Breathing Easier About Air Quality

by Joel Schwartz
Visiting Fellow at the American Enterprise Institute

An Economic Policy Lecture

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INTRODUCTION

Most people associate air pollution with automobiles and factories. But air pollution has been a part of human existence for thousands of years, and accounts of noxious urban air go back to ancient times. The Roman statesman Seneca bemoaned, "the stink, soot, and heavy air" of Rome in 61 AD.[1] London has suffered from air pollution since the Middle Ages, when coal became a common fuel in smithies and lime burners. The problem was bad enough that King Edward I in 1285 created a commission to improve the city's air quality.[2]

Today, despite vast increases in energy production, motorized transportation, and economic activity in general, American cities enjoy cleaner air than at any time in the last century. Monitoring data show air pollution had already been declining for decades before the Clean Air Act was adopted in 1970 and air quality has continued to improve during the last few decades. Existing requirements for motor vehicles, factories, and consumer products ensure that air quality will continue to improve for decades to come. The health effects literature indicates that air pollution has become a minor factor in people's health and welfare.

Despite America's extraordinary success in mitigating air pollution, surveys show great and increasing public concern over air quality. Many people mistakenly believe air pollution has been getting worse and will continue to worsen in the future, and that air pollution is still a serious threat to public health.

Americans receive most of their information about air pollution from journalists, government regulators, environmental activists, and scientists. Unfortunately, much of this information exaggerates air pollution levels and health risks, and obscures or ignores positive trends. As a result, much of what Americans "know" about air pollution is false.

Exaggerating harm from air pollution makes us worse off overall. The public's interest is best served by an accurate portrayal of risk. Environmental regulations are not free. People ultimately bear regulatory costs, because those costs are passed along in the form of higher prices for useful goods and services, lower wages, and lower returns on investments. We have many needs and aspirations and scarce resources with which to fulfill them. When we devote resources to an exaggerated risk, we give up opportunities to address other real and substantial risks, or to pursue other improvements to our health and quality of life. Air pollution alarmism also foments unnecessary public fear.

People can make informed decisions about air pollution policy only if they have accurate information on the risks they face, the costs and benefits of further reductions in pollution emissions, and the benefits of devoting scarce resources to air pollution

control versus other public and private priorities. The question isn't whether we would prefer less air pollution, of course we would. But in the real world, we have to make tradeoffs among competing goals and aspirations. If risks from air pollution are exaggerated, we will make these tradeoffs poorly, to the detriment of our overall health and welfare.

This paper explores air pollution trends and health effects and their portrayal in the media and other popular sources of information.

U.S. AIR QUALITY TRENDS

Air Pollution Declines Preceded the Clean Air Act

Air pollution has been declining for many decades throughout the United States. Contrary to popular mythology, these declines began long before the federal government took over air pollution regulation in 1970, preempting local control by state and local governments. For example, data from Pittsburgh, once America's smokiest city, show that airborne particulate (dust, smoke, and soot) levels declined more than 65 percent between the the 1920s and the 1960s.[3] Airborne particulate matter was declining in other cities as well, as shown in Figure 1.

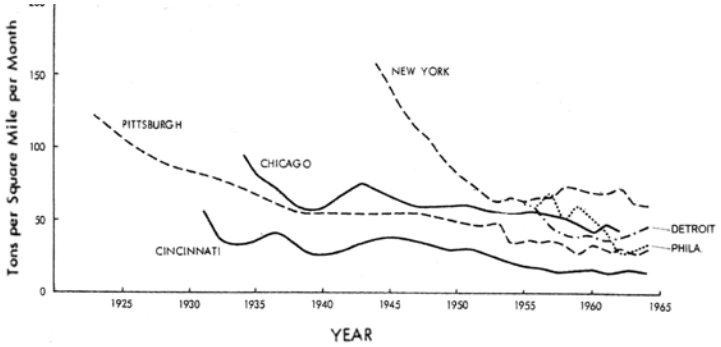

Figure 1. Long-term Trends in Particulate Matter Levels in Several U.S. Cities
Source: J. H. Ludwig, G. B. Morgan and T. B. McMullen, "Trends in Urban Air Quality," EOS 51 (1970): 468-75.

Tropospheric ozone (smog) was first recognized as a problem in Los Angeles in the late 1940s, spurred by rapid growth in population and driving during the preceding two decades. But ozone was already declining by the mid-1950s as a result of local efforts to reduce automobile and industrial pollution. Between 1956 and 1970, the number of days per year with ozone exceeding 0.15 ppm declined more than 25 percent.[iv]

These data refute the standard mythology that state and local governments, competing for economic development, engage in a "race to the bottom" of environmental quality in an effort to attract industry and jobs. In reality, the long-term history of air quality shows a "race to the top" of quality of life.[5] Market forces, common law trespass and nuisance lawsuits, and state and local regulation all contributed to large reductions in air pollution in the decades leading up to the 1970 adoption of the federal Clean Air Act.

Most of the U.S. Meets Federal Air Pollution Standards

Much more extensive monitoring over the last few decades shows that pollution of all kinds has continued to decline since the passage of the Clean Air Act. Virtually the entire nation now attains federal health standards for carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and lead, and levels of all four of these pollutants continue to decline.[6]

The nation is also near full compliance with the original federal health standards for ozone and airborne particulate matter (soot). While 60 percent of the nation's ozone monitors violated EPA's "one-hour" ozone standard in the late 1970s, fewer than 10 percent do so today. The average number of days per year exceeding the standard has dropped more than 95 percent! Among the few remaining areas that violate the standard, most average no more than two or three exceedance days per year.

Particulate Matter (PM) has also declined. EPA adopted standards for particulate matter under 10 microns in diameter (PM_{10}) in 1987.[7] Average PM_{10} levels declined more than 30 percent between the late 1980s and 2004. EPA adopted much tougher standards for ozone and PM in 1996 and, after a protracted legal battle, implemented both standards in 2004.[8] Although these standards are new, we can use past monitoring data to determine progress against these new metrics. About 80 percent of the nation's ozone monitors violated the new 8-hour ozone standard during the late 1970s, but only about 30 percent violated it as of the end of 2004. The average number of days per year exceeding the standard has dropped 75 percent during the last 30 years.

EPA's new PM standards are based on particulate matter under 2.5 microns in diameter, referred to as $PM_{2.5}$. Widespread monitoring of $PM_{2.5}$ began only in 1999. However, special-study data collected in about 90 metropolitan areas around the U.S. from 1979-1983 allows us to look at long-term $PM_{2.5}$ trends. About 90 percent of the nation's monitors would have violated the annual $PM_{2.5}$ standard 25 years ago, but only 14 percent violated the standard as of the end of 2004. Average $PM_{2.5}$ levels have dropped more than 40 percent since the early 1980s and 15 percent since 1999. EPA also created a daily $PM_{2.5}$ standard to guard against excessive daily peaks in $PM_{2.5}$ levels. Virtually all monitoring locations are already in compliance with the daily standard, and peak daily $PM_{2.5}$ levels continue to decline as well.[10] Peak daily $PM_{2.5}$ levels have declined nearly 50 percent since the early 1980s, and 16 percent since 1999.

Levels of other pollutants for which EPA has no specific health standards also continue to decline. For example, sulfate is a component of fine particulate matter formed from sulfur dioxide, which is emitted mainly by coal-fired power plants and industrial boilers. Sulfate makes up about 25 to 45 percent of annual-average $PM_{2.5}$ levels in the eastern half of the U.S., where coal is a major fuel for electricity. Average sulfate levels declined 33 percent between 1989 and 2003.[11]

California has since the early 1990s monitored a number air pollutants for which there are no federal health standards. These data also show substantial declines. For example, between 1994 and 2004, average ambient levels of benzene declined 79 percent, 1,3-butadiene fell by 63 percent, perchloroethylene was reduced 78 percent, hexavalent chromium declined 61 percent, and benzo(a)pyrene fell by 57 percent.[12] A few other states monitor some of these pollutants and have also registered substantial reductions.[13]

More Driving, More Energy Use, More Economic Activity…and Less Air Pollution

What makes these air quality improvements so extraordinary is that they occurred during a period of rapidly increasing motor vehicle use, energy production, and economic activity. Figure 2 compares trends in economic activity, energy, and transportation with measured air pollution levels over time. All variables are indexed to a common value of 1.0 in 1981 (the first year for which we have nationally representative $PM_{2.5}$ data), while later years show the percentage change over time. Values below 1.0, which is marked by the horizontal line, represent decreases over time, while values above 1.0 represent increases.

