prevent asthma.

Your opinions carry weight, not only with your patients but with policy makers, legislators and the media. Contact your representatives in Washington, D.C. and your state capital to let them know firsthand how pollution may be affecting your community's health.

For more information on how you can get involved in this and other public health issues, contact PSR.

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## Resources

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Homepage: <http://www.lungusa.org>

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