A CLEAR THE AIR / PHYSICIANS FOR SOCIAL RESPONSIBILITY REPORT

children at risk

MIKE SEAMANS

How Air Pollution from Power Plants Threatens the Health of America's Children

Prepared by

CLEAN AIR TASK FORCE

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www.cleartheair.org
http://clnatf.org

Foreword | April 2002

By George D. Thurston, Sc.D.
New York University School of Medicine

Millions of children in America today are exposed to unhealthy air at home, at school, or at their playground. Scores of new studies each year demonstrate that children are more susceptible to air pollution than adults. Studies indicate that exposure to air pollutants such as particulate matter, sulfate, sulfur dioxide gas, and ozone can result in reduced lung function, asthma attacks, increased visits to the doctors office and emergency rooms, hospitalizations and may, very tragically, also lead to increased risk of infant death.

Several factors may increase the risk of all children to air pollution relative to adults. One of the greatest causes is the higher activity level of children. Pound for pound, children breathe more air for their size than adults do. Children spend more time playing outdoors, which increases their exposure to outdoor air pollution. The lung's defense systems in children are still developing, and are thus unable to defend against the effects of pollutants as effectively as adult lungs. Children also suffer a higher prevalence of asthma than adults, and asthma makes kids far more susceptible to impacts of air pollution. Finally, a higher percentage of children than adults live in poverty, meaning that their access to health care is more limited, and recent studies indicate that air pollution affects those living in poverty more than those with means.

Health researchers have long known that air pollution reduces the lung function of children and causes asthma attacks, based on research conducted at schools and summer camps over the past few decades. Moreover, asthma has been on the rise in the U.S., having nearly doubled in the past two decades. Why is this? Is it, in part, due to some form of air pollution? We don't yet know. One California study suggests that kids who play sports year-round in polluted areas have more newly diagnosed cases of asthma. Another indicates that people who grow up in high ozone areas have a higher prevalence of asthma.

Children at Risk highlights recent research and describes links between pollutants associated with power plants and children's health. Studies across the world have linked particulate matter exposures to infant deaths. Moreover there is a suggested link between air pollution and adverse birth outcomes, such as slowed development and low birth weight in fetuses, coupled with higher premature births. Newborns also face setbacks from power plant pollutants and possible stunted lung development. All of these adverse outcomes put America's children at risk for health problems later in life.

Aging power plants are the chief sources of many of the pollutants that affect children in the U.S. For example, two thirds of the sulfur dioxide gas emitted in the U.S. comes from power plants. Sulfur dioxide, itself a potential health risk near smokestacks, converts into harmful sulfate particulate matter and sulfuric acid downwind of the plant.

Global warming, driven by our dependence on fossil fuels to generate electricity, presents different risks to children. In a recent health effects analysis[1], my co-investigators and I found that substantial public health gains will result in the nations that mitigate carbon dioxide emissions by switching from carbon intensive energy sources to cleaner technologies due to the associated reductions in particulate matter and ozone smog. The primary beneficiaries of these policies will be children.

In summary, numerous risk analyses have linked power plants to pollutants that can harm children. Considering these potential health risks, Congress should take action now to provide relief to our children by closing the Clean Air Act loophole that still allows hundreds of power plants to avoid modern pollution standards some 30 years after the Act was made law and by requiring steep cuts in mercury and carbon dioxide emissions.

George D. Thurston, Sc.D.
New York University, April 2002

Executive Summary

Whether at home, school, or play, children are exposed to emissions from power plants. This report reviews important recent advances in our understanding of the link between air pollution and children's health. A number of harmful pollutants are emitted by power plants. Thus, cleaning up power plants will have a great impact on the quality of children's health in America. This report can serve as an educational tool and an aide to healthcare providers, politicians and citizens who want to take action to protect children's health using the best science available. Cleaner air means healthier kids today and healthier adults tomorrow.

As this report shows, children are the most susceptible members of our society to the detrimental effects posed by air pollutants emitted from power plants. While countless studies have looked at the effects of various air pollutants on human health, few have focused specifically on children. However, children represent our future and to protect children is to protect all people of all ages. Children remain particularly susceptible to pollution because their defense mechanisms have not yet fully developed, increasing their susceptibility to the harmful effects of pollution. Children also breathe more rapidly and have more lung surface area for their body size compared to adults, which means they take in more air per minute and inhale more air for their size. In fact, pound-for-pound, children breathe 50 percent more air than do adults, and as a result, our children inhale a greater percentage of pollution. Children also spend more time outdoors thus increasing their exposure to outdoor air pollutants. Because exercise increases the penetration of pollutants into the lungs, our children's outdoor activities make adverse health effects more likely. This is of particular concern because tens of thousands of schools are located near the most polluting, outdated power plants.

Power plant emissions and their byproducts form particulate matter, ozone smog and air toxics. These pollutants are associated with respiratory hospitalizations, lost school days due to asthma attacks, low birth weight, stunted lung growth and tragically, even infant death. Air pollution is a pervasive problem across America for urban, suburban, and rural communities. It is an inescapable fact that air pollution is everywhere – indoors and out – and kids breathe and absorb more of it than adults do.

Our children are at risk from power plant pollution:

- Over 25 million children in the U. S. live in counties that violate national air quality standards for the common pollutants ozone, particulate matter and sulfur dioxide;
- Cases of asthma have rapidly increased, more than doubling in the past two decades. Six percent of U.S. children have asthma;
- Thirty-five million of our children live within 30 miles of a power plant — a distance within which local communities may reasonably be affected by a power plant's smoke plume; an estimated 2 million of these children are asthmatic and are particularly susceptible to these pollutants;
- 72,000 of our schools are within 30 miles of a power plant;
- Average health risks to children due to exposure to power plant combustion wastes could be up to 10,000 times higher than EPA's allowable risk levels for cancer and other illnesses.

Power plants are a major source of the most common pollutants in the air that harm children. Power plants emit 67 percent of the sulfur dioxide (SO_2), 23 percent of the nitrogen oxides (NO_x), 33 percent of the mercury, and 38 percent of the carbon dioxide from energy related sources. In much of the U.S., especially in the East, Midwest and South, sulfates make up the bulk of so-called fine particulate matter. Power plants are responsible for about half of the fine particulate matter in many parts of the U.S. Numerous epidemiological studies have suggested that sulfate particles are among those most strongly associated with health impacts and premature mortality in adults.

Coal-fired power plants are also the largest U.S. source of air toxics. Based on an analysis of 1998 Toxics Release Inventory data, power plants ranked 5th in releases of developmental and neurological toxins with a total of 78 million pounds released to the air and surface waters.

Key findings of recent studies include:

For all children:

- As fine particulate levels rise, emergency room visits by asthmatic children also increase, even when fine particulate levels are *below* EPA's air quality standard;
- Exposure to particulate matter can slow lung function growth in children;
- Children living in high ozone communities and who played sports year-round were three times more likely to develop asthma compared to children who did not play sports. This is some of the first evidence suggesting smog can cause asthma;
- Methylmercury can have adverse effects on the developing and adult cardiovascular systems, blood pressure regulation and heart-rate variability;
- Global warming could lead to more frequent and severe air pollution problems, the spread of infectious and communicable diseases, and increasingly extreme weather events such as heat waves that could disproportionately affect children.

For unborn children (prenatal):

- A new California study suggests prenatal ozone exposures may cause heart defects;
- Research in a coal dominated region of the Czech Republic indicates that stunted development in unborn children may be a result of exposure to very high levels particulate matter;
- Researchers in China have found that high concentrations of particulate matter may affect developing babies;
- Methylmercury interferes with the development and function of the central nervous system. Prenatal exposure from maternal consumption of mercury-contaminated fish can result in problems later in childhood such as learning disabilities, attention deficits, loss of IQ points or other disorders depending on the severity of exposure. Ten percent of women of child-bearing age are estimated to carry a body burden of mercury contamination above EPA's safe level.

For newborns:

- U.S. researchers in a study of 86 cities found that infants who lived in a highly polluted city during their first two months of life had a mortality rate ten percent higher than infants living in the city with the cleanest air;
- A preliminary study projects that eleven percent of the infant mortality in the United States is attributable to particulate matter even at low to moderate levels;
- Exposure to ozone may permanently affect lung structure of children; monkeys exposed to ozone developed little more than half of the normal number of branches of their lungs compared to monkeys exposed only to clean air;
- A recent study suggests that asthmatic children that were born pre-term and/or with low birth weights, are at greater risk from ozone exposures;
- The ten percent of women above EPA's safe level of mercury translates nationally into 6 million women of childbearing age with elevated levels of mercury from eating contaminated fish, and approximately 390,000 newborns at risk of neurological effects from being exposed in utero to elevated levels of mercury.