As the graph shows, all measures of economic activity increased, while all measures of pollution decreased. Compared with 1981, Americans now drive automobiles a total of 80 percent more miles each year and burn 40 percent more coal. Gross domestic product and total miles traveled by diesel trucks doubled. Nevertheless, air pollution of all kinds has sharply declined—by 40 percent to 95 percent, depending on the pollution standard. Pollution declined because motor vehicles, power plants, factories, and consumer products became cleaner much faster than driving, energy use, and economic activity increased.

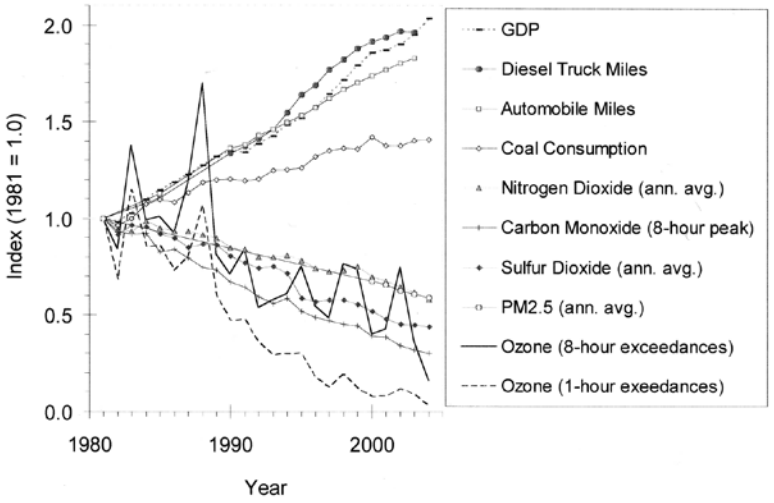

Figure 2. Trends in Transportation, Energy, and Economic Activity vs. Trends in Air Pollution Levels, 1981-2004

Notes: All quantities are indexed to a value of 1.0 in 1981, while later values show the percentage change over time. Pollution levels are averages of all monitoring sites operating in a given year. "Ann. avg." = annual average. The chart starts in 1981, because this is the earliest year for which nationally representative $PM_{2.5}$ *data are available.*

Sources: Bureau of Economic Analysis, National Economic Accounts, U. S. Department of Commerce, http://www.bea.doc.gov/bea/dn/nipaweb/SelectTable.asp; Bureau of Transportation Statistics, National Transportation Statistics 2004 (Washington, DC: U.S. Department of Transportation, January 2005), http://www.bts.gov/publications/national_transportation_statistics/2004/index.html; Energy Information Administration, Annual Energy Review 2004 (Washington, DC: August 2005), http://www.eia.doe.gov/emeu/aer/pdf/aer.pdf; Environmental Protection Agency, Air Quality System (AQS), http://www.epa.gov/ttn/airs/airsaqs/.

Air Pollution Will Continue to Decline

EPA tightened automobile emission standards in 1994, 2001, and 2004. Most of the benefits of these standards won't be fully realized until more than a decade from now as older cars are progressively retired from the on-road fleet.[14] The 2004 standards require at least a 90 percent reduction below the emissions of the current average automobile on the road today. The 2004 regulations also require SUVs and pickup trucks to have the same low emissions as cars.

Growth in driving will do little to offset these per-mile emissions improvements. For example, if total driving increases 3 percent per year over the next 20 years—a typical projection for a rapidly growing region—total miles driven would increase about 80 percent. But the net effect of an 80 percent increase in miles driven and a 90 percent decrease in per-mile emissions is an 82 percent reduction in total automobile emissions. Figure 3 illustrates the combined effects of cleaner cars and more driving on future emissions.

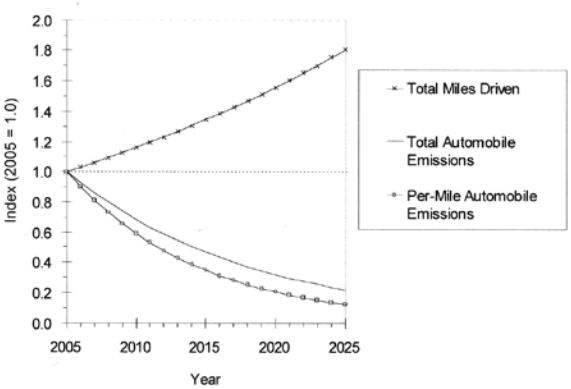

Figure 3. Effect of Growth in Driving on Future Automobile Emissions

Notes: The graph shows how much total automobile emissions will decline in an area assuming that the per-mile emissions of the average car decline 10 percent per year and total miles driven increases 3 percent per year.

Emissions from on- and off-road heavy-duty diesel vehicles will also sharply decline. EPA has tightened standards for new diesels several times during the last 20 years.[15] The benefits of these standards will continue to accrue as earlier models are progressively retired. Additional standards are coming down the pike.

Beginning in 2007, new diesel trucks will have to reduce NOx, soot, and other emissions 90 percent below previous new-vehicle requirements.[16] Similar requirements apply to new off-road diesel vehicles and equipment starting in 2010.[17]

Industrial emissions will also continue to decline. When compared with emissions during 2003, EPA's Clean Air Interstate Rule (CAIR) will reduce power-plant sulfur dioxide emissions by 53 percent in 2010 and 70 percent by 2020, with an ultimate cap 77 percent below 2003 levels.[18] In addition, rules to reduce hazardous emissions from more than a dozen industries come into effect over the next few years.[19]

When compared with past decades, we have already eliminated the vast majority of all air pollution. Already-adopted requirements will eliminate most of the rest during the next 20 years or so.

PUBLIC PERCEPTION OF AIR POLLUTION AND ITS CAUSES

Most Americans are unaware of the nation's success in reducing air pollution, or of the bright outlook for continued progress. When polled, most people say America has made no progress on air pollution or even that air quality has gotten worse. Why is public perception so different from reality?

Polls show that Americans consider environmental groups the most credible sources of information on the environment, and that they also trust information from regulatory agencies.[20] Yet, these trusted sources routinely misrepresent information about air pollution levels, trends, regulatory requirements, and health risks. The news media pass along these distortions with little or no critical review. As a result, most of what Americans "know" about air pollution is false.

In an August 2004 poll conducted by Wirthlin for the Foundation for Clean Air Progress, 38 percent of respondents said they thought air pollution had gotten worse during the last decade, while 31 percent thought it had stayed the same.[21] The good news is that the 2004 results were an improvement over 2002 when a similar poll reported that 66 percent of Americans believed air pollution had gotten worse during the previous 10 years,[22] up from 61 percent in 1999.[23]

A poll commissioned by Environmental Defense in 2000 reported that 57 percent of Americans believe environmental conditions have gotten worse during the last 30 years.[24] State-based surveys have found similar results. The Public Policy Institute of California (PPIC) reported in 2002 that 78 percent of Californians polled believed the state had made only "some" or "hardly any" progress in solving environmental problems.[25]

Americans also say they believe environmental quality will decline in the future. The 2000 Environmental Defense poll reported that 67 percent of Americans believe air pollution will continue to get worse. Likewise, a March 2001 Gallup Poll found that 57 percent of Americans believe environmental quality is deteriorating.[26] A 1999 *Washington Post* poll reported that 51 percent of Americans believe pollution will greatly increase, up from 44 percent in 1996.[27] The 2002 PPIC poll reported that 79 percent of Californians believe the state will make little or no progress on environmental problems in the future.

These surveys show that what Americans believe about air pollution is virtually the polar opposite of reality.

Distortions Behind the Perceptions

Environmental advocacy groups often promote undue fear and pessimism over air pollution by claiming air pollution levels exceed federal standards far more often than they actually do. Each May 1st the American Lung Association (ALA) publishes *State of the Air*—perhaps the nation's most influential annual report on air pollution. Dozens of newspapers cover its release and it is frequently cited in support of stronger air quality regulation.

