STATE OF THE AIR 2011

AMERICAN LUNG ASSOCIATION®

Acknowledgments

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The American Lung Association assumes sole responsibility for the content of the *American Lung Association State of the Air 2011*.

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The State of the Air 2011

State of the Air 2011 shows that

cleaning up air pollution produces healthier air

across the nation.

The *State of the Air 2011* shows that the air quality in many places has improved, but that over 154 million people—just over one half the nation—still suffer pollution levels that are too often dangerous to breathe. Unhealthy air remains a threat to the lives and health of millions of people in the United States, despite great progress. Air pollution lingers as a widespread and dangerous reality even as some seek to weaken the Clean Air Act, the public health law that has driven the cuts in pollution since 1970.

The *State of the Air 2011* report looks at levels of ozone and particle pollution found in official monitoring sites across the United States in 2007, 2008, and 2009. The report uses the most current quality-assured nationwide data available for these analyses.

For particle pollution, the report examines fine particulate matter ($PM_{2.5}$) in two different ways: averaged year-round (annual average) and over short-term levels (24-hour). For both ozone and short-term particle pollution, the analysis uses a weighted average number of days that allows recognition of places with higher levels of pollution. For the year-round particle pollution rankings, the report uses averages calculated and reported by the U.S. Environmental Protection Agency. For comparison, the State of the Air 2010 report covered data from 2006, 2007 and 2008.[1]

Each of the **25** cities with the most ozone pollution improved.

Ozone

Each of the 25 cities with the most ozone pollution improved their air quality over the past year's report. More than half of the country's most smog-polluted cities experienced their best year yet—but people living there are still forced to breathe air that reaches dangerous levels.

Of the 25 metropolitan areas most polluted by ozone, fifteen reported the lowest ozone scores since the State of the Air reports began[2]: Los Angeles, CA; Bakersfield, CA; Fresno, CA; Sacramento, CA; Houston, TX; Dallas-Fort Worth, TX; El Centro, CA; Washington-Baltimore, DC-MD-VA; New York, NY; Knoxville, TN; Phoenix, AZ; Philadelphia, PA; Atlanta, GA; Pittsburgh, PA; and Las Vegas, NV.

Year-round particle pollution

The *State of the Air 2011* finds continued progress in cutting year-round particle pollution, compared to the 2010 report. Thanks to reductions in emissions from coal-fired power plants and the transition to cleaner diesel fuels and engines, cleaner air shows up repeatedly in the monitoring data, especially in the eastern U.S.

All but two cities with the most year-round particle pollution improved over the previous report.[3] Bakersfield, CA, and Hanford, CA, each had worse average year-round levels in 2007–2009 than in 2006–2008. Bakersfield, CA, moved into the most polluted city rank. Improving over the previous report were these 25 metropolitan areas: Los Angeles, CA; Phoenix, AZ; Visalia, CA; Pittsburgh, PA; Fresno, CA; Birmingham, AL; Cincinnati, OH; Modesto, CA; Louisville, KY; Cleveland, OH; Weirton-Steubenville, WV-OH; Charleston, WV; Huntington, WV; Indianapolis, IN; St. Louis, MO; Detroit, MI; Houston, TX; Hagerstown, MD; New York, NY; Dayton, OH; Lancaster, PA; York, PA; Philadelphia, PA; Knoxville, TN; and Parkersburg, WV.

1 A complete discussion of the sources of data and the methodology is included in Appendix: Methodology.

2 Full names for all these metropolitan areas can be found in the lists beginning on page 10. The full metropolitan areas often include multiple counties, incorporated cities and counties in adjacent states.

3 The usual list of 25 cities with the most year-round particle pollution actually includes 27 cities because of ties in the rankings values among many cities.

All but two cities with the most year-round particle pollution improved over the previous report.

Fewer cities with the worst short-term levels of particle pollution improved in 2007-2009.

Honolulu, HI and Santa Fe, NM were the only cities landing on all three of the cleanest cities lists during 2007-2009.