Recommendations

While the benefits of reducing power plant pollution have been estimated for adults and are many times the cost of emissions controls, little work has been done to quantify the benefits for children. But, certainly the benefits will be great. Quality of life can be improved. Premature death can be avoided. The cost of health care can be decreased.

Comprehensively reducing pollution from coal-fired power plants will address each of the threats from air pollution that children face. Power plants must be required to comply with modern emission control standards. In addition, the nation's power fleet should be held to nationwide caps on all four of the key types of power plant pollution including nitrogen oxides, sulfur dioxide, mercury and other air toxics, and carbon dioxide. Reducing power plant emissions of nitrogen oxides and sulfur dioxide by at least 75 percent beyond current legal requirements will dramatically reduce fine particulate matter pollution so that children can breathe more easily.

The threat of power plant air pollution to children can only be meaningfully reduced when the Clean Air Act's 30-year loophole that allows old and dirty power plants to escape modern standards is finally closed. Once this is accomplished, U.S. energy policy will better account for public health and the environmental costs associated with electricity production. This will propel us toward a more sustainable energy future that relies increasingly on cleaner sources of energy including renewable energy resources and conservation.

Strategies that will reduce carbon dioxide pollution from power plants will not only curb emissions of a greenhouse gas that causes climate change, but will provide the added benefits of reducing exposure to air pollutants, decreasing the risk of the spread of infectious diseases, and reducing temperature-related stress on children.

Our children's health and quality of life are harmed by air pollution today. The specter of global warming hangs over their future. We can leave our children a legacy of cleaner air and an improved environment by making wise choices today. Let's make comprehensive power plant clean up our gift to them.

Power Plant Emissions
A Threat to America's Children

Whether at home, school, or play, children are exposed to pollution in our air, land, and water from power plants. As this report shows, children are the most susceptible members of our community to the detrimental effects posed by these emissions. It is an inescapable fact that air pollution is everywhere – indoors and out – and kids breathe and absorb more of it than adults do. In addition to breathing harmful emissions from power plants, children are also exposed to contaminants in water and soil from disposal of coal combustion wastes.[2]

Air pollutants released by power plants are pervasive and harmful. They include particulate matter, ozone, sulfur dioxide gas, sulfate particulate matter, nitrogen oxides, mercury and a host of other air toxics. Collectively, these pollutants are associated with asthma attacks, respiratory disease, heart disease, and have been shown to retard cognitive development and stunt lung growth.[3,4,5,6] A lifetime of exposure to many toxic air pollutants has been associated with cancer in adults. Exposure causes respiratory hospitalizations, lost school days due to asthma attacks, and is associated with low birth weight (birth weight is an important predictor of survival and illnesses in infants).[7] In some cases, power plant pollutants may even cause death.[8,9]

What can be done about the problem? Certainly technology is not a barrier to making progress in reducing the risks to our children. If today's modern smokestack emissions controls were used across the board, emissions of sulfur and nitrogen oxides (that form particulate matter and ozone smog) from old power plants would decrease by 90 percent or more.[10] Combined use of sulfur dioxide and nitrogen oxides removal technologies can achieve substantial mercury reductions too. Committing to a more balanced energy policy will also help. An energy system that relies on conservation, clean renewables, and cleaner burning fossil technologies will reduce the amount of pollutants emitted and can reduce our dependence on carbon-intensive electric generating technologies which will help to stem the problem of global warming.

Currently, proposed state and federal legislation would significantly reduce the impact of power plant emissions on our children by cutting emissions nationally by 75 percent or more beyond the 1990 Clean Air Act Amendments and for the first time set emission standards for mercury and carbon dioxide. In addition to this legislation, it is also crucial that existing laws such as New Source Review, the National Ambient Air Quality Standards and rules governing haze and hazardous air pollutants be maintained and fully enforced to prevent backsliding, as well as to ensure progress in children's respiratory heath.

This report describes the risks to children posed by air pollution associated with coal-fired electricity generation. It summarizes the most recent research on how particulate matter, ozone, sulfur dioxide and hazardous air pollutants such as mercury affect children. Supplementing this report are state-by-state fact sheets with locations of power plants and statistics on the children at risk who live near them. These fact sheets can be found at – **www.cleartheair.org** or **http://clnatf.org**.

Children Face the Highest Risks

Air pollution is a pervasive problem across America for urban, suburban, and rural communities. Tens of thousands of schools are located near outdated, grandfathered power plants. Children are far more susceptible than adults to the adverse health effects of air pollution for a variety of reasons.[11,12] First, children are more active than adults and therefore breathe more rapidly. Second, compared to adults, children (including teenagers) also have more lung surface area compared to their body weight that means that they inhale more air for their size. In fact, they breathe 50 percent more air pound-for-pound than adults do. As a result, our kids inhale a greater percentage of pollution for their size. Children also spend more time outdoors where air pollution may be higher. What's worse is that this combination of exercise and higher pollution levels outdoors increases the penetration of pollutants into the lungs, making children more likely to suffer adverse health effects. Moreover, children's defense mechanisms have not yet developed fully, which also increases their susceptibility to the harmful effects of pollution.

Children are Growing Up Breathing Dirty Air

National air quality standards were designed by Congress to protect all Americans from certain forms of common air pollution with "an adequate margin of safety", but our children are far from safe. Over 25 million

children in the U. S. live in counties that violate national air quality standards for the common pollutants ozone, particulate matter and sulfur dioxide.[13] Nearly two million of the children in areas violating air standards are asthmatic and are particularly susceptible to these pollutants.

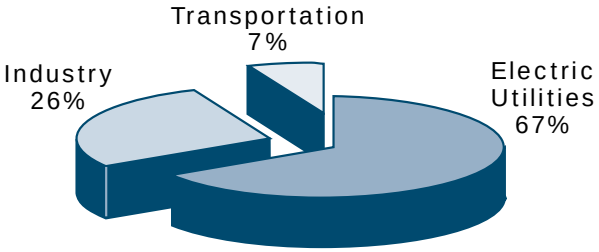
Many of America's children also live close to and go to school near power plants. Thirty-five million of our children live within 30 miles of a power plant – a distance within which local communities may be directly affected by a power plant's smoke plume.[15] An estimated 2 million of these children are asthmatic. What's worse, 72,000 of our schools are within 30 miles of a power plant. *(See state statistics, Appendix A and ranked exposure profiles, Appendix B.)* Also, as described below, children living near power plants may also inhale various other air toxics emitted from the smokestack or may be exposed to pollutants in power plant combustion wastes released into ground water.

Power Plants are the Largest Sources of Air Pollution in the U.S.

Power plants are a major source of the most common pollutants in the air that harm children. In 1998, power plants emitted 67 percent of the sulfur dioxide (Figure 1) 25 percent of the nitrogen oxides, 34 percent of the mercury and 38 percent of the CO_2 in the United States.[16,17,18] Moreover, after spewing from smokestacks right in our communities, these pollutants combine in the atmosphere forming "secondary pollutants".[19] Secondary pollutants, particularly ozone and sulfate, are some of the most harmful and widespread. For example, nitrogen oxides form acidic nitrate particulate matter, nitric acid droplets and ozone smog. Sulfur dioxide emissions from power plants form sulfate particulate matter and sulfuric acid. Sulfates are the dominant contributor to fine particulate matter in many areas of the U.S., especially in the eastern half.[20] Burning coal also releases highly toxic mercury and other toxic air emissions. Coal-fired power plants are the largest U.S. source of air toxics.[21] Smokestacks directly emit toxic metals and gases directly into the atmosphere such as mercury, arsenic, chromium, beryllium and acid gases such as hydrochloric acid. Stack tests at the nation's coal-fired power plants have detected sixty-seven different air toxics emitted from the smokestacks.