But *State of the Air*'s portrayal of air pollution levels and trends is more fiction than fact. For example, in *State of the Air 2003* ALA claimed that from 1999 to 2001

Los Angeles County averaged 35 days per year with ozone in excess of EPA's 8-hour ozone standard. In reality, none of L.A. County's 14 ozone monitors registered anywhere near that many ozone exceedances. The worst location in the county averaged 18 exceedance days and the average location just 6 exceedance days per year—85 percent less than ALA claimed for the whole county. Sixty percent of the county's residents lived in areas that complied with both the federal 1-hour and 8-hour ozone standards.[28] Nevertheless, ALA gave the entire county a failing grade for ozone.

ALA derived its inflated value by assigning an ozone exceedance day to the entire county on any day in which at least one location in the county exceeded the 0.085 ppm 8-hour ozone standard. For example, if ozone was high one day in Glendora and the next day in Santa Clarita, 50 miles away, the report counted two exceedance days for all 9 million people in L.A. County. Of course most people in the county did not experience even one day above the standard. ALA similarly inflates pollution levels in dozens of counties around the United States.[29]

The 2004 edition of *State of the Air* included $PM_{2.5}$ data for the first time, and ALA's exaggerations are even more extreme for $PM_{2.5}$ than for ozone. EPA set its 24-hour ozone standard at 65 ug/m^3. However, ALA counts a $PM_{2.5}$ exceedance on any day in which $PM_{2.5}$ is greater than 40 ug/m^3, far lower than EPA's standard. As a result, even though only 10 U.S. counties had a monitoring location that violated EPA's 24-hour $PM_{2.5}$ standard as of 2002 (and only 4 counties as of 2003), ALA gave failing grades to 107 counties in *State of the Air 2004* (which is based on data through 2002).

For example, even though Cook County (Chicago), Illinois had zero days exceeding EPA's 24-hour $PM_{2.5}$ standard from 2000-2002, ALA claimed the county had unhealthy $PM_{2.5}$ levels on 43 days.[30] Hundreds more counties received grades of B, C, or D, even though they comply with the 24-hour $PM_{2.5}$ standard with plenty of room to spare.

ALA is not alone in its record of overstating pollution problems. Federal and state regulators use similar pollution counting methods with similarly inflated results. And some environmental groups go even further in their efforts to exaggerate pollution levels.

For example, in the 2002 installment of its annual *Danger in the Air* report, the Public Interest Research Group (PIRG) claimed that California exceeded the 8-hour ozone standard on 130 days in 2001.[31] Yet nearly half of the state's monitoring locations had no exceedance days at all, while the average location had seven. PIRG claimed fictionally large ozone problems for every other state as well.

Reporters also inflate air pollution levels, often by default. By reporting regulators' and activists' claims without critical review, journalists contribute to public misperception. For example, a recent New York Times feature story on air pollution in Los Angeles claimed the Los Angeles metropolitan area exceeded the 1-hour ozone standard on 68 days in 2003.[32] In fact, the worst site in the area had 39 exceedance days that year, and the average site had about 10.[33]

ALA also uses pollution rankings to create a false impression of high pollution in many areas of the country. Each year, ALA ranks the worst 25 metropolitan areas for ozone. For example, *State of the Air 2004* ranked Knoxville, Tennessee 9th in the nation. That sounds bad. But as shown in Figure 4 once you get past the worst few

areas in the country—all in the Los Angeles and San Joaquin Valley areas of California—ozone levels are much lower everywhere else. Figure 4 displays the actual number of 8-hour and 1-hour ozone exceedances per year at the worst location in each of ALA's 25 worst cities. ALA gave all of these areas, and many more, an F grade for air quality.

Note, for example, that even though ALA ranked Knoxville 9th worst in the country, it averaged close to zero 1-hour ozone exceedances and 21 8-hour exceedance days per year. And even those numbers represent only the worst of Knoxville's six monitoring locations.[34] The average and best Knoxville locations averaged, respectively, 12 and one 8-hour exceedance days per year during 2000-2002.

Outside of a few California metropolitan areas, the next worst areas in the country have relatively low ozone levels. But ALA's simplistic letter grades and rankings make Sheboygan sound as bad as San Bernardino, when it doesn't even come close. By ignoring context, ALA creates the appearance that air pollution is much worse than it actually is throughout the country.

ALA's rankings, which appear along the top of Figure 4, don't even reflect actual pollution levels. The ranking from worst to best in the chart is based on the actual number of 8-hour exceedances at the monitoring site with the worst 8-hour ozone in each metro area. But ALA's rankings are based on its artificially inflated ozone values. ALA's method inflates ozone values by different percentages in different areas, depending on how many ozone monitors a region has, and on how much ozone varies from place to place within a given region. Thus, ALA not only exaggerates air pollution levels, it also ends up with pollution rankings that have little relationship to actual relative pollution levels between cities.

Despite ALA's consistent record of misinformation, 90 percent of Americans trust ALA to provide accurate information on air pollution.[35]

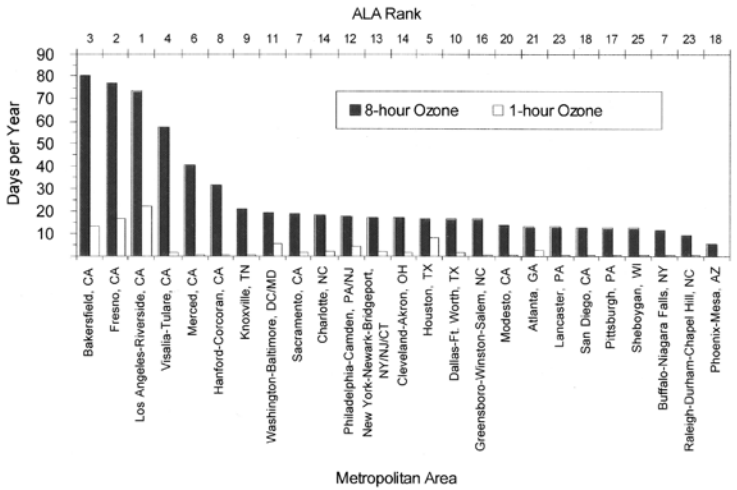

Figure 4. Average Ozone Exceedance Days per Year during 2000-02 at the Worst Monitoring Site in the 25 Metropolitan Areas Ranked Worst by ALA

Notes: Data are averages for 2000-2002, the same years used by ALA for State of the Air 2004.

Bad News Sells Newspapers

Another source of false impressions of pollution problems is media reports of "some of the worst air pollution in the nation." Figure 4 shows for ozone that no area outside California comes anywhere close to having "some of the worst air pollution in the nation." The same is true for $PM_{2.5}$, for which parts of the Riverside and Bakersfield areas of California have by far the highest $PM_{2.5}$ levels in the U.S. And yet a search through newspapers both large and small reveals that journalists have put more than half the country into this category.

A sampler: The *Chicago Sun-Times* reports that Chicago has "**some of the worst air pollution** in the nation."[36] The Dallas-Fort Worth area has "**some of the country's worst air**" claims the *Fort Worth Star-Telegram*. The *Baltimore Sun* says Baltimore has "**some of the worst air pollution** in the country" as well.[37] The New York metropolitan area has "**some of the country's dirtiest air**" according to the Westchester *Journal-News*.[38] *The Atlanta Journal and Constitution* claims Atlanta has "**some of the worst air pollution** in the country."[39] The *Washington Post* puts not only the Washington-Baltimore metropolitan area but also Phoenix in the "**some of the worst air pollution**" fraternity.[40]

Sometimes it is entire states that have "some of the worst air pollution." The *Bergen County Record* says New Jersey has "**some of the worst air pollution** in the country."[41] Just across the Hudson River, the *New York Times* claims it is the State of New York that "has **some of the nation's dirtiest air**," and that "the **smog in Connecticut is among the worst** in the nation."[42] Tennessee experiences "**some of the worst air pollution** in America," according to the *Chattanooga Times Free Press*.[43] Maryland is "faced with **some of the worst air pollution** in the country," according to the *Baltimore Sun*.[44] And so it goes.