Only these eight cities averaged levels higher than the official national standard: Bakersfield, CA; Los Angeles, CA; Phoenix, AZ; Visalia, CA; Hanford, CA; Fresno, CA; Pittsburgh, PA; and Birmingham, AL. Nineteen of these cities actually had levels of year-round particle pollution that were lower than the official national air quality standard. However, that standard is currently under review. The American Lung Association and other public health and medical groups have long supported a much more protective national air quality standard for particle pollution.

Short-term particle pollution

Unlike with year-round particle pollution levels, fewer cities with the worst short-term levels improved in 2007–2009. Only 12 cities had fewer unhealthy days or lower daily levels, while 16 of the cities on the list did worse than in 2006–2008. One city stayed the same.[2,4] Although "short-term" particle pollution looks at the same type of pollution that the year-round levels do, this measure focuses on the spikes in particle levels that can last from hours to days. Those days or weeks of high levels can be dangerous, even deadly.

Twelve cities improved, having cut the average number of days with high particle levels: Pittsburgh, PA; Los Angeles, CA; Visalia, CA; Birmingham, AL; Sacramento, CA; Modesto, CA; Stockton, CA; Philadelphia, PA; Louisville, KY; Phoenix, AZ; San Jose-San Francisco-Oakland, CA; and Wheeling, WV. The Chicago metropolitan area had the same average number of unhealthy days in 2007–2009 as in 2006–2008.

The remaining sixteen cities had more days or higher daily levels: Bakersfield, CA (ranked most polluted); Fresno, CA; Salt Lake City, UT; Provo, UT; Hanford, CA; Logan, UT; Merced, CA; Eugene-Springfield, OR; San Diego, CA; Seattle-Tacoma, WA; Fairbanks, AK; Macon, GA; Green Bay, WI; Davenport, IA; Portland, OR; and Madison, WI.

4 The usual list of the 25 cities with the most short-term particle pollution actually includes 29 cities because of ties in the rankings.

Cleanest cities

Honolulu, HI and Santa Fe, NM were the only metropolitan areas landing on all three of the cleanest cities lists during 2007–2009.[2] Four cities ranked on the cleanest for both ozone and short-term particle pollution: Brownsville, TX; Lincoln, NE; Monroe, LA; and Spokane, WA. Five other cities were on the cleanest cities lists for both ozone and year-round particle pollution: Bismarck, ND; Duluth, MN-WI; Fargo, ND; Port S. Lucie-Sebastian-Vero Beach, FL; and Rapid City, SD. Eleven cities ranked as the cleanest for both measures of particle pollution: Amarillo, TX; Bangor, ME; Billings, MT; Burlington, VT; Cape Coral-Fort Myers, FL; Cheyenne, WY; Fort Collins-Loveland, CO; Palm Bay-Melbourne-Titusville, FL; Salinas, CA; Sarasota, FL; and Tucson, AZ.

People at risk

Looking at the nation as a whole, the American Lung Association *State of the Air 2011* finds—

- **Roughly half the people (50.3%) in the United States live in counties that have unhealthful levels of either ozone or particle pollution.**
  Almost 154.5 million Americans live in the 366 counties where they are exposed to unhealthful levels of air pollution in the form of either ozone or short-term or year-round levels of particles.
- **Nearly half the people in the United States (48.2%) live in areas with unhealthful levels of ozone.**
  Counties that were graded F for ozone levels have a combined population of almost 148.1 million. These people live in the 338 counties where the monitored air quality places them at risk for decreased lung function, respiratory infection, lung inflammation and aggravation of respiratory illness. The actual number who breathe unhealthy levels of ozone is likely much larger, since this number does not include people who live in adjacent counties in metropolitan areas where no monitors exist.

18.5 million

people in the US live in counties where the outdoor air failed all three tests.