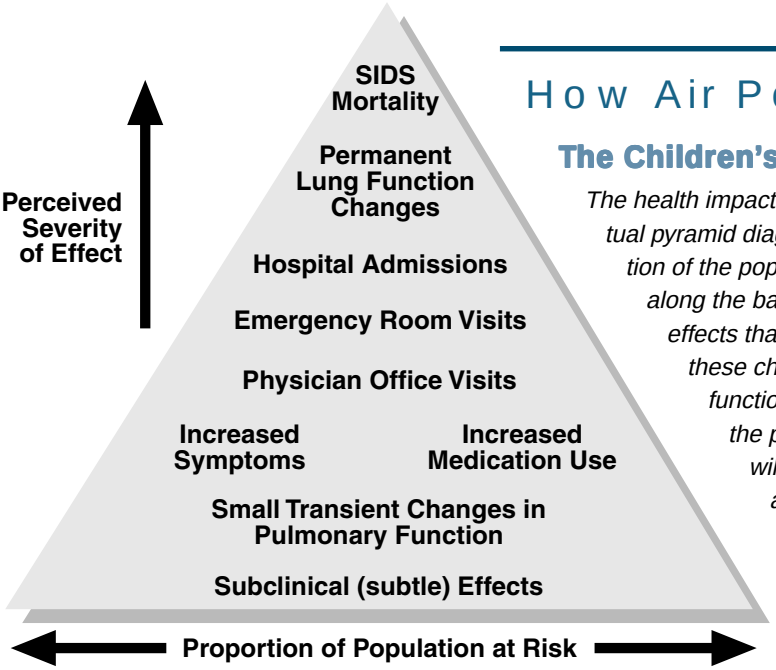
Figure 1 –

Sources of Sulfur Dioxide in the U.S., 1999.[16] Electric utilities comprise two thirds of all sulfur emissions.



How Air Pollution Harms Children

The Children's Health Impacts Pyramid[14]



The health impacts of air pollution on children are illustrated in a conceptual pyramid diagram. The base of the pyramid represents the proportion of the population at risk from air pollution. Children represented along the base experience some symptoms beginning with subtle effects that may either go untreated or need no treatment. Of these children, however, some will have small changes in lung function, increased symptoms and medication use (higher up the pyramid). With more severe exposures, some children will see physicians and be prescribed medications or be admitted to the hospital. For the children represented by the top of the pyramid, in the worst instances, permanent changes may occur in the developing lungs of children and in some cases pollution can result in death.

Particulate Matter
Dangerous for Children to Breathe

Particulate matter is, perhaps, the most pervasive and harmful pollutant from power plants plaguing America's children (Figure 2). During the hot, hazy days of summer, it is the particulate matter haze that you see hanging in the air not just humidity. While power plants directly emit some particulate matter as soot, the sulfur dioxide gas from power plants is a major source of particulate matter as it becomes transformed into tiny acidic sulfate particles in the atmosphere. These tiny particles are the most harmful and therefore of greatest concern. Fine particulate matter is of concern because it penetrates into our indoor living spaces thereby increasing our exposure. Fine particulate matter, known as $PM_{2.5}$, less than 2.5 microns in diameter or 1/100th the width of a human hair is deposited deep in the lung where it can affect both the respiratory and cardiovascular systems. Power plants release more tons of particulate matter-forming sulfur dioxide than any other pollution source. This means that power plants are responsible for about half of the fine particulate matter in many parts of the U.S. Epidemiological studies have suggested that sulfate-related particles are among the most strongly associated with health impacts and premature mortality in adults due to heart attacks, respiratory disease and lung cancer.[22,23,24]

A recent report estimated that 30,000 premature adult deaths a year occur because of particulate matter.[26] However, children may be at even higher risk for particulate matter exposure than adults.[27] One factor contributing to this higher risk may be that their exposure to fine particulate matter can be much higher than adults.[28] Another factor may be that children are more susceptible to the effects of particulate matter than adults. Studies in the U.S. have shown that emergency room visits by asthmatic children increase when particulate matter levels rise just slightly above the national air quality standards.[29,30] Moreover, a Seattle study found that emergency room visits by asthmatic children increased even at fine particulate levels *lower* than EPA's air quality standard.[31] Some children in the U.S. may be more susceptible to particulate matter than other children in the population. In one of the first studies of its kind, researchers are evaluating how particulate matter exposure affects African American children with asthma. Results suggest that even small increases in particulate matter may substantially increase asthma symptoms in these children. Results were examined relative to socio-economic factors relating to access of medical care; relationships remained regardless of whether or not their families had contact with a physician for asthma management, other than emergency room visits.[32] Seventy-eight percent of African Americans live within 30 miles of a power plant.[33]

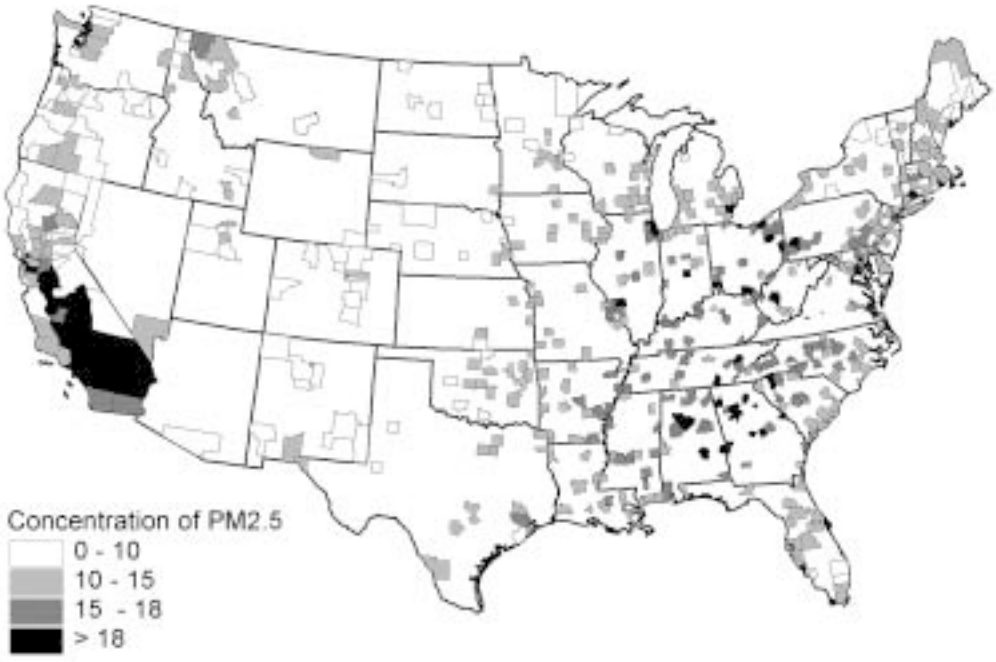


Figure 2 –
Average annual fine particulate matter conditions in the United States, 1999-2000 (EPA)[25]

1997 National Ambient Air Quality Standard for fine particles is 15 micrograms per cubic meter of air (ug/m3)

The benefits of reducing particulate matter are clear. For example, in a study undertaken in Germany, changes in respiratory disorders in children were tracked as particulate matter and sulfur dioxide in the air declined in East Germany following the fall of the Berlin Wall.[34] The results suggest that non-asthmatic respiratory symptoms such as coughing, chronic bronchitis, ear infections, frequent colds and febrile infections declined in parallel with improving air quality.

Lung Growth in Children is Decreased by Particulate Matter

Can exposure to particulate matter permanently affect a child's developing lungs? The Children's Health Study in California study suggests that particulate matter (PM_{10}) may slow lung function growth in children. Children examined in a dozen communities near Los Angeles experienced a three to five percent relative reduction in lung function *growth* between the most polluted and least polluted cities as a result of exposure to particulate matter.[35] When children moved to communities with higher particulate matter, a decreased growth in lung function was observed.[36] Conversely, for those children who moved to communities with cleaner air, lung function growth rates increased. This suggests serious permanent harm may befall children living in areas polluted with particulate matter.