This is just a small sample of the dozens of news stories in which journalists have claimed some area or other has some of the worst air pollution in the country.[45] Even without looking at any data, it's clear they can't all be right. And in fact all of them are wrong.

Often, reporters are only parroting the press releases of environmental advocacy groups. Other times journalists are more direct sources of public misperception of air pollution trends. For example, despite a nationwide 95 percent reduction in 1-hour ozone exceedance days over the last 30 years, and a 75 percent reduction in 8-hour exceedances, the *Washington Post* asserted "ozone pollution has declined *slightly* over the last 30 years" (emphasis added).[46] The *Post* story heralded the release of the 2004 edition of ALA's *State of the Air*.

A recent USA Today headline reads "SMOGGY SKIES PERSIST DESPITE DECADE OF WORK."[47] Incredibly, this same story claimed smog is increasing because "Americans are driving more miles than they did in the 1980s. *And they're driving vehicles that give off more pollution than the cars they drove in the '80s"* (emphasis added).

Instead of providing the public with a realistic assessment of air quality, too often environmentalists and journalists encourage their readers to draw conclusions about air pollution that are grossly at odds with reality.

Americans believe current air pollution levels are a serious threat to their health. In a recent nationwide survey, 85 percent of Americans rated air pollution as a "very serious" or "somewhat serious" problem.[48] Some 80 percent of New Yorkers rate air pollution as a "very serious" or "somewhat serious" problem, as do 77 percent of Texans, and 86 percent of New Jersey residents.[49]

When asked about the most serious environmental issue facing California, a 34 percent plurality chose air pollution, with "growth" coming in a distant second at 13 percent.[50] Roughly a third of Californians put air pollution first in San Diego and the San Francisco Bay Area, even though almost everyone in these regions lives in areas that meet all federal air pollution standards.

Americans are alarmed about air pollution because most of the information they receive about air pollution is alarming. Activist reports often come with scary titles such as *Danger in the Air; Death, Disease and Dirty Power; Highway Health Hazards*; or *Children at Risk*.[51] State and local air pollution regulatory agencies issue "code orange" and "code red" alerts on days when air pollution is predicted to exceed one or more federal health standards. For $PM_{2.5}$, regulators issue air pollution alerts even on days when $PM_{2.5}$ is well below the federal standard.[52]

News stories on air pollution regularly feature scary headlines such as "Traffic is Choking Charlotte's air," "Air pollution's threat proving worse than believed," "Don't breathe deeply today," "Study finds smog raises death rate," and "Asthma risk for children soars with high ozone levels."[53] Health researchers often issue alarming summaries of their research as well. Recent press-release headlines from health research institutes include: "Smog May Cause Lifelong Lung Deficits," "Link Strengthened between Lung Cancer, Heart Deaths and Tiny Particles of Soot," "USC study shows air pollution may trigger asthma in young athletes," and "Traffic exhaust poisons home air."[54]

These claims, and the fear they instill, might be warranted if popular accounts of air pollution health risks accurately reflected the weight of the evidence from the research literature; but they do not. Environmentalists, regulators, journalists, and even some health scientists have created public fear of air pollution out of all proportion to the actual risks suggested by the underlying health studies. As shown below, air pollution affects far fewer people, far less often, and with far less severity than people have been led to believe.

Asthma and Air Pollution

Asthma provides a signal example of how conventional wisdom on air pollution and health can be the opposite of reality. According to the Centers for Disease Control, the prevalence of asthma in the U.S. rose 75 percent from 1980 to 1996, and nearly doubled for children. Prevalence may have leveled off since then.[55] Could air pollution be the cause?

Asthma prevalence rose at the same time that air pollution of all kinds declined! Figure 5 displays trends in asthma and various air pollutants for California. The graph displays data for ozone, carbon monoxide, nitrogen dioxide, and PM_{10}.

The trends are similar for all other pollutants measured by California regulators, including $PM_{2.5}$, benzene, 1-3-butadiene, benzo(a)pyrene, perchloroethylene, xylene, lead, and many more.[56] In all cases, air pollution has been declining while asthma has been rising. Data from other states tell the same story—declining air pollution, rising asthma.

Air pollution—at least the wide range of air pollutants that regulators measure and control—is not a plausible cause of rising asthma. These facts have not prevented media and activist reports from implying or claiming outright that air pollution is a key cause of rising asthma.[57]

Regulators and health experts have even turned a study that found air pollution to be associated with a lower overall risk of developing asthma into a key piece of evidence in support of an air pollution-asthma link. Beginning in 1993, the California Air Resources Board (CARB) funded the Children's Health Study (CHS), in which researchers from the University of Southern California (USC) tracked several thousand California children living in 12 communities with widely varying air pollution levels, including areas of southern California with the highest air pollution levels in the country. At a joint press conference in 2002, the USC researchers and CARB managers reported that children who played three or more team sports were more than three times as likely to develop asthma if they lived in one of the six highest-ozone communities in the study, when compared with the six low-ozone communities.[58] They also claimed the study's results apply to cities all around the United States.

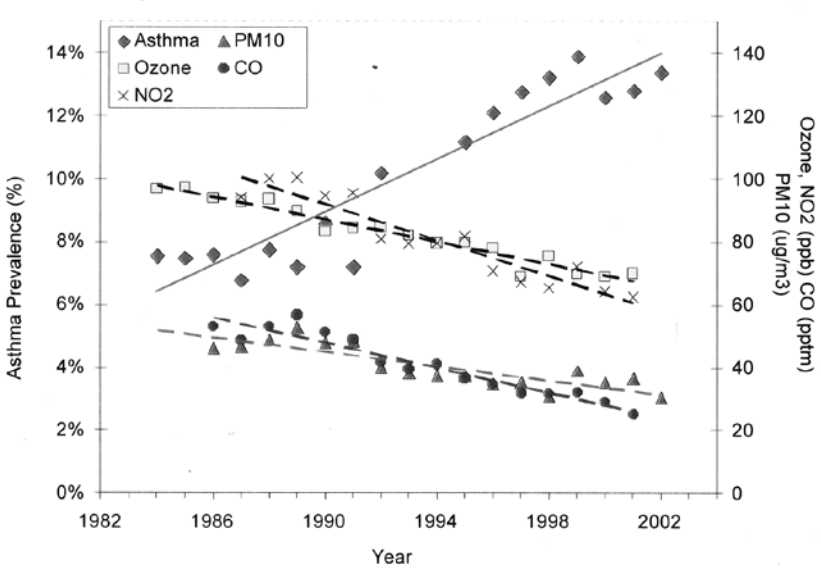

Figure 5. Trend in Asthma Prevalence vs. Trends in Air Pollution in California

Sources: Asthma prevalence: California Department of Health Services (2003) Air pollution: California Air Resources Board, 2003 Air Pollution Data CD, http://www.arb.ca.gov/aqd/aqdcd/aqdcd.htm.

Ironically, the CHS asthma study actually showed just the opposite! Unmentioned at the press conference was that, while higher ozone was associated with a greater risk of developing asthma for children who played three or more team sports (8 percent of children in the study), higher ozone was associated with a 30 percent *lower* risk of asthma in the full sample of children in the study.[59] Furthermore, higher levels of other pollutants, including nitrogen dioxide and particulate matter, were also associated with a lower asthma risk.[60] The results of the Children's Health Study were just the opposite of what the CARB press release reported. Unfortunately, the many journalists who covered the study reported only what the researchers told them, rather than what the study actually found.[61]

Furthermore, the assertion that the study is relevant in other parts of the country was also false. The six high-ozone areas in the study averaged nearly 80 days per year exceeding the federal 8-hour ozone standard during 1994-97, the years used to assess pollution exposure. No area of the U.S. outside of a few parts of California has ever had ozone levels anywhere near this high. In fact, by the time the study was released in February 2002 it no longer applied even in the southern California areas where it was performed, because ozone levels there had declined in the interim.

In a recent commentary on air pollution and asthma in the *Journal of the American Medical Association*, two prominent air pollution health researchers stated, "Evidence exists that air pollution may have contributed to the increasing prevalence of asthma."[62] The evidence they cite is the CHS asthma study—the one that found that higher air pollution levels were associated with a *lower* risk of developing asthma!