- **Nearly one in five (19.8%) of people in the United States live in an area with unhealthful short-term levels of particle pollution.**
  Nearly 61 million Americans live in 76 counties that experienced too many days with unhealthy spikes in particle pollution, a decrease from the last report. Short-term spikes in particle pollution can last from hours to several days and can increase the risk of heart attacks, strokes and emergency-room visits for asthma and cardiovascular disease, and most importantly, can increase the risk of early death.
- **Over 18.5 million people (6%) in the United States live in an area with unhealthful year-round levels of particle pollution.**
  These people live in areas where chronic levels are regularly a threat to their health. Even when levels are fairly low, exposure to particles over time can increase risk of hospitalization for asthma, damage to the lungs and, significantly, increase the risk of premature death.
- **Roughly one in 17 people—more than 18.5 million in the United States—live in 10 counties with unhealthful levels of all three: ozone and short-term and year-round particle pollution.**

With the risks from airborne pollution so great, the American Lung Association seeks to inform people who may be in danger. Many people are at greater risk because of their age or because they have asthma or other chronic lung disease, cardiovascular disease, or diabetes. The following list identifies the numbers of people in each at-risk group.

- **People with Asthma—**Approximately 3.2 million children and nearly 9.5 million adults with asthma live in parts of the United States with very high levels of ozone. Over 3.8 million adults and over 1.2 million children with asthma live in areas with high levels of short-term particle pollution. Nearly 1.1 million adults and over 339,000 children with asthma live in counties with unhealthful levels of year-round particle pollution.
- **Older and Younger—**Nearly 17.4 million adults age 65 and over and nearly 37 million children age 18 and under live in counties with unhealthful ozone levels. Nearly 7 million seniors and nearly 15.5 million children live in counties with unhealthful short-term levels of particle pollution. Over 2 million seniors and nearly 5 million children live in counties with unhealthful levels of year-round particle pollution.
- **Chronic Bronchitis and Emphysema—**Nearly 4.8 million people with chronic bronchitis and nearly 2.3 million with emphysema live in counties with unhealthful ozone levels. Over 1.9 million people with chronic bronchitis and over 917,000 with emphysema live in counties with unhealthful levels of short-term particle pollution. Nearly 573,000 million people with chronic bronchitis and more than 268,000 with emphysema live in counties with unhealthful year-round levels of particle pollution.
- **Cardiovascular Disease—**Over 15.9 million people with cardiovascular diseases live in counties with unhealthful levels of short-term particle pollution; nearly 4.7 million live in counties with unhealthful levels of year-round particle pollution. Cardiovascular diseases include coronary heart disease, heart attacks, strokes, hypertension and angina pectoris.
- **Diabetes—**Over 3.9 million people with diabetes live in counties with unhealthful levels of short-term particle pollution; over 1.2 million live in counties with unhealthful levels of year-round particle pollution. Research indicates that because diabetics are already at higher risk of cardiovascular disease, they may face increased risk due to the impact of particle pollution on their cardiovascular systems.
- **Poverty—**Over 20 million people with incomes meeting the federal poverty definition live in counties with unhealthful levels of ozone. Over 9.3 million people in poverty live in counties with unhealthful levels of short-term particle pollution, and nearly 3 million live in counties with unhealthful year-round levels of particle pollution. Evidence shows that

people who have low incomes may face higher risk from air pollution.

What needs to be done

Many major challenges require the Administration and Congress to take steps to protect the health of the public. Here are a few that the American Lung Association calls for to improve the air we all breathe.

Protect the Clean Air Act. The continued improvement shown in the *State of the Air* report is possible because of the Clean Air Act, the nation's landmark public health law that the U.S. Congress passed 40 years ago. The Act requires that the U.S. Environmental Protection Agency (EPA) and each state take steps to clean up the air. Some members of Congress are proposing changes to the Clean Air Act that could dismantle 40 years' progress. We must keep that law strong to continue to protect public health.

The strong, continued **improvement** shown in this report is possible because of the **Clean Air Act.**

Clean up dirty power plants. Over 440 coal-fired power plants in 46 states are among the largest contributors to particulate pollution, ozone, mercury, and global warming. Their pollution blows across state lines into states thousands of miles away. They produce 84 known hazardous air pollutants, including arsenic, mercury, dioxins, formaldehyde and hydrogen chloride. EPA has proposed steps that will cut the emissions that create ozone and particle pollution and, for the first time, set national limits on the toxic pollutants they can emit. EPA needs to issue the final rules that will start those cleanup measures. Congress needs to support EPA's actions to clean these plants up.

