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South Coast
Air Quality Management District
Cleaning the air that we breathe...

Smog and Health

Caveat: The following information was first published on SCAQMD's website in 1996 and is provided for historical information only.

In addition to the health studies discussed below, there are more recent, and ongoing, studies. For further information on health studies, please contact AQMD's Health Effects Officer, Dr. Jean Ospital by e-mail or by phone at (909) 396-2582. Please also see the health effects section -- Appendix I -- of the latest AQMP (pdf, 131kb*)

Also, the air quality standards mentioned in this historical data may have been changed. To see the current air quality standards, visit the California Air Resources Board website regarding California Air Quality Standards and Health & Air Pollution. See also the list of standards updated 6/7/12 by ARB. Also visit the U. S. Environmental Protection Agency website.

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Introduction

The symptoms are familiar to all those who live in cities where the air is polluted: aching lungs, wheezing, coughing, headache. Millions of residents of the South Coast Basin (which includes Los Angeles, Orange, and parts of San Bernardino and Riverside counties) breathe dirty air some one-third the days of the year.

Ozone levels here, or what most refer to as smog, are often twice the federal health standard. In 1995, the standard was exceeded on 98 days at one or more Basin locations, most frequently in the east San Gabriel Valley.

What does all of this polluted air do to the body? The answer depends on the situation. How long a person is exposed to pollution, the type and concentration, the place, time and day, temperature, weather and more.

But one thing is certain: Smog is harmful to your health.

Lungs are ozone's primary target. Studies on animals show that ozone damages cells in the lung's airways, causing inflammation and swelling. It also reduces the respiratory system's ability to fight infection and remove foreign particles.

Ozone may pose a particular health threat to those who already suffer from respiratory problems such as asthma, emphysema and chronic bronchitis. About 10% of the basin's approximately 14 million residents fit into this category. Ozone may also pose a health threat to the young, elderly and cardiovascular patients.

Ozone affects healthy people as well. In 1990, the State Air Resources Board established a new health advisory level in response to mounting evidence that smog affects healthy, exercising adults at lower levels than previously believed. Now, a health advisory is issued at .15 parts per million (on the pollutant standards index) before a first stage smog alert is called when ozone levels reach .20 ppm.

During a health advisory, everyone, including healthy adults and children are advised to avoid prolonged, vigorous outdoor exercise. Susceptible individuals, including those with heart or lung disease, should avoid outdoor activities until the advisory is cancelled.

Currently, the federal Environmental Protection Agency is reviewing the adequacy of the federal health standard for ozone and is considering tightening it.

Sources of Smog

The sources of pollution include emissions from on-road vehicles, non-road vehicles like planes, ships and trains, industries, and even small businesses and households where polluting products are used.

Ozone, an invisible gas, is not emitted directly into the air, but forms when nitrogen oxides from fuel combustion and volatile organic gases from evaporated petroleum products react in the presence of sunshine. Ozone levels are highest during the warm months when there is strong sunshine, high temperatures and an inversion layer.

Nitrogen oxides are produced when fossil fuels are burned in motor vehicles, power plants, furnaces and turbines.

Carbon monoxide is a by-product of combustion that comes almost entirely from motor vehicles.

Fine particulates, which are emitted directly as smoke and diesel soot and form in the air out of nitrogen oxides and sulfur oxides, obscure visibility and can be inhaled deep into the lungs.

Historical Perspective

During the early years of World War II, Los Angeles residents began to realize the consequences of an increasingly industrialized area. Investigations began to determine the cause of resident's eye irritation, crop damage, severe reductions in visibility and the rapid deterioration of rubber products. "Smog" became a familiar word and everyday presence and scientists and medical personnel began to look at its effects on public health.

In the mid-1950s, the state of California's Public Health division started to step up its efforts to define the problem of how and where smog forms, as well as address the health concerns associated with exposure to smog. Ozone levels were reaching peaks of .68 parts per million, more than six times the federal health standard. Early efforts to study the health effects of exposure to air pollution focused on acute exposure episodes. Only recently have the long-term exposure effects been addressed.