And they aren't the only health professionals to misinterpret the results of the CHS asthma study. For example, on the day the study was released, a professor at the State University of New York at Stony Brook—who is now the American Lung Association's medical director—claimed: "This is not just a Southern California problem. There are communities across the nation that have high ozone."[63] The director of the pediatric asthma program at the University of California at Davis claimed "Sacramento is a very high ozone area, so this [the CHS asthma study] is going to be very relevant to us."[64] According to the Houston Chronicle, Houston asthma specialists said the study showed that "Houston [should] step up its efforts to implement a state plan to reduce ozone."[65]

None of the health professionals cited above appear to be familiar with the actual results of the CHS asthma study. Nor do they know the ozone levels in their areas relative to the much higher ozone levels in the high-ozone CHS communities, or the implausibility of air pollution as a significant cause of asthma.

Unfortunately, the case of the Children's Health Study is not an isolated incident. Medical experts often dispense erroneous information on air pollution and health. For example, a researcher from the Bloomberg School of Public Health at Johns Hopkins University asserted in a recent Sierra Club report that "traffic presents a unique public health threat" including "children's asthma rates occurring at epidemic proportions."[66] After the American Lung Association gave Tarrant County (Fort Worth), Texas a failing grade for air quality in 2003, the president of a local branch of the Tarrant County Medical Society asserted, "It means we can anticipate a worsening of an already epidemic asthma problem…"[67]

Ozone's Minor Health Effects

In a recent study published in the journal *Environmental Health Perspectives*, EPA scientists estimated that reducing nationwide ozone from 2002 levels, by far the highest ozone levels in the last six years, down to the federal 8-hour standard would decrease asthma emergency room visits by 0.04 percent, respiratory hospital admissions by 0.07 percent, and premature mortality by 0.03 percent.[68]

The California Air Resources Board recently adopted an ozone standard for California that is much tougher than the federal standard, requiring ozone to be reduced to near, or even below background levels throughout the state.[69] Despite the fact that parts of California have much higher ozone levels than the rest of the country, CARB predicts that reducing ozone will result in little health improvement. For example, based on CARB's estimates, going from peak ozone levels during 2001-2003 down to attainment of CARB's standard—in effect an elimination of all human-caused ozone in the state—would reduce emergency room visits for asthma by 0.35 percent, respiratory-related hospital admissions by 0.23 percent, and premature mortality by 0.05 percent.[70]

The pattern of hospital visits for asthma also suggests ozone can't be a significant factor. Emergency room visits and hospitalizations for asthma are lowest during July and August, when ozone levels are at their highest.[71]

The estimates above address only short-term effects of ozone. But the Children's Health Study suggests that ozone is having little effect on long-term health as well. In addition to asthma, the CHS assessed the relationship between air pollution and growth in children's lung function.[72] After following more than 1,700 children from age 10 to 18, the study reported that there was no association between ozone and children's lung-function growth. Yet the 12 communities in the study ranged from among the lowest to the very highest ozone levels in the United States.

Thus, even regulators themselves have concluded that ozone is having a tiny effect on people's health. But these quantitative estimates appear only in technical reports. Popular literature from regulatory agencies suggests ozone is causing grave damage to many Americans. For example, a recent EPA fact sheet claims: "Ozone can inflame and damage the lining of the lungs, which may lead to permanent changes in lung tissue, irreversible reductions in lung function if the inflammation occurs repeatedly over a long time period and a lower quality of life. People who are particularly susceptible to the effects of ozone include healthy children and adults who are active outdoors, people with respiratory disease, such as asthma, and people with unusual sensitivity to ozone."[73]

Some of EPA's claim is true, strictly speaking. At high enough levels, ozone can cause permanent lung damage. What EPA left out is that such harm occurs only at ozone levels higher than ever actually occur in the United States. And the implication that all healthy children and adults who spend time outdoors are "particularly susceptible to ozone" is simply false. By leaving out important context and speaking in misleading generalizations, EPA creates the false impression that current ozone levels are causing serious and permanent harm to most Americans.

Activists likewise create a misleading impression of widespread, serious harm. For example, in a recent edition of its annual *State of the Air Report*, the American Lung

Association says: "Ozone is an intensely irritating gas. At levels routinely found in the air in many American cities during summer months, ozone can damage the lungs and airways, causing them to become inflamed, reddened and swollen" and "children are especially vulnerable to the harmful effects of ozone."

Reducing ozone is expensive, because large reductions in nitrogen oxides and volatile organic compounds—the two groups of chemicals that help form ozone—are necessary to achieve small decreases in ozone.[74] Nationwide attainment of EPA's 8-hour ozone standard will cost from tens of billions of dollars per year to perhaps more than a $100 billion per year—or hundreds to more than a thousand dollars per year for each American household.[75] And yet even by EPA's own estimates, for these huge expenditures we would eliminate only a fraction of a percent of all respiratory distress and disease.

Exaggerated Health Risks from Fine Particles

The Children's Health Study (CHS) also suggests that $PM_{2.5}$ is causing little long-term harm. Unlike ozone, $PM_{2.5}$ actually had a small association with children's lung development. Annual-average $PM_{2.5}$ levels ranged from about 6 to 32 ug/m^3 in the 12 communities in the study.[76] Comparing the lowest- and highest-pollution communities, $PM_{2.5}$ was associated with about a 3 to 4 percent decrease in lung capacity.[77] But this drastically inflates the apparent importance of the results because no location outside of the CHS communities has $PM_{2.5}$ levels anywhere near 32 ug/m^3. In fact, even the worst area in the U.S. averaged 25 ug/m^3 for 2002-2004. There also didn't appear to be any association with decreased lung capacity until average $PM_{2.5}$ levels exceeded about 16 ug/m^3. [78] But 94 percent of the nation's monitoring locations already averaged less than 16 ug/m^3 for 2002-2004, and $PM_{2.5}$ levels have been steadily declining.

It is also worth noting that the children in the CHS were already 10 years old when they entered the study, and had therefore been breathing the much higher air pollutant levels extant during the 1980s in southern California. If it was these greater 1980s pollution levels that caused the lung-function declines, then the harm from current air pollution levels is even smaller than the already small effect reported in the study. Thus, taking the CHS results at face value, ozone is having no effect on children's lung growth anywhere in the U.S. $PM_{2.5}$ is having no effect in the vast majority of the U.S. Even in areas that have the highest $PM_{2.5}$ levels in the country, the effect on lung function is at worst a decline of one or two percent.

Despite finding little effect of air pollution on children's lung growth, USC's press release on the study created the appearance of serious harm. Titled, "Smog May Cause Lifelong Lung Deficits," the press release asserted, "By age 18, the lungs of many children who grow up in smoggy areas are underdeveloped and will likely never recover."[79] The press release didn't mention that even the highest $PM_{2.5}$ levels were associated with only a small percentage decrease in lung growth. And by referring vaguely to "smoggy areas" the press release created the false impression that the study is relevant for many areas of the United States, when in fact even the small reductions in lung function applied only to a few areas in California with uniquely high air pollution levels—areas that now have much lower pollution levels than when the study was performed.

Just as for ozone, reducing $PM_{2.5}$ would at best result in small reductions in short-term

health effects. For example, a technical report sponsored by the Clean Air Task Force (CATF), an environmental group, recently concluded that completely eliminating all $PM_{2.5}$. pollution from U.S. power plants would reduce respiratory and cardiovascular hospital admissions and emergency room visits by 0.4 to 1.6 percent, depending on the condition.[80] The technical report buried this information in a table in the middle of the report and did not highlight it elsewhere in the study. In addition, based on the technical study, CATF published a more sensational report for public consumption titled, *Death, Disease, and Dirty Power*, which created the impression that power plants are causing a large fraction of all respiratory and cardiovascular distress and disease—just the opposite of what the report's underlying research actually concluded.[81]

Thus, even by regulators' and environmentalists' own estimates, air pollution accounts for a small fraction of the total burden of respiratory and cardiovascular disease experienced by Americans. But even these estimates are likely to be inflated, because they rely on a reading of the research literature that gives greater weight to epidemiological studies reporting larger air pollution health effects. A more inclusive reading of the research literature would suggest even smaller air pollution effects than assumed by regulators and environmentalists.[82]

Does Air Pollution Kill?

