The Positive Health Benefits of Negative Ions

By Jim English

Air pollution is a serious, though often unrecognized health problem. Epidemiological studies consistently point to a direct link between urban air pollution – especially particulate pollution created by combustion powered vehicles and power generation plants – and cardiovascular and pulmonary diseases. (1) Long-term exposure to particulate pollution – tiny particles smaller than 10 microns (a human hair is 70 microns wide) – is known to increase illness and death rates from lung cancer, chronic obstructive pulmonary disease and emphysema. Additionally, exposure to other airborne pollutants, including sulfur dioxide (SO2), nitrogen dioxide (NO2) and ozone (O3), is associated with development of asthma, bronchitis, and respiratory infections. (2) European researchers investigated the risks of long-term exposure to traffic pollution in a study examining 5000 volunteers selected from the ongoing Netherlands Cohort study on Diet and Cancer (NLCS). They discovered that people living near major roads (and therefore exposed to higher levels of traffic-related air pollution) were more likely to die from cardiopulmonary disease or lung cancer than their rural peers, leading the authors to conclude that 'long-term exposure to traffic-related air pollution may shorten life expectancy. (3)

Air Pollution Linked to Heart Damage

In addition to causing lung damage, air pollution is now also recognized as a threat to cardiovascular health. Reporting in the March 6, 2002 *Journal of the American Medical Association* (JAMA), researchers examined long-term health data on 500,000 individuals to compare increases in air pollution levels with incidence of death. They discovered that when air pollution levels suddenly increased, in addition to expected increases in deaths from asthma, pneumonia, and emphysema, there was an unexpected increase in the number of deaths related to heart attacks and stroke. Most surprising was the finding that when air pollution levels rose, so did deaths from all causes, not just those related to the heart and lungs (Fig. 1). (4)

One possible explanation for the increase in cardiovascular-related deaths is that air pollution causes oxidative stress that, in turn, triggers an inflammatory response in the lungs that leads to the release of chemicals that impair heart function and blood pressure.

This was shown to be the case when scientists working in the Netherlands exposed rats to high levels of particulate air pollution. Following exposure, the researchers found that plasma levels of fibrinogen were elevated by 20 percent, which could presumably increase blood viscosity, leading to decreased tissue blood flow. They also measured a 400 percent jump in tumor necrosis factor (TNF)-alpha, and a 350 percent increase in nitric oxide synthase (NOS) in lung fluids. The researchers speculated that as particulates lodge in lung tissues they induce an increase in the production of nitric oxide (NO). Under normal conditions nitric oxide is an important neurotransmitter that aids numerous signaling pathways involved in motor learning, protein modification, arterial dilation and immune defense. But when conditions trigger the overproduction of NO as seen in the Netherlands study, the result is serious damage to the endothelial cells lining the blood vessels of the lungs. (5)

When Japanese researchers exposed guinea pigs to particulates from diesel exhaust, the lungs showed a significant elevation of leukotrienes and eosinophils, two important biomarkers of inflammation and cytotoxicity commonly observed in cases of chronic obstructive lung disease (COLD). The researchers noted that these findings indicate that chronic exposure to diesel exhaust induces continuous inflammation and overproduction of mucus and phospholipids in the lung. (6)

Another mechanism implicated in air pollution-related heart failures involves bone marrow and atherosclerotic plaques. Researchers in Vancouver, British Columbia found that exposure to high levels of air pollution stimulates bone marrow to release leukocytes and platelets that accumulate preferentially in pulmonary capillaries. In addition to causing damage to lung tissues, the researchers also observed that inhalation of particulate pollution causes changes in atherosclerotic plaque lesions that make the deposits more vulnerable to rupture.

They postulated that exposure to particulate air pollution induces a systemic inflammatory response that includes the release of inflammatory mediators that stimulate bone marrow to release leukocytes and platelets, leading to lung inflammation and changes of atherosclerotic plaque, making them more vulnerable to rupture. (7)

Diabetics and Elderly at Increased Risk

Diabetics are particularly susceptible to cardiovascular damage caused by airborne pollution. A recent study published in the journal Epidemiology examined Medicare records and hospital admissions in US cities: Chicago, Detroit, Pittsburgh, and Seattle. Looking at records from 1988 to 1994 they found that diabetics were twice as likely as non-diabetics to be admitted to a hospital with a cardiovascular problem caused by airborne particulate pollution. They also found that persons 75 years of age and older also faced a higher risk of cardiovascular injury. (8)

Children and Air Pollution

Children are particularly at risk for health issues related to air pollution. Chronic exposure to particulates, sulfur dioxide and nitrogen dioxide have been associated with up to 300 percent increases in nonspecific chronic respiratory symptoms. Exposure to automotive pollution, particularly from truck and diesel exhaust, has been shown to cause significant increases in respiratory symptoms and decreased lung function. (9)

To examine the relationship between traffic-related air pollution and childhood development of asthma and other childhood respiratory diseases and infections, researchers in the Netherlands looked at data from some 4,000 babies born in the Netherlands. The health of the children was linked to measurements of traffic-generated air pollution (nitrogen dioxide, particulate matter less than 2.5 microns in diameter, and soot) in the homes of each subject. Their study found that, by the age of two years, children exposed to higher levels of air pollutants were more likely to suffer from wheezing, physician-diagnosed asthma, ear/nose/throat infections, and flu/serious colds. (10)

Part of the problem for children is that studies show that – relative to their size – children inhale more deeply and trap more airborne particles and pollutants in their lungs than either adolescents or adults. (11) Children also have higher metabolic rates than adults, breathe more than adults, and spend more time outdoors than adults, exacerbating their susceptibility to pollution-related health problems.