In a 1956 survey sent out by the Los Angeles County Medical Association, physicians reported the following:

- 94.7% recognized the existence of a "smog complex" involving eye irritation, irritation of the respiratory tract, chest pains, cough, shortness of breath, nausea and headache;
- 56.1% have "authenticated cases of individuals leaving this area solely because of smog";
- 43.3% have recommended that patients move from the area on account of the effect of smog on their health;
- 86.7% have observed that patients with respiratory diseases are more susceptible to smog than healthy adults;
- 68% believe that patients with cardiac diseases are more susceptible to smog than healthy adults;
- 89.6% have noticed patients with allergies are more susceptible to smog than healthy adults; and
- 81.3% believe that smog is a contributing factor to cancer of the lungs and air passages.

Historic Air Pollution Disasters

There have been several episodes in history which illustrate the harmful effects of acute short-term exposure to air pollution. Among those include:

Belgium's Meuse Valley

During a five-day fog in December 1930, 63 people died, most of the deaths occurring on the fourth and fifth days. Older persons with previously known diseases of the heart or lungs accounted for the majority of fatalities. The signs and symptoms were primarily those caused by a respiratory irritant. They include chest pain, cough, shortness of breath and irritation of the eyes. Sulfur dioxide gas is suspected as the cause of the disaster.

Donora, Pennsylvania

Twenty people died and approximately 7,000 or 50% of the population, experienced acute illness during the week of Oct. 25, 1948, when temperature inversion and air stagnation occurred. Persons of all ages became ill, but those over 55 were more severely affected. Those with previous heart or respiratory disease, particularly bronchial asthma, suffered most.

Symptoms were primarily respiratory and secondarily gastrointestinal, and included cough, sore throat, chest constriction, shortness of breath, eye irritation, nausea and vomiting. The onset of the illness for most persons occurred on the evening of the third day. Of the 20 who died, 14 had some known heart or lung disease.

London, England

Three episodes during which heavy fogs and air pollution were associated resulted in the death of nearly 5,000 people - in 1948, 1952 and 1956.

The episode in December of 1952 alone, resulted in at least 3,000 deaths more than expected for that time of year. Although the increase was present in every age group, the greatest increase was in the age group of 45 years and over. More than 80% of these deaths occurred among individuals with known heart and respiratory disease.

During each of these incidents, comparable conditions were present: limited air supplies as a result of low-lying temperature inversions and faint winds, and a continuing heavy output of air pollution from multiple sources.

Also, in none of the incidents was technology sophisticated enough to properly monitor the air and diagnosis of the specific causes of the illness and deaths were based on limited evidence gathered after the disasters.

Health Effects Studies

Since the 1950s, medical evidence chronicling the effects of air pollution on the human body has continued to mount. Here are summaries of some of the most recent medical studies:

- A 1989 study funded by AQMD and conducted by Dr. Jane Hall of Cal State Fullerton found that meeting federal clean air standards for ozone and fine particulates in the South Coast region would provide $9.4 billion in health-related benefits each year. The study found that 98% of the four-county basin's population of 13 million is exposed to unhealthful air, with children especially vulnerable. In addition, 1,600 people die prematurely as a result of exposure to air pollution, according to the study.
- In 1991, as a follow up to the study, Hall looked at how air quality impacts minority communities. The study showed that minorities as a whole were shown to be exposed more often to poor air quality since they tend to live in more polluted air where housing is affordable. African-Americans and Hispanics generally breathe the worst air, partly because they tend to work in outdoor occupations.
- Children are the focus of a study funded by the California Air Resources Board that began in spring 1992 and will track 9,600 fourth, eighth and twelfth grade students for up to 10 years to assess the potential health damage from continued exposure to ozone, fine particulates and atmospheric acidity. The lead scientist on the project is Dr. John Peters of the University of Southern California.
- David Abbey, Ph.D., of Loma Linda University, studied a group of 6,340 Seventh Day Adventists living throughout California (62% lived in the Basin). Results of the study suggest a relationship between long term exposure to air pollution and the development of specific chronic diseases. Residents living in areas which exceeded state and federal standards for suspended particulates on 42 days or more per year had higher risks of respiratory diseases, including a 33% greater bronchitis risk and 74% greater asthma risk. In addition, women living in those high particulate areas had a 37% higher risk of developing some form of cancer.
- In 1987, Drs. Russell Sherwin and Valda Richters of USC examined the health of 152 young people, between the ages of 15 and 25, who died suddenly from accidents or homicide. In lung autopsies of over 100 of the subjects, slight lung airspace inflammation was found in 75% of the group, with severe damage in 27%. In addition, all of the youths examined had some degree of airway inflammation, while 39% had severe illness in the bronchial glands and 29% had severe illness in their bronchial linings. Combined, about 54% of the youths examined had at least one site of severe illness. While no evidence has been found to deter-ine the levels of smoking or other contributing factors that could have affected their health, these youths appear to have provided the first positive proof of health damage from long-term exposure to poor air quality.

- A study conducted by Dr. Roger Detels of UCLA on chronic obstructive respiratory disease (CORD) looked at residents of three Southern California areas (Long Beach, Glendora and Lancaster) with different types and levels of air pollution.
  Participants aged 7 to 59 were questioned about lifestyle habits and examined using lung function tests and histories to record exposures to pollutants from workplaces and personal habits, such as smoking.
  Researchers followed those participants for more than five years and found that the residents who lived in the more polluted areas, Long Beach and Glendora, which experience numerous days of unhealthful air, had more symptoms of respiratory diseases such as bronchitis and asthma, while the residents of Lancaster had measurably fewer symptoms of those illness.
- Athletes may be relatively young, healthy, physically fit and nonsmokers, but they may be among the most vulnerable to the effects of inhaled ozone (and other environmental pollutants), according to Dr. Henry Gong of UCLA. Endurance studies suggest that athletic performance may begin to suffer at the .12 ppm level of ozone (the federal health standard), and is very likely at .20 ppm for most athletes exercising heavily for one or more hours.
- Fine particulate pollution -- even at levels below the federal health standard -- can shorten lifespans by two years, according to a 16-year study by Harvard University researchers. In a study of 8,111 residents of six U.S. cities, particle pollution was strongly associated with excess deaths from lung cancer and heart disease -- even when other lifestyle risks such as cigarette smoking were factored out.
  The six cities studied -- Watertown, Mass., Harriman, Tenn., St. Louis and Steubenville, Ohio, Portage, Wis. and Topeka, Kan. -- all have PM10 levels below the federal health standard. In contrast, the South Coast Air Basin has some of the worst PM10 pollution in the nation, nearly twice the federal health standard.
- A study by C. Arden Pope III, Ph.D., of Brigham Young University found that particulate pollution reduces the average life expectancy by one to three years in some of the most polluted cities.
  There have been many Environmental Protection Agency studies looking at health effects. Some findings include:
- A study of 10 adult men exposed to .12 ppm ozone for 6.6 hours (including five hours of moderate exercise), found that lung function decreased and respiratory symptoms (coughing and breathing discomfort) increased over the more than six hours of exposure.
- In a study done on rats, continuous low level exposure to ozone caused restrictive lung disease. Removal of the rats from the ozone environment to one of clean, filtered air appeared to reverse the disease state back to normal. However, the study indicated that since people do not breathe filtered air, ozone exceedances in numerous cities would appear to promote pulmonary fibrosis.