Unborn Children are at Risk from Particulate Matter

Particulate matter may affect children even before they are born. Low birth weights and premature births may result due to exposure of a developing fetus to particulate matter in utero. Research in a coal-dominated region of the Czech Republic indicates that stunted development of the fetus may be a result of exposure to very high levels of particulate matter.[37] In fact, in utero exposure to a mixture of power plant pollutants (including sulfur dioxide, nitrogen oxides, polycyclic aromatic hydrocarbons and metals) were associated with neurobehavioral impairment and learning disabilities that extended to 8th grade.[38]

Similarly, researchers in China have found that high particulate matter concentrations may affect a developing baby. In a study of 75,000 births, an approximate 10 percent higher risk of having a low-birth weight baby associated with increases in sulfur dioxide and total particulate matter levels.[39]

Particulate Matter Increases the Risk of Infant Death

In the U.S., lung disease and breathing problems are the number one killers of babies under the age of one year, and air pollution is clearly a contributor. Breathing problems accounted for thirty percent of all infant deaths in 1997.[40] In a comparison of 86 cities in the U.S., researchers found that infants who lived in a highly polluted city during their first two months of life had a mortality rate ten percent higher than infants living in the city with the cleanest air.[41] Investigators in this study found that high particulate matter levels were associated with a 26 percent increased risk of Sudden Infant Death Syndrome and 40 percent increased risk of respiratory mortality.[42] In a preliminary study extending this work, researchers recently estimated that eleven percent of the infant mortality in the United States is attributable to particulate matter even at low to moderate levels.[43,44] Studies in the Czech Republic and Mexico City previously had supported the relationship between elevated particulate matter levels and increases in infant mortality.[45,46]

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EDITORIALS

Air Pollution Kills Babies. . .

or so suggests a new study[1] from the Czech Republic, published in this issue of *Epidemiology*. This case-control study shows that exposure to air pollution was higher in infants who died when they were between 4 weeks and 12 months old than in control infants who survived. Using a unique set of registry data, the authors, Bobak and Leon, were able to adjust for various risk factors, including socioeconomic status, birth weight and length, and gestational age. The association was found to be specific for respiratory causes of death, which comprised about 13% of postneonatal infant deaths over all. The association was also stronger for postneonatal infant deaths over all-cause as total suspended particles, TSP, than for particulate matter (PM, measured as PM_{10}), nitrogen dioxide (NO_2), providing further evidence of the adverse health effects airborne particulate matter may have. Levels of exposure were relatively high in the study period (1989–1991), the 50th percentile of TSP being 68.7 mg/m³.

The Czech study follows an earlier, less detailed report[2] that also found an association between postneonatal infant mortality and particulate matter as pollution. In the earlier study, potential confounders could not be controlled at the individual level, making the current study more convincing than the earlier one.

The issue of fatal effects of air pollution has received an enormous amount of attention in the last decade. The reason is that numerous time series studies have suggested that the day-to-day variation in air pollution concentrations is related to the day-to-day variation in the number of deaths in the population. There have also been some cohort studies suggesting that at low levels of exposure, PM exposure is associated with reduced survival.[3,4] Neither the time series studies nor the cohort studies have paid much attention to deaths among the very young. In part, this is a problem of information: infant deaths are, fortunately, rare in the developed world, and one needs large populations studied over extensive periods of time to estimate effects on mortality in time series or cohort studies. It is, however, also a problem of where we focus our attention. It is, however, suggests that deaths related to air pollution are observed in time series studies occur primarily among the old and infirm, who may not have long to live anyway ("harvesting"). For this reason, it is sometimes even thought that the public health impact of air-pollution-related deaths is limited, when measured as reduced life expectancy. The cohort study findings clearly show that the effect on life expectancy could be substantial,[5] and recent analyses of the harvesting issue

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Ozone Smog Harms Developing Lungs

Ozone, Another Byproduct of Fossil Power is Hazardous to Children

Millions of children live in areas that violate national air quality standards for the ozone (see Table 1). Ground level ozone—the main component of smog—is formed in the presence of sunlight from nitrogen oxides and hydrocarbon vapors emitted by power plants, motor vehicles and industrial processes. Power plants are the source of approximately one quarter of all nitrogen oxide emissions in the U.S. While ozone in the upper levels of the atmosphere provides a protective layer from the sun's ultraviolet radiation, ozone smog at ground level is extremely harmful to lungs.

The respiratory health effects of ozone have been well documented.[47] According to EPA, short-term exposure to ozone can cause rapid, shallow breathing and related airway irritation, coughing, wheezing, shortness of breath, and exacerbation of asthma, particularly in sensitive individuals and asthmatic children. Short-term ozone exposure also suppresses the immune system, decreasing the effectiveness of bodily defenses against bacterial infections. In research studies, markers of cell damage increase with ozone exposure. An increase in symptoms means an increase in hospital usage. As shown in Figure 3, ozone is a pervasive problem throughout the eastern half of the United States and California. But ozone is also increasing in the West.

Because air quality is typically the poorest in the summer, studies performed on kids at summer camp provide an excellent setting for examining the effect of air pollution on children. At camp, kids are highly active and are constantly exposed to outdoor air pollution. Moreover, pollution levels can be accurately measured at or near the camps. In typical field studies, children are asked several times a day to perform tests that measure their lung function. The lung function data are then compared to rises and falls in pollution levels. Studies performed in the Northeast, southern California, and Canada show clear decreases in lung function associated with exposure to ozone pollution. In addition, the studies demonstrate that the higher the ozone, the more lung function decreased.[48]

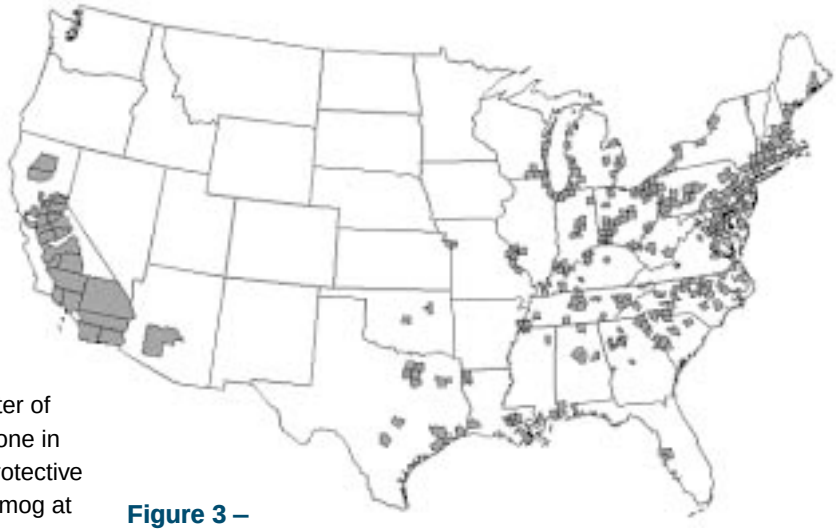


Figure 3 –
Counties in the United States exceeding the level of the 8 hour standard in 1999.
(U.S.EPA)

Ozone Exposures Result in Pediatric Emergency Room Visits and Hospitalizations

Emergency room visits for asthmatic children are strongly linked to ozone levels. Especially during the summer months, daily hospital admissions and emergency room visits increase as ozone levels increase. These relationships have been demonstrated in the U.S., Mexico and Canada.[50,51,52,53] Ozone-related asthma attacks also can result in missed school days. In California, absences from school were correlated with daily changes in ozone.[54]

State	Children	State	Children	State	Children
AL	359,885	KY	413,100	NJ	1,166,298
AR	15,925	LA	451,898	OH	2,076,127
AZ	555,791	MA	927,975	OK	288,184
CA	5,633,990	MD	941,629	PA	2,126,349
CT	723,218	ME	116,439	RI	36,336
DC	117,092	MI	1,281,472	SC	318,427
DE	163,341	MO	351,897	TN	703,083
FL	268,654	MS	81,006	TX	2,528,719
GA	575,431	NC	686,109	VA	554,056
IL	1,491,773	NH	150,169	WI	483,516
IN	702,749	NY	1,483,078	WV	118,273

Table 1 –
Number of children by state living in counties that exceed the level of the 8-hour ozone standard.[49]

Can Ozone Result in Premature Death?

For many years, researchers have been investigating the potential association between ozone and premature death. While still hotly debated, there is a growing body of evidence supporting such a relationship for adults.[55] But can ozone exposure result in premature death in children? One study suggests that exposure to ozone and nitrogen oxides in Mexico City is linked to infant deaths.[56] Interestingly, the study also found that the relationship between air pollution and infant death was even stronger when particulate matter levels were included in the analysis.