Clean up the existing fleet of dirty diesel vehicles and heavy equipment. Rules EPA put in effect over the past several years mean that new diesel vehicles and equipment must be much cleaner. Still, the vast majority of diesel trucks, buses and heavy equipment (such as bulldozers) will likely be in use for thousands more miles, spewing dangerous diesel exhaust into communities and neighborhoods. The good news is that affordable technology exists to cut emissions by 90 percent. Congress needs to fund EPA's diesel cleanup ("retrofit") program. Congress should also require that clean diesel equipment should be used in federally-funded construction programs.

Strengthen the ozone standards. The Lung Association urges the EPA to adopt a much tighter, more protective national air quality standard for ozone, set at 60 parts per billion. The EPA is currently considering strengthening the standard adopted in March 2008, which they now believe was not strong enough to protect health against the widespread harm from ozone smog. The 2008 decision set 75 ppb as the standard, despite the unanimous recommendations of EPA's official science advisors that such a level would allow too much ozone to meet the requirements of the Clean Air Act. The American Lung Association challenged the 2008 decision in court, along with several states, public health and environmental groups. In January 2010, the EPA proposed a range for the new standard that met the earlier recommendations of the expert panel and the nation's leading public health organizations. EPA will announce the decision on the new standard the summer of 2011.

Strengthen the particle pollution standards. In 2006, EPA failed to strengthen the annual standard for fine particles, despite the near unanimous recommendation by their official science advisors. EPA lowered the 24-hour standard, though not to the level the Lung Association recommended. EPA can save thousands of lives each year by dramatically strengthening the annual average and the 24-hour standards. In 2009, the Lung Association challenged that 2006 standard in the U.S. Circuit Court and won. EPA is expected to issue a new proposal for the particle pollution standards in 2011.

Clean up harmful emissions from tailpipes. EPA needs to set new pollution standards for cars, light trucks, SUVs and gasoline fuels to reduce nitrogen oxides, hydrocarbons, and particle pollution emissions. Science shows that people who live or work near highways or busy roads bear a disproportionate health burden from air pollution. Cleaner cars will help reduce this impact for all, but especially those who live closest to the traffic.

What you can do

Individual citizens can do a great deal to help reduce air pollution outdoors as well. Simple but effective ways include—

Tell the President and Congress to support the Clean Air Act.

- **Send a message to EPA.** Send a message to tell EPA to clean up hazardous air pollutants from coal-fired power plants. Tell EPA you support stronger standards for ozone and particle pollution to limit how much of those pollutants can be in the air.
- **Tell the President and Congress** that you support the Clean Air Act and that they should, too. Send a message to tell them to keep the safeguards in place in this public health law.
- **Drive less.** Combine trips, walk, bike, carpool or vanpool, and use buses, subways or other alternatives to driving. Vehicle emissions are a major source of air pollution. Support community plans that provide ways to get around that don't require a car, such as more sidewalks, bike trails and transit systems.
- **Don't burn wood or trash.** Burning firewood and trash are among the largest sources of particles in many parts of the country. If you must use a fireplace or stove for heat, convert your woodstoves to natural gas, which has far fewer polluting emissions. Compost and recycle as much as possible and dispose of other waste properly; don't burn it. Support efforts in your community to ban outdoor burning of construction and yard wastes. Avoid the use of outdoor hydronic heaters, also called outdoor wood boilers, which are frequently much more polluting than woodstoves.
- **Make sure your local school system requires clean school buses,** which includes replacing or retrofitting old school buses with filters and other equipment to reduce emissions. Make sure your local schools don't idle their buses, a step that can immediately reduce emissions.
- **Get involved.** Participate in your community's review of its air pollution plans and support state and local efforts to clean up air pollution. To find your local air pollution control agency, go to www.4cleanair.org.
- **Use less electricity.** Turn out the lights and use energy-efficient appliances. Generating electricity is one of the biggest sources of pollution, particularly in the eastern United States.