There is no question that high levels of air pollution can kill. About 4,000 Londoners died during the infamous five-day "London Fog" episode of December 1952, when soot and sulfur dioxide soared to levels tens of times greater than the highest levels experienced in developed countries today.[83] The question is whether current, far lower levels of air pollution can also be deadly.

EPA's $PM_{2.5}$ standards are based on the assumption that $PM_{2.5}$ at current levels is killing tens of thousands of Americans each year, due to both long-term exposures and the acute effects of daily PM fluctuations.[84] EPA based its annual $PM_{2.5}$ standard mainly on the American Cancer Society (ACS) cohort study. The ACS study followed more than 500,000 Americans in 50 cities from 1982 to 1998.[85] In their most recent report, the ACS researchers concluded that each 10 ug/m^3 increase in long-term $PM_{2.5}$ levels is associated with a 4 percent increase in risk of death.[86]

However, inspection of the detailed results of the ACS study raises questions about PM's role in increasing people's risk of premature death. For example, the ACS study reported that $PM_{2.5}$. apparently kills men, but not women; those with no more than a high school degree, but not those with at least some college; current- or never-smokers but not former smokers; and those who said they were moderately active, but not the very active or the sedentary. These results are biologically implausible. They suggest that the correlation between $PM_{2.5}$ and mortality is a spurious artifact of the statistical model the researchers used, and does not represent a genuine causal relationship.

Reanalysis of the ACS data has also shown that considering additional factors in the statistical analysis of the data can make the apparent $PM_{2.5}$ effect disappear. For example, when migration rates into and out of cities was added to the statistical model relating $PM_{2.5}$ and premature death, the apparent effect of $PM_{2.5}$ declined by two-thirds and became statistically insignificant.[87]

Cities that lost population during the 1980s—Midwest "rust belt" cities that were in

economic decline—also had higher average $PM_{2.5}$ levels. The hypothesis is that people who work and have the wherewithal to migrate are more likely to be healthier than the average person. Thus, the apparent effect of $PM_{2.5}$ could actually have resulted from healthier people moving away from areas of the country that were in economic decline, rather than from a change in any individuals' health status due to PM exposure. The Harvard Six Cities study, another cohort study cited in support of PM-mortality claims, suffers from similar anomalies.[88]

Regulators and environmentalists have also ignored another major study that reported no association between long-term $PM_{2.5}$ levels and mortality in a cohort of 50,000 male veterans with high blood pressure—a group that should have been *more* susceptible than the average person to any pollution-related health effects.[89]

Studies of the short-term health effects of daily fluctuations in air pollution levels likewise suffer from a number of difficulties that create the appearance of an association between low-level air pollution and mortality where none may in fact exist. One key problem is publication bias—the tendency for researchers and journal editors to selectively publish studies that find an air pollution-health association rather than studies that fail to find such an association. Furthermore, in published studies there is a tendency to screen several ways of analyzing the data, but then report the analyses that result in the largest and most statistically significant associations between air pollution and health—an effect known as model-selection bias.[90] As a recent review of air pollution epidemiology studies concluded:

Estimation of very weak associations in the presence of measurement error and strong confounding is inherently challenging. In this situation, prudent epidemiologists should recognize that residual bias can dominate their results. Because the possible mechanisms of action and their latencies are uncertain, the biologically correct models are unknown. This model selection problem is exacerbated by the common practice of screening multiple analyses and then selectively reporting only a few important results.[91]

Studies of the effect of publication bias have shown that it can reduce the apparent association between daily air pollution levels and mortality by as much as 70 percent.[92] After accounting for model-selection bias, a recent study concluded that the air pollution-mortality association drops to zero.[93]

Given the unreliability of epidemiological studies in cases where the magnitude of the potential risk is small, it is also important to note that controlled toxicological studies with animals and human volunteers do not find evidence that PM can cause disease or death at concentrations anywhere near as low as the levels found in ambient air in the United States.[94] A recent review concluded,

It remains the case that no form of ambient PM—other than viruses, bacteria, and biochemical antigens—has been shown, experimentally or clinically, to cause disease or death at concentrations remotely close to U.S. ambient levels. This lack of demonstration is not for lack of trying: hundreds of researchers, in the U.S. and elsewhere, have for years been experimenting with various forms of pollution-derived PM, and none has found clear evidence of significant disease or death at relevant airborne concentrations.[95]

Despite the conclusion above, in December 2005 the *Journal of the American Medi-*

cal Association published the results of a study that suggested even relatively low current levels of $PM_{2.5}$ might be increasing Americans' risk of heart disease. The study exposed mice to 85 ug/m³ of $PM_{2.5}$ drawn from ambient air for 6 hours per day for 6 months, or about one-fourth of a typical mouse life-span.[96] The exposed mice had higher rates of atherosclerosis and other signs of heart disease, when compared with an unexposed control group. The $PM_{2.5}$ effect was more pronounced in mice fed a high-fat diet.

The study caused a minor media sensation, with both journalists and health experts claiming the study provides strong evidence that particulate pollution is a significant risk factor in human heart disease.[97] But what none of the reporters or health experts mentioned is that the mice in the study had been genetically engineered to have blood cholesterol levels five times greater than normal mice, and eight times normal when fed a high-fat diet.[98] These are stupendous cholesterol levels. For comparison, only about one in 50 American men has a cholesterol level more than 50 percent above the U.S. average.[99] And only about one in 500 has cholesterol greater than twice the U.S. average. While this study is likely not relevant for humans, it seems certain to enter the canon of studies that "prove" the need for more stringent air pollution regulations.

EPA estimates that reducing particulate matter accounts for about 90 percent of the total benefits of the Clean Air Act since it was implemented in 1970.[100] But if PM is not killing people, then the vast majority of these purported benefits have never actually been realized.

Despite the problems and limitations of the epidemiologic studies, and the lack of toxicological support for low-level particulate matter exposure as a cause of death or disease, popular accounts of the effects of air pollution take the claims of tens of thousands of deaths per year as a given.

It is no wonder that most Americans think air pollution is a major cause of death and disease. The information they receive from journalists, regulators, environmentalists, and even doctors and scientists, greatly exaggerates the harm from current air pollution levels.

CONCLUSION

Current air pollution is only a fraction of former levels and the vast majority of potential health gains from air quality improvement have already been achieved. Already-adopted measures will progressively eliminate most remaining air pollution emissions during the next two decades, even in the face of increasing fossil-fuel use.

Nevertheless, most Americans aren't aware that air quality has improved and mistakenly believe air quality will worsen in the future. Most Americans also believe that air pollution, even at current historically low levels, is still a serious threat to their health. The public's mistaken views are due largely to two factors. First, the presumptive proponents of the public good—environmentalists, regulators, and health experts—paint a misleadingly pessimistic and alarmist picture. Second, journalists generally report this misleading information with little or no critical review.

If journalists continue to be unable or unwilling to improve environmental reporting, Americans are likely to remain misinformed and unnecessarily afraid. At the very least, reporters and editors must begin to treat claims by environmentalists, regulators,

and even scientists with the same skepticism appropriate for other interested parties in regulatory debates. So long as media and public perception of air pollution remains at odds with reality, we will continue to invest too many scarce resources into cleaning up air that is already safe to breathe, giving short shrift to other public and private priorities that would genuinely improve Americans' health, safety, and quality of life.

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[57]See, for example, Fresno Bee, "Asthma in the Valley; More Research Is Needed into a Disease That Runs Rampant Here," Fresno Bee, October 4, 2004; NRDC, "EPA Set to Launch New Study on Causes of Asthma," last updated October 31, 2002, www.nrdc.org/bushrecord/health_air.asp#1157; Sacramento Bee, "Smog and Asthma: The Link - and Threat - Are Real," Sacramento Bee, May 6, 2003, p. B6; R. Sanchez, "In Calif., a Crackling Controversy over Smog; Illnesses Drive Push to Ban Fireplaces," Washington Post, February 16, 2003, p. A1; D. S. Stanley, "Stop the Spread of Asthma by Cleaning up Our Air," Fresno Bee, August 7, 2004, p. B9; Surface Transportation Policy Project, Clearing the Air (Washington, DC: August 2003).