Ozone is Associated with Adverse Birth Outcomes and May Retard Lung Development

Adverse birth outcomes such as premature birth and low birth weight are fairly common in the U.S. Ten percent of all U.S. births are pre-term (more than 3 weeks premature) and some of these premature births may be due to air pollution.[59] These and other effects on the fetus put children at risk for adverse long-term health problems and recently, researchers have begun to more deeply explore the association of ozone and other pollutants with adverse birth outcomes. For example, a new California study suggests associations between ozone exposures during the second month of gestation and aortic valve defects, pulmonary artery and valve anomalies and other defects.[60]

Other evidence also suggests that exposure to ozone may permanently affect the lung structure of children. In one of the most stunning new developments, researchers at the University of California suggest that lung development may be stunted by regular exposure to ozone that appears to cause fundamental changes in lung and related brain development. In the study, monkeys exposed to ozone developed little more than half of the normal number of branches of their lungs compared to monkeys exposed only to clean air.[61] The lung receives oxygen from the alveoli at the end of the branches and therefore researchers suspect that fewer branches could cause more difficulty breathing.[62] Researchers also observed that pollutants caused changes in the brains of these monkeys that made them "hypersensitive" and more likely overreact to irritants. This study provides compelling evidence of the potential serious long-term harm to young children by ozone smog.

Some Children are More Susceptible to Ozone than Others

While scientists have documented that children are generally more susceptible to ozone pollution than adults, asthmatic children are even more vulnerable. However, some subgroups of asthmatic children appear to be more susceptible than others. A recent study suggests that asthmatic children that were born pre-term and/or with low birth weights, are at greater risk from ozone exposures.[63,64] The same study found that susceptibility varied among inner city Black and Hispanic populations as well. Affluence may play a role in susceptibility; children in homes with air conditioners suffered lower exposures than those in homes without because air conditioners are effective in reducing indoor ozone levels.[65]

Can Ozone Pollution Cause Asthma?

We know that inhaling ozone exacerbates asthma in children, but can it cause asthma? The answer is not clear at this time, but a few new studies point in that direction. Researchers examined associations between exercise and asthma in 3500 children from 12 communities with high ozone levels in Southern California. They found that 265 new cases of asthma were diagnosed in the five years following exposure.[57] Moreover, children living in high ozone communities and who played 3 or more sports were three times more likely to develop asthma compared to children who didn't play sports. The researchers concluded that new asthma diagnoses were associated with heavy exercise in areas with high ozone levels. This is some of the first evidence that ozone may cause asthma. In another California study, scientists related cumulative lifetime ozone exposures to small airway lung function and found evidence of early indicators of chronic obstructive pulmonary disease.[58]

Sulfur Dioxide
Asthmatic Children at Risk

Harmful Sulfur Dioxide Gas Directly Affects Nearby Communities

Sulfur dioxide is a dangerous gas that adversely affects human health throughout the U.S. (Figure 4) and can especially affect people living in the shadow of power plant smokestacks where impacts are highest. Power plants are the predominant source of sulfur dioxide, emitting 67 percent the emissions in the U.S. One hundred thousand children with asthma lived in counties in 13 states that violated the sulfur dioxide standard in 1998.[66,67] Despite improvements resulting from the 1990 Clean Air Act amendments, there were 31 nonattainment areas in the U.S. for sulfur dioxide in 1999.[68] Unfortunately, serious health effects are also associated with sulfur dioxide levels well below the national ambient air quality standard.[69] Moreover, acute impacts of sulfur dioxide gas are observed in short-term (less than 5 minute) spikes in concentrations. In fact, in 1996 EPA found the current national ambient air quality standards for SO2 not to be adequately protective for short-term exposures to asthmatic individuals.[70] While EPA declined to adopt a new short-term standard, it established guideline for reducing this risk at the state level.

Health Impacts of Sulfur Dioxide Emissions

Sulfur dioxide has been associated with health effects ranging from asthma attacks to premature death. It is an irritant that has been shown in both laboratory and epidemiology studies to exacerbate respiratory disease such as asthma, coughing, wheezing, shortness of breath, and reduce lung function in general.[72] Inhalation is associated with upper respiratory symptoms including nasal congestion and inflammation. Sulfur dioxide gas can also destabilize normal heart rhythms.[73] Controlled laboratory and epidemiology studies have demonstrated that children and people with constrictive pulmonary disease such as asthma are at increased risk from exposure to sulfur dioxide.[74] Asthmatics in particular can suffer when exposed to sulfur dioxide. These individuals are commonly stricken with shortness of breath, coughing, wheezing and reductions in lung function. Moreover, sulfur dioxide gas is toxic following only minutes of exposure. Exercising asthmatics can experience lung constriction within 5-10 minutes of exposure.[75]

Sulfur dioxide can be deadly. Numerous studies link sulfur dioxide with bronchial reactions, reduced lung function and premature death.[76] Some studies associate even very small sulfur dioxide exposures with premature death.[77] Indeed, sulfur dioxide has also been associated with low birth weight and increased risk of premature death at levels below the national ambient air quality standards. Reproductive effects such as reduced sperm quality have also been linked with sulfur dioxide exposure.[78] A study of infant mortality in the Czech Republic associated high sulfur dioxide exposures[79] with a 74 percent higher risk of infant death from respiratory causes.[80]

Sulfur dioxide gas is considered to be most toxic in the presence of ozone and particulate matter, a common mixture that results from power plant emissions.[82] Prior exposure to ozone has been shown to lead to greater sensitivity to sulfur dioxide in adolescents.

Asthma Cases Have Doubled.

Cases of asthma have rapidly increased, more than doubling in the past two decades. Children age 17 and under account for 29 percent of all the asthma cases in the U.S. and 6 percent of US children have asthma.[71] In 1992, 10 percent of U.S. children with asthma were hospitalized sometime during the year.

Figure 4 –
Areas at Risk for Sulfur Dioxide Exposure *(U.S. EPA, 1999).*[81]

Air Toxics Hazardous to Our Children

Air Toxics and the Environment: The Role of Coal

Coal-fired power plants emit many air toxics. In EPA stack tests, 67 different pollutants have been detected in the flue gas of coal-fired power plants.[83] Of these, 55 are known to affect the development of a child's brain or nervous system or to affect the way a child's body develops.[84] Of these 55, 24 are characterized by EPA as either: known, possible, or probable human carcinogens.[85] These toxic pollutants are formed during the combustion of coal or are present in coal (e.g., metals like mercury and arsenic), and subsequently released through the smokestack. The amount and type of pollutant emitted from the smokestack depends on the combustion temperature, other characteristics of the coal such as ash content, and the type of pollution control devices in place.

Table 2 summarizes recent emission estimates from the Toxics Release Inventory (TRI) for several important toxics and illustrates the magnitude of power plant emissions relative to other source categories. Because power plants are currently uncontrolled for air toxics, as other source categories are controlled, power plants will account for a larger and larger share of air toxic emissions nationally. Furthermore, in an analysis of fuel use through the year 2010, the EPA predicts that emissions from coal-fired power plants will increase commensurate with an increased demand for electricity.[86]

Health Effects of Air Toxics

Some air toxics are carcinogens and others are neurotoxins (which affect the development of a child's brain or nervous system) or developmental toxins (which affect the way a child's body develops).[87] Brain development begins in utero and continues until about age 14.[88] Normal brain development consists of cell formation and organization that takes place at precise times during gestation in a precise sequence. Interference with any stage of these cellular events may have long-term effects.[89] The timing, pattern and level of exposure largely determine which parts of the brain will be affected and to what degree.[90] Thus, exposure of pregnant women and women of childbearing age to air toxics is a

Table 2 –

1999 Toxics Release Inventory (TRI) Data for Selected Power Plant Air Toxic Emissions.

	Total Air Emissions (lbs), TRI 1999	Percent of National TRI Air Emissions	Health Effects
Arsenic and compounds	298,297	48 percent	Neurotoxin / Endocrine disruptor / Known human carcinogen of high potency
Beryllium and compounds	8,585	81 percent	Probable human carcinogen of moderate to low potency
Chromium and compounds	1,053,160	25 percent	Known human carcinogen of high potency (Chromium VI)
Manganese and compounds	3,273,899	16 percent	Neurotoxin
Mercury and compounds	Not reported	33 percent (EPA, 1998)	Methylmercury is a known human neuro logical and developmental toxin and a possible human carcinogen. Elemental mercury is a neurotoxin. Inorganic mercury can cause kidney damage and is a possible human carcinogen.
Nickel and compounds	1,502,569	50 percent	Neurotoxin nickel refinery dust and nickel subsulfide are known human carcinogens. Nickel carbonyl is a probable human carcinogen.
Selenium and compounds	660,424	77 percent	Neurotoxin selenium sulfide is a probable human carcinogen.
Hydrogen chloride	666,193,000	92 percent	Strong respiratory irritant
Hydrogen fluoride	72,700,182	80 percent	Neurotoxin / Strong respiratory irritant

concern. The potential effects of exposure to these pollutants may be cancer or a range of developmental problems such as learning disabilities, attention deficits, loss of IQ points or other disorders depending on the severity of exposure. Many air toxics are also respiratory irritants that can worsen conditions such as asthma.