People at Risk from Short-term Particle Pollution (24-Hour $PM_{2.5}$)

In Counties where the Grades were:	Chronic Diseases: Adult Asthma	Pediatric Asthma	Chronic Bronchitis	Emphysema	CV Disease	Diabetes	Poverty	Age Groups: Under 18	65 and Over	Total Population	Number of Counties
Grade A (0.0)	1,971,559	631,469	994,663	498,303	8,390,082	2,056,404	4,212,190	7,189,834	3,977,708	29,964,695	139
Grade B (0.3-0.9)	3,072,492	983,227	1,505,369	734,927	12,557,984	3,027,179	5,907,902	11,417,242	5,629,468	46,216,077	182
Grade C (1.0-2.0)	3,267,080	1,064,195	1,656,331	818,511	13,887,267	3,330,980	6,423,414	11,701,176	6,435,736	49,887,758	133
Grade D (2.1-3.2)	1,360,920	467,562	720,134	343,264	5,944,250	1,486,651	3,193,153	5,355,664	2,578,742	22,235,806	46
Grade F (3.3+)	3,814,340	1,211,124	1,930,376	917,820	15,912,763	3,944,139	9,339,268	15,491,071	6,950,809	60,921,655	76
National Population in Counties with $PM_{2.5}$ Monitors	13,981,412	4,520,949	7,077,034	3,450,294	58,986,094	14,425,846	30,307,311	53,090,799	26,707,334	217,329,744	637

People at Risk from Year-Round Particle Pollution (Annual $PM_{2.5}$)

In Counties where the Grades were:	Chronic Diseases: Adult Asthma	Pediatric Asthma	Chronic Bronchitis	Emphysema	CV Disease	Diabetes	Poverty	Age Groups: Under 18	65 and Over	Total Population	Number of Counties
Pass	11,782,176	3,804,274	5,908,715	2,884,062	49,275,596	11,974,999	24,713,502	43,790,193	22,310,786	180,765,573	516
Fail	1,084,656	339,493	572,689	268,425	4,691,047	1,220,449	2,968,257	4,916,821	2,017,113	18,516,713	10
National Population in Counties with $PM_{2.5}$ Monitors	13,978,245	4,520,382	7,075,664	3,449,614	58,974,595	14,422,959	30,301,175	53,083,823	26,701,815	217,291,013	636

People at Risk from Ozone

In Counties where the Grades were:		Chronic Diseases: Adult Asthma	Pediatric Asthma	Chronic Bronchitis	Emphysema	Poverty	Age Groups: Under 18	65 and Over	Total Population	Number of Counties
Grade A	(0.0)	703,711	207,718	381,530	191,499	1,483,879	2,723,437	1,537,025	11,459,610	82
Grade B	(0.3-0.9)	952,592	295,991	515,494	265,139	2,186,428	3,659,910	2,196,893	15,336,801	76
Grade C	(1.0-2.0)	1,448,582	445,265	724,178	364,081	2,977,882	5,045,020	2,922,055	21,604,100	142
Grade D	(2.1-3.2)	1,407,537	442,528	715,047	354,495	2,906,192	4,986,790	2,816,311	21,477,147	64
Grade F	(3.3+)	9,498,324	3,170,965	4,769,138	2,296,660	20,025,436	36,937,212	17,392,675	148,061,191	338
National Population in Counties with Ozone Monitors		14,445,482	4,702,553	7,333,231	3,585,499	30,504,009	54,999,066	27,757,857	224,798,559	755

Note: The *State of the Air 2011* covers the period 2007-2009. The Appendix provides a full discussion of the methodology.

People at Risk In 25 U.S. Cities Most Polluted by Short-term Particle Pollution (24-hour $PM_{2.5}$)