Children's Growth Stunted

When Polish researchers examined the effects of air pollution in Krakow they discovered that children living in those areas with the highest levels of air pollution suffered from stunted growth. After collecting data on 958 children and assessing body growth rates by height changes they found that body growth rates for children from the most highly polluted area was lower by 1.5 cm over a 2-year period than those from the control area. The compromising effect of air pollution on height gains was about the same for both short and tall children. (12)

Air Pollution and DNA Mutations

New research shows that the health threat posed by air pollution may actually affect children even before they are born. On December 9, 2002, Canadian researchers published a study revealing that animals exposed to polluted air close to a steel mill suffered genetic damage and produced fewer offspring. Most alarming was the discovery that damaged DNA was being passed on to offspring by their fathers. While virtually all mutations were inherited from the father mice, the researchers said this doesn't mean that females are not susceptible. What it does suggest is that steel workers, who are mostly male, may be at extra risk of similar damage. Christopher Somers, James Quinn, and colleagues published an earlier study that found that gulls living near a steel mill on Lake Ontario suffered from genetic mutations. In a current study the researchers raised two groups of mice – the first a half-mile downwind of a steel mill on Lake Ontario, and the second about 20 miles away. The mice breathing the polluted air had twice as many mutations in their DNA as the mice breathing fresh country air. (13)

The findings suggest that steel mill workers and people living near those mills should be checked for damage to their health, said the researchers, at McMaster University in Hamilton, Ontario. "Our findings suggest that there is an urgent need to investigate the genetic consequences associated with exposure to chemical pollution through the inhalation of urban and industrial air."

Ironically, the study was originally aimed at showing how efforts to clean up pollution around the steel mill had improved the environment. 'This had been one of the most polluted places, if not the most polluted place in Canada,' stated Christopher Somers, one of the lead researchers. 'There has been a concerted effort to clean up Hamilton harbor and reduce air emissions.' The experiment had been aimed at showing these had helped. "We haven't really seen that," he said.

Protecting Your Lungs

While government, business and environmental interests wrangle over a morass of economic, legislative and technological solutions for cleaning up polluted air, the vital issue facing individuals is how best to protect their health. Currently over 75 million people in the US live in counties where the air concentrations of particulate matter smaller than 2.5 microns (PM2.5) exceed safe levels (Fig. 2.). (14)

While living away from polluted urban centers is an obvious choice, this option is not always possible. Nor is it always effective. Air currents and weather patterns can move polluted air out of urban manufacturing centers and into rural areas where pollution can concentrate to a dangerous degree. Additionally, modern farming produces more food with fewer workers, using

improved productivity methods that increasingly rely on the use of agricultural pesticides and chemicals, and irrigation pumps and tractors powered by diesel engines. (15)
Staying indoors does not guarantee better air quality, either. Several recent studies have indicated that much of the significant health risk associated with exposure to fine particles actually occurred indoors. (16) And many individuals at increased risk of health complications following exposure to high particle concentrations, such as the elderly and those suffering from cardiovascular and pulmonary diseases, may spend more than 90% of their time indoors, raising new concerns about the relationship between outdoor particle concentrations and those found in indoor microenvironments. (17)

Air Purifiers

As the scope of air pollution related health problems grows, so too does the number of people turning to air purifying solutions for protection. Home air filtration products offer a number of options, including electrostatic, UV radiation, water and advanced HEPA filtration technologies. Until recently, these products – many engineered for entire houses and buildings – were bulky and expensive to install and maintain, placing them out of reach for most people. Recently, a number of consumer products have become available utilizing ion-generating technology to eliminate airborne pollutants, allergens and viruses from immediate breathing spaces.
These devices work by generating a flow of negative ions that charge and bind together airborne particulate matter, which then clumps and precipitates out of the air. Ion generating devices have been shown to be effective against dust, cigarette smoke, pet dander, pollen, mold spores, viruses, and bacteria. In addition to eliminating harmful particulates from the air, negative ions also have a number of unique health benefits.