Children are Exposed to Power Plant Air Toxics in Many Ways

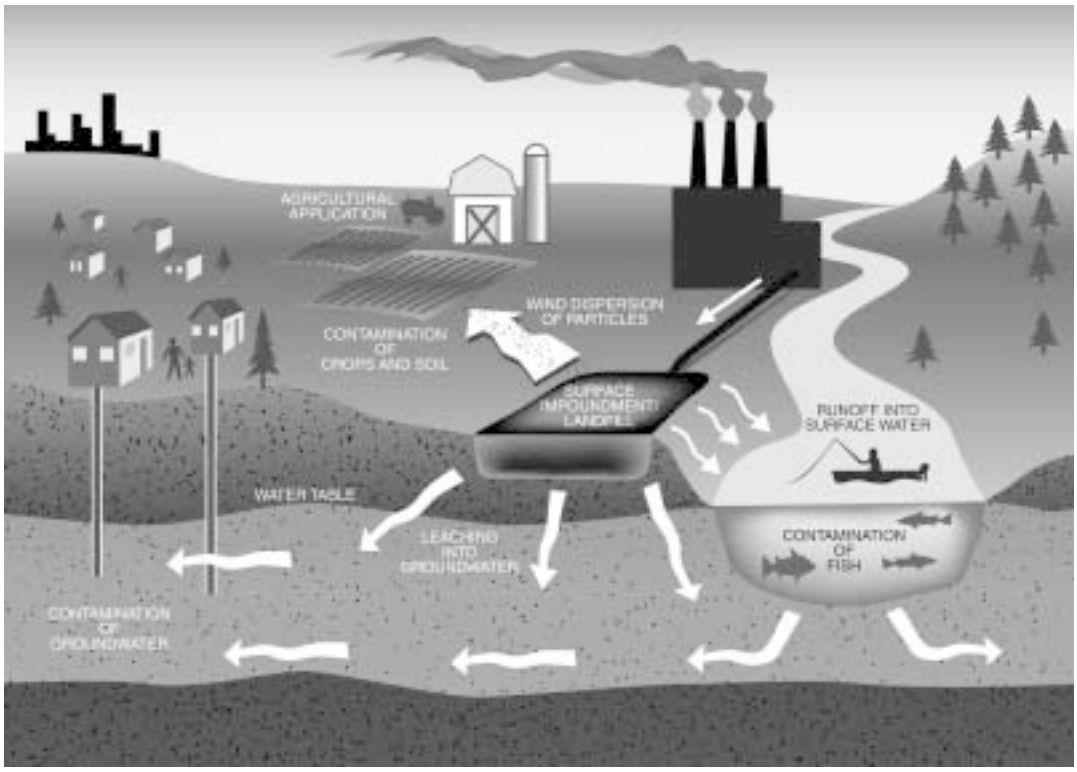
Some air toxics bioaccumulate in the food chain and are ingested as part of our diet, while still others are dispersed globally and contaminate regions far from the emitting source. Exposure to air toxics from power plants may occur from direct inhalation of air pollutants, or "indirect exposure" including the ingestion of meat, dairy products and fish, as well as water, soil, or vegetation that becomes contaminated by air emissions that have deposited to earth and accumulated in the food chain. Pollutants for which indirect exposure is particularly important are mercury, arsenic, dioxins, cadmium and lead. Some toxics may be absorbed through the skin. Absorption through the skin of some power plant air toxics may also occur, especially from direct contact with contaminated water or soil. Another important exposure pathway for children is the ingestion of contaminated soil during play.

Children also can be exposed to contaminants in power plant combustion wastes. Minefilling (i.e., dumping large volumes of combustion waste in abandoned mines) and the disposal of combustion waste in unlined surface impoundments and landfills can contaminate groundwater (a source of drinking water). Agricultural uses of combustion waste as a soil amendment directly contaminates the soil and can contaminate nearby areas with windblown dust. Combustion waste is largely made up of ash and other uncombusted materials that are left when coal and oil are burned. Each year more than 100 million tons of waste is generated from coal and oil combustion. These wastes contain concentrated levels of numerous contaminants, particularly metals like mercury, arsenic, lead, chromium and cadmium.

How Hazardous Pollutants from Power Plants Get into the Environment

Because power plant waste is generally disposed of at the plant site, children living in the vicinity of power plants experience the highest exposure to coal combustion waste and consequently have the highest risk of adverse health effects. Using computer models, EPA assessed the potential health risks to children if power plant

ALAN MORIN



How hazardous materials from power plants get into the environment

combustion waste leaked from surface impoundments or ash landfills and contaminated drinking water wells.[91] EPA found that if children drink, over a period of years, an average amount of water contaminated with combustion waste, they will have a higher risk of cancer and other health effects. The EPA found the highest potential risks to children from contaminated groundwater were from arsenic, chromium VI, nickel and selenium.

The EPA also analyzed other ways children might be exposed to power plant combustion waste such as inhalation and the ingestion of fruit, vegetables, beef and dairy products contaminated by the wastes.[92] The highest risks predicted for inhalation were from chromium VI that is dispersed with dust from uncovered ash landfills. Arsenic, barium, beryllium and posed the highest risks from ingestion of food. In fact, according to EPA analyses, children exposed to power plant combustion wastes could have a considerably higher risk of developing cancer and other illnesses than non-exposed children.[93]

These children may be even more vulnerable to the health risks posed by these facilities because many of them are living in poverty (see Table 3). Living in poverty is usually associated with poor nutritional status, limited access to health care and substandard housing conditions (including exposure to lead paint), all of which may make these children more susceptible to the effects of toxins in their air and food.

Children at Risk from Air Toxics

Health risks from power plant toxics depend on the severity and duration of the exposure, the exposure pathway, whether the child is especially sensitive to the pollutant, and the pollutant's toxicity. Studies that have attempted to quantify the health risks of toxic emissions are limited because they fail to account for multiple and cumulative exposure to many pollutants at the same time.[94] This has resulted is assessments that generally underestimate the health risk from exposure to power plant emissions.

Table 3 –

Children living within one mile of a coal-fired power plant.[95]

	U.S. Population *(November 2000 Projections)*	Within 1 Mile of a Coal-Fired Power Plant
Total U.S. population	276,059,000	836,097
Total children (under age 19)	78,537,000	245,400
Children in poverty	12,845,000	48,477
Childhood poverty rate	14.8 %	19.8 %
Percent non-white	17.8 %	21.5 %

Air of Concern: Mercury Emissions from Power Plants

Of the hazardous air pollutants from power plants, the pollutant of greatest concern is mercury. Two national reports by the EPA have implicated coal-fired power plants as the largest industrial emitters of mercury, producing over one third of all mercury pollution in the U.S.[96,97] But, inhaling airborne mercury is not the problem. Airborne mercury eventually deposits in water bodies where it is converted to methylmercury and accumulates in fish tissue. The ingestion of mercury-contaminated fish by expectant mothers and the subsequent exposure of the developing fetus to methylmercury poses the highest risk to children.