- In a field study of children during normal activities at summer camp, lung function measurements were taken before, during and after ozone levels reached above .12 ppm on four days and .18 ppm on one day. Lung function failed to return to its pre-episode level for many days after the ozone episode had passed.
- An acute exposure of humans to .40 ppm ozone initiates biochemical changes in the lung resulting in the production of components which contribute to inflammation and acute lung damage and which can lead to long term effects such as fibrosis. A study was initiated to determine if prolonged exposure to low levels of ozone would produce similar biochemical changes. Non-smoking males were randomly exposed to filtered air and either .10 ppm or .08 ppm of ozone for 6.6 hours with moderate exercise. The study concluded that exposure of humans to low levels of ozone is sufficient to cause an inflammatory reaction in the lungs.

Children and smog

A 1984 study conducted by Dr. Kay Kilburn, M.D., Professor of Medicine at USC showed that children raised in the South Coast Air Basin suffer a 10% to 15% decrease in lung function compared to children who grow up where the air is less polluted.

The California Air Resources Board has concluded that "since the lungs of children are not fully developed, early damage to the respiratory tract could increase the risk of respiratory disease in adult life."

Jane Hall's 1989 study on the health effects of air pollution on residents of the South Coast Air Basin estimated that school-age children, who represent only 20% of the basin's population, experience more than 40% of the symptoms associated with exposure to ozone.

Because of their physiology, children are much more likely than adults to develop smog-related lung damage. For their body size, children inhale several times more air than adults, and they breathe faster, particularly during strenuous physical activity. In addition, they spend more time outdoors than any other segment of the population according to the AQMD study.

Dr. Robert F. Phalen, Ph.D., professor of community and environmental medicine and director of the Air Pollution Health Effects Laboratory at the University of California, Irvine, says that when children exercise, they tend to breathe through their mouths.

According to Phalen, mouth-breathing bypasses the natural filtering of air pollutants by the nose and allows large volumes of polluted air to affect the more sensitive areas of children's lungs which are still developing.

Studies show that children exposed to summer ozone pollution year in, year out, have a greater susceptibility to respiratory infections because chronic exposure to smog impairs their immune system.

Research findings also suggest that, even if children do not show symptoms while exercising in unhealthful air, they are likely to suffer a loss in lung function compared to youngsters who grow up where the air is less polluted.

Air quality standards and health

State and federal governments have set health standards for pollutants, specifying levels beyond which the air is unhealthful.

California's state standards for air pollutants are more stringent than the federal government's. It is up to each individual state to determine if they want to set tougher standards.

Standards are set to provide an adequate margin of safety in the protection of public health. Under the federal Clean Air Act, EPA must base standards solely on health considerations and not economics or technology.

The standards for pollutants in California include:

Ozone (one-hour average)

Federal = Not to exceed .12 ppm (parts per million) more than one day per year. That means no more than .12 of a volume of ozone per million volumes of air.

State = Not to equal or exceed .09 ppm

Carbon Monoxide

Federal = Not to exceed 35 ppm for one-hour average; 9.4 ppm for eight-hour average

State = Not to exceed 20 ppm for one-hour average; 9 ppm for eight-hour average

PM 10 (particles 10 micrometers (millionths of a meter) or less in diameter)

Federal = 150 micrograms per cubic meter of air for 24-hour average (arithmetic mean); 50 micrograms per cubic meter of air for annual average (arithmetic mean)

State = 50 micrograms per cubic meter of air for 24-hour average; 30 micrograms per cubic meter of air for annual average (geometric mean).

Nitrogen Dioxide

Federal = .52 ppm for one-hour average

State = .25 for one-hour average

Smog episodes and what they mean

Various levels of smog episodes are reported for the pollutant ozone. The declaration of a first, second or third stage smog alert is based on the degree of health risk. The protective actions help to reduce exposure to unhealthful levels of ozone, but those who are especially sensitive should contact their physician for more specific advice.

Generally, in the event of a smog alert, outdoor activities should be scheduled for morning or early evening hours to avoid the mid-day peak when ozone levels are at their highest.

Informational telephone number

Hourly updates on air pollution levels are available to the public through the AQMD's toll-free, taped telephone information service at 800-CUT-SMOG (288-7664).

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