[58]For CARB's press release, see California Air Resources Board, "Study Links Air Pollution and Asthma," January 31, 2002, http://www.arb.ca.gov/newsrel/nr013102.htm.

[59]This result is discussed in the peer-reviewed journal article the researchers published on the study. Asthma risk was 30 percent lower based on 1-hour ozone levels, and 20 percent lower based on 8-hour ozone levels. The 1-hour effect was statistically significant, while the 8-hour effect was on the verge of statistical significance (the top of the 95 percent confidence interval was a relative risk of 1.0). R. McConnell, K. T. Berhane, F. Gilliland et al., "Asthma in Exercising Children Exposed to Ozone: A Cohort Study," Lancet 359 (2002): 386-91.

[60]Asthma risk was 20 percent lower in communities with the highest PM10 and NO_2 levels. This "protective" effect of air pollution was nearly statistically significant. The top of the 95 percent confidence interval was a relative risk of 1.0. Any value less than 1.0 would be classified as statistically significant.

[61]See, for example, W. Booth, "Study: Pollution May Cause Asthma; Illness Affects 9 Million U.S. Children," Washington Post, 2002, p. A1; C. Bowman, "Asthma's Toll a New Study Links Children's Sports Activities in Smoggy Areas to the Illness.," Sacramento Bee, February 1, 2002, p. A1; Enge, "Study Links Pollution to Asthma in Children; Active Kids in Smoggy Areas at More Risk, Researchers Say."; Freemantle, "Asthma Risk for Children Soars with High Ozone Levels - Study." A Nexis search of major papers and wire services found 21 stories on the study, including stories in major papers such as the Los Angeles Times, the Washington Post, and USA Today.

[62]G. D. Thurston and D. V. Bates, "Air Pollution as an Underappreciated Cause of Asthma Symptoms," Journal of the American Medical Association 290 (2003): 1915-7.

[63]Dr. Norman Edelman, quoted S. Borenstein, "Air Pollution Is a Cause of Asthma, Study Contends," Philadelphia Inquirer, February 1, 2002, p. A04.

[64]Dr. Jesse Joad, quoted in Bowman, "Asthma's Toll a New Study Links Children's Sports Activities in Smoggy Areas to the Illness.."

[65]T. Freemantle, "Asthma Risk for Children Soars with High Ozone Levels - Study," Houston Chronicle, 2002, p. A1.

[66]Sierra Club, Highway Health Hazards.

[67]Dr. Mark Brown, quoted in N. Strassman, "Tarrant 19th on List of Poor Air Quality," Fort Worth Star-Telegram, May 1, 2003.

[68]This analysis assumes that there are no health benefits from further reductions of ozone once the standard is achieved. However, attaining the ozone standard requires reducing ozone below the standard on the worst day at the worst location in a given region. Within any given region, ozone does not exceed the standard on most days in most locations. Nevertheless, the measures necessary to attain the standard on the worst day at the worst location would also reduce ozone on other days and other locations. As a result, most of the reduction in ozone exposure occurs on days and locations in which ozone already complies with the standard. If benefits continue to accrue when ozone is reduced below the federal 8-hour standard, then the benefits of attaining the federal 8-hour standard would be several times greater—about an 0.2 percent reduction in asthma ER visits, an 0.35 percent reduction in respiratory hospital admissions, and an 0.15 percent reduction in premature deaths. B. J. Hubbell, A. Hallberg, D. R. McCubbin et al., "Health-Related Benefits of Attaining the 8-Hr Ozone Standard," Environmental Health Perspectives 113 (2005): 73-82.

[69]J. Schwartz, Rethinking the California Air Resources Board's Ozone Standards (Washington, DC: American Enterprise Institute, September 2005), http://www.aei.org/doclib/20050912_Schwartzwhitepaper.pdf.

[70]Just as in the case of EPA's benefit estimates, this assumes that benefits continue to accrue only until ozone levels are reduced down to the 0.070 ppm standard. If benefits continue to accrue for ozone levels below the standard, then the percentage reduction in total health effects would be about 1.8 percent for asthma ER visits, 1.2 percent for respiratory hospital admissions, and 0.3 percent for premature deaths.

[71]For data on asthma symptoms by month, see, for example, J. F. Gent, E. W. Triche, T. R. Holford et al., "Association of Low-Level Ozone and Fine Particles with Respiratory Symptoms in Children with Asthma," Journal of the American Medical Association 290 (2003): 1859-67; Spokane Regional Health District, Asthma in Spokane County (Spokane, Washington: April 2002), http://www.srhd.org/information/pubs/pdf/factsheets/AsthmaInSpokaneCounty.pdf; J. Stockman, N. Shaikh, J. Von Behren et al., California County Asthma Hospitalization Chart Book, Data from 1998-2000 (California Department of Health Services, September 2003), http://www.ehib.org/cma/papers/Hosp_Cht_Book_2003.pdf ; Texas Department of Health, Asthma Prevalence, Hospitalizations and Mortality – Texas, 1999-2001 (November 21, 2003), http://www.tdh.state.tx.us/cphpr/asthma/asthma.pdf ; K. Tippy and N. Sonnenfeld, Asthma Status Report, Maine 2002 (Augusta, Maine: Maine Bureau of Health, November 25, 2002); K. R. Wilcox and J. Hogan, An Analysis of Childhood Asthma Hospitalizations and Deaths in Michigan, 1989-1993 (Michigan Department of Community Health, undated), http://www.michigan.gov/documents/Childhood_Asthma_6549_7.pdf

[72]W. J. Gauderman, E. Avol, F. Gilliland et al., "The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age," New England Journal of Medicine 351 (2004): 1057-67.

[73]Environmental Protection Agency, Public Health and Environmental Benefits of EPA's Proposed Program for Low-Emission Nonroad Diesel Engines and Fuel (Washington, DC: April 2003), http://www.epa.gov/nonroad/f03010.pdf.

[74]S. Reynolds, C. L. Blanchard and S. D. Ziman, "Understanding the Effectiveness of Precursor Reductions in Lowering 8-Hr Ozone Concentrations," Journal of the Air & Waste Management Association 53 (2003): 195-205; S. Reynolds, C. L. Blanchard and S. D. Ziman, "Understanding the Effectiveness of Precursor Reductions in Lowering 8-Hour Ozone Concentrations--Part II. The Eastern United States," Journal of the Air & Waste Management Association 54 (2004): 1452-70.

[75]S. E. Dudley, National Ambient Air Quality Standard for Ozone (Arlington, VA: Mercatus Center, George Mason University, March 12 1997), http://www.mercatus.org/pdf/materials/125.pdf; R. Lutter, Is EPA's Ozone Standard Feasible? (Washington, DC: AEI-Brookings Joint Center for Regulatory Studies, December 1999), www.aei.brookings.org/publications/reganalyses/reg_analysis_99_06.pdf.

[76]The actual range in the study was 5 to 28 ug/m^3. However, $PM_{2.5}$ was measured using a different method from the one EPA began requiring in 1999 to determine compliance with the federal $PM_{2.5}$ standard. The CHS measured two-week-average $PM_{2.5}$ levels. This understates actual $PM_{2.5}$ levels, because it allows some "semi-volatile" species to evaporate, both because of the long collection time and because the filters are at ambient temperature. The new federal method measures daily-average $PM_{2.5}$ and keeps the filters cooled to prevent evaporation. Because I compare the CHS $PM_{2.5}$ levels with $PM_{2.5}$ levels measured around the country using the new EPA method, I've corrected the CHS $PM_{2.5}$ measurements to make them equivalent to the EPA method. For details on the correction, see N. Motallebi, J. Taylor, Clinton A., B. E. Croes et al., "Particulate Matter in California: Part 1--Intercomparison of Several $PM_{2.5}$, $PM_{10\text{-}2.5}$, and PM_{10} Monitoring Networks," Journal of the Air & Waste Management Association 53 (2003): 1509-16.

[77]As measured by forced vital capacity (FVC) and forced expiratory volume in one second (FEV1).

[78]See Figure 3 in Gauderman, Avol, Gilliland et al., "The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age.".