Once emitted, mercury can be transported long distances in the atmosphere. Water bodies are contaminated when mercury in the atmosphere depositsing to earth in rain and other forms of precipitation. Run-off and erosion into water bodies is also a source of contamination.[98] In the aquatic environment, mercury is converted by microorganisms into methylmercury. Fish absorb methylmercury from water as it passes over their gills and as they feed on other aquatic organisms. As larger fish eat smaller ones, concentrations of the pollutant increase in the bigger fish, a process known as

bioaccumulation. Consequently, larger predator fish have higher concentrations as a result of eating contaminated prey.[99]

Mercury contamination in fish across the United States is so pervasive that health departments in 42 states have issued fish consumption advisories.[100] In addition, 11 states have consumption advisories for every inland water body for at least one fish species; 6 states have consumption advisories for canned tuna, and 8 have statewide coastal marine advisories for king mackerel. The U.S. Food and Drug Administration has also issued a consumer advisory for pregnant women, women of child-bearing age, nursing mothers and young children. These groups are advised not to eat swordfish, tilefish, shark and king mackerel because of high mercury levels.[101]

Methylmercury is both a developmental toxin and a neurotoxin. A spectrum of health effects has been observed following exposure, with the severity of effects depending largely on the amount and timing of exposure.[102] Children and the developing fetus are most vulnerable to mercury exposure. Methylmercury that is consumed by the mother passes through the placenta to the developing fetus. Mercury exposure prior to pregnancy is as critical as exposure during pregnancy because it persists in tissues and is slowly excreted from the body. The first weeks of pregnancy also represent a critical time for fetal development. Women of childbearing age (i.e., 15 to 44 years of age) and pregnant women are therefore the most important members of the population in terms of mercury exposure.[103]

In addition to exposure in utero, infants and children ingest methylmercury from breast milk and other foods in their diet. Children and infants are sensitive to mercury's effects because their nervous systems continue to develop until about age 14. Children also have higher exposures than adults because a child eats more food relative to his or her body weight than an adult does. As a result, they have a higher risk for adverse health effects than adults do.[104]

Methylmercury interferes with the development and function of the central nervous system. Prenatal exposure from maternal consumption of fish can cause later impairments in children. Infants appear normal during the first few months of life, but later display subtle effects. These effects include poor performance on neurobehavioral tests, particularly on tests of attention, fine motor function, language, visual-spatial abilities (e.g., drawing), and memory. These children will likely have to struggle to keep up in school and might require remedial classes or special education.[105]

There is also evidence in humans and animals that exposure to methylmercury can have adverse effects on the developing and adult cardiovascular system, blood pressure regulation and heart-rate variability.[106]

The Children Left Behind

On March 2, 2001, the Centers for Disease Control and Prevention (CDC) released preliminary findings on mercury levels in blood and hair from the 1999 National Health and Nutrition Examination Survey (NHANES). This is the first time that human tissues have been systematically analyzed for this mercury. The survey found that 10 percent of the women of childbearing age tested had mercury in their blood at levels above the level that the EPA considers to be safe.[107,108] Nationally, this translates into 6 million women of childbearing age with elevated levels of mercury from eating contaminated fish, and approximately 390,000 newborns at risk of neurological effects from being exposed in utero to elevated levels of mercury.[109]

While power plants are not the only source of mercury, three facts are clear: (1) power plants are the largest emitting source category in the U.S., (2) as other sources are controlled, power plants become a bigger factor; and (3) mercury from power plants have yet to be regulated at the state or national level.

There is also statistical evidence that a number of disorders that have been linked to environmental toxins are increasing. These disorders include premature birth and low birth weight, structural birth defects and behavioral and learning disorders.[110] How

much of this increase can be attributed to environmental exposures? The National Academy of Sciences (NAS) recently concluded that as many as 3 percent of known developmental and neurological deficits in children are caused by exposure to known toxic substances, including developmental and neurological toxins. The panel also concluded that 25 percent of these problems may be the result of environmental and genetic factors working in combination, and that toxic substances may play a significant but yet undetermined role.[111]

Using this estimate, the National Environmental Trust (NET), Physicians for Social Responsibility and the Learning Disabilities Association of America calculated that 360,000 children – or 1 in 200 children suffer from developmental or neurological defects caused by exposure to known toxic substances including developmental and neurological toxins.[112] They note however that this number is likely underestimated because the NAS considered only known developmental and neurological toxicants. Remarkably, information about potential neurotoxicity and developmental neurotoxicity is essentially absent even for the chemicals produced in the highest volumes.[113] Also, the NAS estimate of neurological and developmental defects refers only to well-recognized and clinically diagnosed mental and physical disabilities. This underestimates other subtle mental and physical deficits that are difficult to diagnose because of the extended time between exposure and effects, or due to effects that have not yet been recognized.[114]

Scientists recognize that in addition to environmental toxins, genetics and a child's physical and home environment also contribute to developmental disorders in children. No one can say with certainty to what degree a child's impairment is caused by exposure to any one of these particular factors.[115] We do know however, that power plant pollution is a contributing factor and we are certain that exposure to these pollutants can be minimized.

Greenhouse Gas Mitigation Benefits to Children's Health

The health of America's children is linked to climate change too. Scientists in the U.S. and worldwide agree that changes in the Earth's atmosphere are occurring due to the build up of carbon dioxide in our atmosphere from burning fossil fuels. In fact, power plants release 38 percent of all of the carbon dioxide emitted from burning fossil fuels in the U.S.[116] By reducing emissions from power plants and other CO_2 sources we can diminish the impact of climate change and with it the expected spread of infectious diseases, increased heat and cold-related illnesses, and increased smog formation and the resultant respiratory illnesses.

In a 2001 report to the President, a panel of the National Academy of Sciences concurs with the Intergovernmental Panel on Climate Change (IPCC) scientific report that concludes that global average surface temperatures may increase by 3-10 degrees Fahrenheit by the end of the 21st Century as a result of human activities.[117]

The potential health impacts associated with climate change are still being assessed, however, based on what we know some early conclusions can be drawn.[118,119] Potential human health risks include increased prevalence of infectious disease associated with increasing local temperatures, increased cases of heat related stress and illness, and increased exposure to secondarily-formed pollutants, such as ozone smog, the formation of which is largely dependent on heat and sunlight. Diseases common to tropical and warmer areas could spread; especially those carried by mosquitoes and other insects. These diseases could become progressively more common as warmer temperatures enable these insects to become established further north.

Ozone smog is both a potent greenhouse gas and unhealthy to breathe. As discussed in detail earlier in this report, ozone is associated with increased pediatric asthma, emergency room visits hospitalizations, and lost school days. As the climate gets warmer ozone levels are likely to increase. Atmospheric chemists suggest that warming alone may enhance smog formation; a warming of 4 degrees Fahrenheit could increase ozone concentrations by about 5 percent.[120]

A few studies have attempted to estimate the health benefits of strategies to abate greenhouse gases.[121,122] The Working Group on Public Health and Fossil Fuel Combustion of the World Health Organization in 1997 projected that "business as usual" energy policies between 2000 and 2020 would lead to 8 million premature deaths from increases in particulate matter alone.[123] The same study estimated that 700,000 of these deaths would be avoidable. Another international study recently suggests that many lives could be improved or even saved under greenhouse gas mitigation policies that would result in reduced ozone and particulate matter. According to the study, a 10 percent reduction in ozone and particulate matter as a result of applying climate policies in four cities studied in North and South America would result in avoiding 64,000 premature deaths along with 6.1 million asthma attacks and 37 million work loss days.[124] While the more heavily polluted South American cities stand to gain the most from greenhouse gas mitigation, the study estimated that 56 neonatal deaths and 3000 pediatric hospitalizations would be avoided each year in New York City alone.

It is apparent that climate strategies that reduce greenhouse gases from power plants and other sources will have a positive effect on human health by decreasing levels of other pollutants such as ozone, lessening the risk of the spread of infectious diseases, and reducing temperature related stress and illness.[125]

What Should be Done?
Wise Choices To Improve Children's Health

Air pollution from power plants imposes a serious health burden on our children. We know that pollutants have a greater impact on children than adults. These impacts range from minor coughs to asthma attacks, missed school days, hospitalizations, neurological damage, increased risk of cancer and infant death. The pollutants that affect children are also present in our homes (e.g., particulate matter) and our food (e.g., mercury). While the benefits of reducing power plant pollution have been estimated for adults and are many times the cost of emissions controls, little work has been done to quantify the benefits for children. Certainly the benefits will be great. Saving an infant from death means many decades of life preserved.

Polluting coal-fired power plants must be made to comply with modern emission control standards. In addition, the nation's power fleet should be held to nationwide caps on all four of the key types of power plant pollution including nitrogen oxides, sulfur dioxide, mercury and other air toxics, and carbon dioxide. Reducing power plant emissions of nitrogen oxides and sulfur dioxide by 75 percent or more beyond current legal requirements will dramatically reduce fine particulate matter pollution so that children can breathe more easily.

The threat of power plant air pollution to children can be reduced comprehensively only when the Clean Air Act's 30-year loophole that allows old, dirty power plants to avoid modern standards is finally closed. Technologies that can reduce sulfur dioxide, nitrogen oxides emissions 90 percent or greater are proven and also appear feasible for mercury. The threat posed by global warming requires that we address carbon dioxide as part of a comprehensive strategy to address power plant pollution. Requirements such as these can ensure that U.S. energy policy better accounts for public health and the environmental costs associated with electricity production and will propel us toward a more sustainable energy future that relies increasingly on cleaner sources of energy including renewable energy resources and conservation. Our children's health and quality of life are harmed by air pollution today. The specter of global warming hangs over their future. We can leave our children a legacy of cleaner air and an improved environment by making wise choices today. Let's make comprehensive power plant clean up our gift to them.