Positive Ions - An Ill Wind Blows

Early clues about the biological effect of ions on human health appear as reports of increased irritability, migraine attacks and thromboembolism in response to alterations in atmospheric electrical states that accompany incoming weather fronts. (18)
Scientific evidence began to mount in the 1970s when researchers measured metabolic changes in mice and rats in response to changes in ion charge (negative or positive) and concentration, including alterations in serotonin levels and recovery from illness. When exposed to positive ions (which accumulate in the atmosphere at the beginning of a storm) researchers routinely noted that animals became agitated, aggressive and were more prone to respiratory illness. Furthermore, when mice were infected with influenza virus and housed in an environment depleted of all ions, death rates increased, indicating a previously unknown benefit on overall health. (19)
Later, researchers measured the impact of atmospheric electricity on human subjects by monitoring daily changes in urine excretion of neurohormones in samples gathered from 1,000 volunteers exposed to positive ions generated 1 to 2 days prior to the arrival of a storm front. By measuring the changing levels of neurohormones in the 24-hour urinary output of the subjects during normal and weather-stress days, the researchers compiled a profile of changes in levels of serotonin, 5-HIAA (5-hydroxyindole acetic acid, a serotonin metabolite), adrenaline, noradrenaline, histamine and thyroxine.

The researchers found that the electrical charges (positive ionization) engendered by every incoming weather front produce a release of serotonin. (20) They further identified three classes of weather sensitivity reactions:
1. serotonin hyperproduction causing a typical irritation syndrome;
2. adrenal deficiency producing a typical exhaustion syndrome;
3. hyperthyroidism with subclinical 'apathetic' thyroid symptoms.

Noting that these conditions occur during annual wind storms (Sirocco, Sharav and Santa Ana winds), the authors stated that the effects, "which are mainly due to positive ionization of the air," could be "prevented by negative ionizing apparatuses or specific drug treatment." (21)
Further evidence of the influence of ions appeared when scientists exposed mice to an atmosphere enriched with either positive or negative ions. While negative ions had no negative effect on the mice, positive ions caused elevations in norepinephrine levels within one day. When exposure to positive ions was continued for longer periods, ranging from 3 to 10 days, norepinephrine levels dropped. The author noted that the results showed that "positive ions cause stress after short time application in excess. After longer exposure, a state of exhaustion can be observed in the form of a lowered norepinephrine level." (22)

Health Benefits of Negative Ions

Just as positive ions build up in the atmosphere prior to a storm front, negative ions accumulate following a storm. This surfeit of negative ions has long been associated with improvements in mood and physical health. Research conducted in the last decade has begun to support the view that negative ions have a net positive effect on health.
One of the most tantalizing hints regarding negative ions and health surfaced when German researchers discovered a link between catecholamine regulation and lifespan after depriving experimental animals of negative ions. First, researchers at the Goldstein and Lewin Dept. of Medical Research in Stahnsdorf, Germany isolated mice and rats in air-tight, sealed acrylic cases. Next, they filtered the ambient air to remove all negative ions from the sealed cases. Their research led to the discovery that a prolonged deficiency of negative ions led to an accelerated rate of death for the experimental animals. Examination of the animals led researchers to conclude that the results 'strongly suggest that animal death is related to disturbances in neurohormonal regulation and pituitary insufficiency. (23)
Researchers at the Russian Academy of Sciences in Moscow discovered that negative ions are able to help protect the body from induced physical stress. When the researchers immobilized rats and exposed them to negatively charged air ions they discovered that the ions prevented the development of pathological changes characteristic of acute stress that are observed in untreated rats. The protective action of negative air ions was observed in all the experimental animals independently of their types of behavior. (24)
British researchers at the Centre for Sport and Exercise Sciences in Liverpool exposed male subjects to negative ions and measured physiological responses, including body temperature, heart rate and respiration, while at rest and during exercise. Negative ions were found to significantly improve all physiological states, particularly during rest. Most important was the finding that negative ions are "biologically active and that they do affect the body's circadian rhythmicity." (25)
Another clue to the role of negative ions in health comes from Russian research conducted at the Institute of Theoretical and Experimental Biophysics of the Russian Academy of Sciences, in

Pushchino, Russia. Researchers found that exposure to negative ions increased levels of the protective antioxidant enzyme superoxide dismutase (SOD) in mammalian erythrocytes. The researchers also discovered minute amounts of H2O2 (hydrogen peroxide), writing, "The primary physiochemical mechanism of beneficial biological action of negative air ions is suggested to be related to the stimulation of superoxide dismutase activity by micromolar concentrations of H2O2 (hydrogen peroxide)." (26)

Summary

While progress has been made in some areas of air pollution, such as reductions in emissions of lead, sulfur dioxide (SO2), nitrogen dioxide (NO2) and ozone (O3), air pollution, particularly from particulates, remains a serious health problem. In addition to damaging the lungs and heart, air pollution is now recognized as being especially harmful to children, the elderly, and select sensitive populations, such as those afflicted with diabetes, cardiopulmonary diseases and other debilitating illnesses.

To address air pollution-related health problems a growing number of people are using personal and home air filtration products that generate negative ions to charge and precipitate airborne particulate matter for removal to create localized zones of improved air quality.

Consumer devices that utilize negative ion-generating technology have been shown to eliminate airborne pollutants, dust, cigarette smoke, pet dander, pollen, mold spores, viruses, and bacteria from the air. Negative ions have long been attributed to improvements in mood and physical health. Research supports the view that negative ions have a net positive effect on health, including improved mood, stabilized catecholamine regulation and circadian rhythm, enhanced recovery from physical exertion and protection from positive ion-related stress and exhaustion disorders.

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