[79]A. D. Rado, Smog May Cause Lifelong Lung Deficits (Los Angeles: University of Southern California, September 8, 2004), http://www.usc.edu/uscnews/stories/10495.html.

[80]For example, the report estimated that asthma ER visits would be reduced by 1.6 percent and cardiovascular hospital admissions would be reduced by 0.4 percent. ABT Associates, The Particulate-Related Health Benefits of Reducing Power Plant Emissions, Prepared for the Clean Air Task Force (Bethesda, Maryland: October 2000), http://cta.policy.net/fact/mortality/mortalityabt.pdf.

[81]Clean Air Task Force, Death, Disease and Dirty Power.

[82]For examples, see L. Green, E. Crouch, M. Ames et al., "What's Wrong with the National Ambient Air Quality Standard (NAAQS) for Fine Particulate Matter ($PM_{2.5}$)?" Regulatory Toxicology and Pharmacology 35 (2002): 327; L. C. Green and S. R. Armstrong, "Particulate Matter in Ambient Air and Mortality: Toxicologic Perspectives," Regulatory Toxicology and Pharmacology 38 (2003): 326-35; S. H. Moolgavkar, "A Review and Critique of the EPA's Rationale for a Fine Particle Standard," Regulatory Toxicology and Pharmacology 42 (2005): 123-44; Schwartz, Rethinking the California Air Resources Board's Ozone Standards.

[83]Goklany, Clearing the Air.

[84]Natural Resources Defense Council, Breath-Taking: Premature Mortality Due to Particulate Air Pollution in 239 American Cities (Washington, DC: May 1996), http://www.nrdc.org/air/pollution/bt/btinx.asp; R. Wilson and J. Spengler, Particles in Our Air: Concentrations and Health Effects (Cambridge, Massachusetts: Harvard University Press, 1996).

[85]C. A. Pope, 3rd, M. J. Thun, M. M. Namboodiri et al., "Particulate Air Pollution as a Predictor of Mortality in a Prospective Study of U.S. Adults," American Journal of Respiratory and Critical Care Medicine 151 (1995): 669-74.

[86]C. A. Pope, 3rd, R. T. Burnett, M. J. Thun et al., "Lung Cancer, Cardiopulmonary Mortality, and Long-Term Exposure to Fine Particulate Air Pollution," Journal of the American Medical Association 287 (2002): 1132-41.

[87]D. Krewski, R. T. Burnett, M. S. Goldberg et al., Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality (Cambridge, MA: Health Effects Institute, July 2000).

[88]F. W. Lipfert, "Estimating Air Pollution-Mortality Risks from Cross-Sectional Studies: Prospective vs. Ecologic Study Designs," Health and Regulatory Issues, Proceedings of the International Specialty Conference, Air and Waste Management Association, 1995; F. W. Lipfert, "Commentary on the HEI Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality," Journal of Toxicology and Environmental Health, Part A 66 (2003): 1705-14; J. Schwartz, Particulate Air Pollution: Weighing the Risks (Washington, DC: Competitive Enterprise Institute, April 2003), http://www.cei.org/pdf/3452.pdf.

[89]F. W. Lipfert, H. M. Perry, J. P. Miller et al., "The Washington University-EPRI Veterans' Cohort Mortality Study," Inhalation Toxicology 12 (suppl. 4) (2000): 41-73.

[90]Publication bias is a well-documented problem in a range of disciplines. See, for example, V. M. Montori, M. Smieja and G. H. Guyatt, "Publication Bias: A Brief Review for Clinicians," Mayo Clinic Proceedings 75 (2000): 1284-8; A. Thornton and P. Lee, "Publication Bias in Meta-Analysis: Its Causes and Consequences," Journal of Clinical Epidemiology 53 (2000): 207-16. For more on publication bias in air pollution epidemiology studies, see H. Anderson, R. Atkinson, J. Peacock et al., Meta-Analysis of Time-Series Studies and Panel Studies of Particulate Matter (PM) and Ozone (World Health Organization, 2004), www.euro.who.int/document/e82792.pdf; Moolgavkar, "A Review and Critique of the EPA's Rationale for a Fine Particle Standard."

[91]T. Lumley and L. Sheppard, "Time Series Analyses of Air Pollution and Health: Straining at Gnats and Swallowing Camels?" Epidemiology 14 (2003): 13-4.

[92]M. Bell, J. Samet and F. Dominici, Ozone and Mortality: A Meta-Analysis of Time-Series Studies and Comparison to a Multi-City Study (the National Morbidity, Mortality, and Air Pollution Study) (Baltimore: Johns Hopkins School of Public Health, July 19, 2004), http://www.bepress.com/cgi/viewcontent.cgi?article=1057&context=jhubiostat.

[93]G. Koop and L. Tole, "Measuring the Health Effects of Air Pollution: To What Extent Can We Really Say That People Are Dying from Bad Air?" Journal of Environmental Economics and Management 47 (2004): 30-54.

[94]Green, Crouch, Ames et al., "What's Wrong with the National Ambient Air Quality Standard (NAAQS) for Fine Particulate Matter ($PM_{2.5}$)?";" Green and Armstrong, "Particulate Matter in Ambient Air and Mortality: Toxicologic Perspectives";" Moolgavkar, "A Review and Critique of the EPA's Rationale for a Fine Particle Standard."

[95]Green and Armstrong, "Particulate Matter in Ambient Air and Mortality: Toxicologic Perspectives."

[96]Q. Sun, A. Wang, X. Jin et al., "Long-Term Air Pollution Exposure and Acceleration of Atherosclerosis and Vascular Inflammation in an Animal Model," Journal of the American Medical Association 294 (2005): 3003-10.

[97]Newspapers carrying articles on the study included the Los Angeles Times, Houston Chronicle, Philadelphia Inquirer, and several others. The National Institutes of Health also put out a press release highlighting the study (http://www.nih.gov/news/pr/dec2005/niehs-22.htm). Some of the articles mentioned that the mice had been "bred" to be more likely to develop atherosclerosis, but none hinted at the huge difference between the genetically engineered mice in the study when compared with natural mice or with humans.

[98]A few of the news stories mentioned that the study used "specially bred mice prone to heart disease." But this is a great understatement, because it creates the impression that the mice were similar to humans who have a high heart disease risk, and therefore that the study is relevant for human beings. In reality, the mice were genetically engineered to have cholesterol far beyond even the highest levels that would ever occur in humans or in "natural" mice.

[99]Based on National Health and Nutrition Examination Survey (NHANES) data on 4,090 adult men collected from 1999-2002. Data were downloaded from http://www.cdc.gov/nchs/nhanes.htm.

[100]Environmental Protection Agency, The Benefits and Costs of the Clean Air Act, 1970 to 1990 (Washington, DC: October 1997), http://www.epa.gov/air/sect812/; Environmental Protection Agency, The Benefits and Costs of the Clean Air Act, 1990 to 2010 (Washington, DC: November 1999), http://www.epa.gov/air/sect812/1990-2010/fullrept.pdf. EPA also estimates that removing lead from gasoline accounts for another 8.3 percent of total benefits. EPA says it used PM as a proxy for all criteria pollutants (except lead) that could contribute to premature mortality. So some of the mortality benefits might be attributable to other pollutants. However, based on the epidemiologic literature and actual pollution levels, the vast majority of the mortality reductions—certainly well over 95 percent—are due PM reductions. For example, taking the most recent ozone mortality estimates at face value, the reduction in ozone from 1970-1990 would have saved a few thousand lives per year. Yet EPA estimates a total mortality reduction due to the Clean Air Act of 184,000 lives per year.

Joel Schwartz is one of America's foremost experts on air quality issues. He is a Visiting Fellow at the American Enterprise Institute in Washington, DC. Previously he directed the Air Quality Project for Reason Public Policy Institute. Mr. Schwartz has also been a public servant -- executive officer for the California Inspection and Maintenance Review Committee and a senior policy analyst in the Legislative Analyst's Office in Sacramento.

Joel Schwartz is a prolific writer. He has authored nearly thirty studies in the past decade alone. His most recent book is *No Way Back* (AEI Press). Schwartz writes, "It would be virtually impossible for anyone, no mater how tenacious or determined, to prevent continued and substantial reductions in air pollution."

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