Appendix A:
Children Affected by Coal-Fired Power Plants.[126]

State	Number of Coal Plants in State	Coal Plants in State plus Coal Plants Within 30 Miles of Border	Children Living Within a 30 Mile Radius of a Coal Plant	Total Number of Children in State with Asthma in 1998
AK	1	1	7,220	10,281
AL	9	15	645,531	57,092
AR	3	5	245,378	35,088
AZ	6	7	213,144	68,563
CA	0	1	5,271	473,486
CO	13	18	777,975	55,524
CT	1	5	151,632	42,883
DC	0	5	117,092	5,244
DE	2	7	142,099	9,557
FL	12	13	1,393,092	187,314
GA	12	18	1,247,012	107,578
HI	0	0	0	15,696
IA	19	24	567,140	38,367
ID	0	1	1,348	18,693
IL	24	57	2,746,764	168,852
IN	24	53	1,127,326	80,699
KS	8	15	316,011	37,044
KY	22	44	811,993	51,766
LA	4	6	334,941	63,692
MA	4	6	499,994	77,300
MD	7	19	1,124,288	68,593
ME	0	2	29,352	15,527
MI	20	24	1,929,662	135,345
MN	13	20	900,276	67,048
MO	20	35	1,163,815	74,452
MS	4	7	260,136	40,174
MT	3	3	47,746	12,006
NC	14	19	1,166,947	101,517
ND	7	10	38,701	8,640
NE	7	11	316,623	23,598
NH	2	3	218,610	15,939
NJ	5	12	1,696,787	105,914
NM	4	8	60,926	26,531
NV	3	3	11,529	24,857
NY	12	16	3,199,588	237,291
OH	27	46	2,577,634	151,149
OK	5	9	294,473	46,877
OR	1	1	12,623	43,688
PA	23	44	2,596,063	151,857
RI	0	2	215,366	12,591
SC	12	20	879,240	50,763
SD	2	5	43,734	10,640
TN	7	14	860,535	70,880
TX	19	20	1,509,580	300,326
UT	5	8	46,530	37,367
VA	9	20	1,256,936	87,625
VT	0	0	0	7,500
WA	1	2	81,014	78,244
WI	16	25	1,095,253	71,626
WV	14	27	398,632	21,746
WY	8	9	76,239	6,869
Total			**35,459,801**	**3,711,899**

Data Sources: MSB Energy Associates. Coal plant data: Energy Information Administration; Children data: U.S. Census tract population estimates 1997; Pediatric asthma data: American Lung Association:1998.

Appendix B:
Ranked Exposure Profiles for Children within 30 Miles of a Coal-Fired Power Plant.

State	Children with Pediatric Asthma	Pediatric Asthma *(State Rank)*	Total State Coal Plant Air Emissions *(tons)*	Emissions per Child / 30 Mile Radius *(tons)*	Emissions per Child / 30 Mile Radius *(State Rank)*	Schools / 30 Mile Radius	Schools / 30 Mile Radius *(State Rank)*	Children in Non-Attainment Areas / 30 Miles of Coal Plant
AK	406	47	0	0	44	0	48	5,938
AL	34,733	21	88,323,224	137	10	1,992	13	189,779
AR	14,090	30	28,644,100	117	16	841	26	0
AZ	13,952	31	47,135,216	221	9	232	35	188,021
CA	339	48	0	0	44	1	47	5,271
CO	50,336	17	40,535,866	52	29	713	28	523,415
CT	8,715	34	2,287,185	15	41	600	29	151,632
DC	5,244	36	0	0	44	389	32	117,092
DE	8,312	35	5,670,211	40	34	266	34	142,099
FL	90,859	8	77,702,956	56	27	1,723	17	0
GA	78,897	9	83,778,288	67	23	2,379	10	674,716
IA	30,470	22	40,512,642	71	21	1,016	24	0
ID	71	49	0	0	44	0	48	0
IL	157,659	2	92,931,607	34	36	7,464	1	2,034,274
IN	62,469	14	137,162,285	122	15	1,743	15	168,690
KS	18,157	25	39,717,525	126	14	1,051	23	0
KY	44,158	20	104,420,412	129	13	1,326	20	90,616
LA	17,199	27	24,287,341	73	20	568	30	121,999
MA	28,266	23	13,806,340	28	39	1,729	16	499,994
MD	66,360	12	32,503,474	29	38	2,075	12	1,027,336
ME	1,541	44	0	0	44	17	44	29,352
MI	106,194	5	75,587,293	39	35	3,079	7	0
MN	52,479	16	38,300,886	43	33	1,147	21	149,632
MO	65,728	13	71,722,251	62	25	4,630	4	482,500
MS	14,468	29	15,678,705	60	26	537	31	0
MT	2,553	41	17,955,967	376	6	163	39	34,708
NC	74,947	10	73,944,757	63	24	1,659	18	0
ND	1,943	43	37,382,883	966	2	172	38	0
NE	17,706	26	21,435,881	68	22	822	27	111,898
NH	12,630	32	4,706,364	22	40	190	37	205,132
NJ	99,488	6	9,815,066	6	43	1,421	19	1,696,787
NM	3,539	39	33,799,488	555	5	98	41	0
NV	929	45	20,289,092	1,760	1	12	45	5,454
NY	179,051	1	25,760,999	8	42	3,453	6	2,634,480
OH	139,029	4	137,570,633	53	28	7,107	2	836,411
OK	16,611	28	38,849,383	132	11	348	33	0
OR	761	46	4,021,645	319	7	12	46	0
PA	140,949	3	112,280,946	43	32	5,117	3	2,047,542
RI	11,966	33	0	0	44	64	42	215,366
SC	48,567	19	41,015,630	47	30	3,885	5	0
SD	2,327	42	4,159,081	95	18	159	40	0
TN	49,941	18	65,294,367	76	19	2,817	9	226,307
TX	92,386	7	163,298,619	108	17	1,059	22	682,338
UT	2,603	40	37,118,861	798	3	48	43	3,576
VA	73,891	11	39,780,790	32	37	2,136	11	371,590
VT	0	50	0	0	44	0	48	0
WA	5,116	37	10,451,134	129	12	894	25	0
WI	60,829	15	51,081,291	47	31	1,832	14	514,494
WV	19,642	24	92,265,497	231	8	2,987	8	14,165
WY	3,880	38	51,357,490	674	4	190	36	0
US Total	**2,032,385**		**2,154,343,671**			**72,163**		**16,202,605**

Data: MSB Energy Associates; 2000 Emissions (PM10, ozone, SO2, NOX, VOC, mercury, acid gases, CO2); 1998 asthma statistics: ALA; 1997 children statistics: U.S. census estimate; non-attainment data: EPA Green Book as of January 15, 2002.

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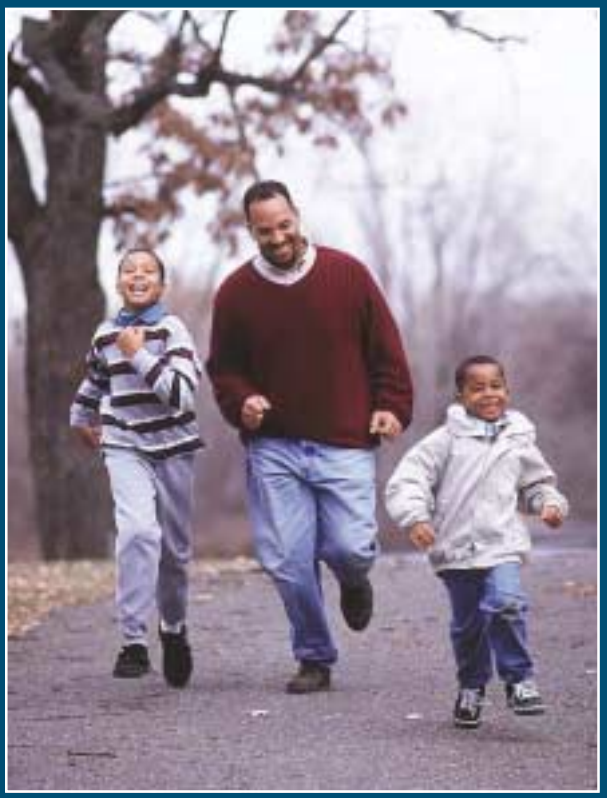

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