2011 Rank[1]	Metropolitan Statistical Areas	Total Population[2]	Under 18[3]	65 and Over[3]	Pediatric Asthma[4,8]	Adult Asthma[5,8]	Chronic Bronchitis[6,8]	Emphysema[7,8]	CV Disease[9]	Diabetes[10]	Poverty[11]
1	Bakersfield-Delano, CA	807,407	250,561	72,666	16,621	43,747	23,012	10,309	184,959	48,102	170,614
2	Fresno-Madera, CA	1,063,899	319,551	104,947	21,198	58,379	30,977	14,213	251,405	65,433	221,348
3	Pittsburgh-New Castle, PA	2,445,117	495,068	422,943	51,002	174,497	89,288	48,733	783,055	183,922	290,876
4	Los Angeles-Long Beach-Riverside, CA	17,820,893	4,682,410	1,902,902	310,610	1,030,481	552,457	257,170	4,512,759	1,179,719	2,579,016
5	Salt Lake City-Ogden-Clearfield, UT	1,743,364	528,004	154,359	38,413	96,430	49,678	21,913	396,577	75,234	172,338
6	Provo-Orem, UT	555,551	193,164	36,244	14,053	28,686	13,744	5,338	104,030	18,731	77,177
7	Visalia-Porterville, CA	429,668	141,279	40,393	9,372	22,622	11,998	5,494	97,299	25,326	97,542
8	Birmingham-Hoover-Cullman, AL	1,212,848	291,846	160,168	25,030	70,273	40,311	20,201	340,136	107,132	177,638
9	Hanford-Corcoran, CA	148,764	41,081	11,466	2,725	8,468	4,221	1,721	32,615	8,286	24,546
9	Logan, UT-ID	127,945	39,861	10,455	2,783	7,009	3,438	1,431	26,746	5,015	20,081
9	Sacramento—Arden-Arcade—Yuba City, CA-NV	2,436,109	607,251	300,098	40,307	143,692	79,445	39,034	664,653	175,011	320,925
12	Modesto, CA	510,385	149,225	53,538	9,899	28,322	15,287	7,192	125,454	32,878	85,583
13	Merced, CA	245,321	78,461	24,167	5,205	13,076	6,948	3,210	56,540	14,704	59,349
14	Eugene-Springfield, OR	351,109	70,025	50,780	3,931	31,083	12,379	6,290	105,086	23,292	58,935
15	San Diego-Carlsbad-San Marcos, CA	3,053,793	739,625	347,859	49,063	181,385	97,908	46,204	804,440	210,648	372,782
16	Stockton, CA	674,860	202,135	68,180	13,409	37,098	19,982	9,330	163,489	42,864	103,777
17	Chicago-Naperville-Michigan City, IL-IN-WI	9,804,845	2,491,070	1,104,442	231,348	660,705	312,722	148,887	2,580,626	586,411	1,231,739
18	Seattle-Tacoma-Olympia, WA	4,158,293	944,478	468,853	64,582	281,862	137,891	65,277	1,135,710	241,202	421,614
19	Fairbanks, AK	98,660	25,640	6,170	1,775	6,482	2,900	1,146	22,185	3,823	7,420
20	Philadelphia-Camden-Vineland, PA-NJ-DE-MD	6,533,122	1,535,672	869,965	158,452	438,946	219,155	109,986	1,850,540	428,512	760,156
21	Macon-Warner Robins-Fort Valley, GA	394,538	102,473	47,839	10,108	20,164	12,685	6,229	106,099	29,946	67,875
22	Louisville-Jefferson County-Elizabethtown-Scottsburg, KY-IN	1,395,634	335,150	177,354	31,918	105,477	46,544	23,133	391,515	118,443	193,601
23	Green Bay, WI	304,783	72,441	37,275	5,016	22,809	10,116	4,951	84,521	18,546	31,142
24	Davenport-Moline-Rock Island, IA-IL	379,066	89,246	55,929	6,420	23,219	12,981	6,779	111,579	23,842	42,634
24	Madison-Baraboo, WI	628,947	134,274	68,877	9,298	49,319	20,807	9,598	169,365	36,341	74,105
24	Phoenix-Mesa-Glendale, AZ	4,364,094	1,187,246	496,355	96,895	347,250	133,817	63,556	1,101,803	255,571	643,772
24	Portland-Vancouver-Hillsboro, OR-WA	2,241,841	533,526	244,548	31,367	183,150	72,947	34,260	598,721	132,377	265,996
24	San Jose-San Francisco-Oakland, CA	7,427,757	1,679,302	898,351	111,397	450,647	247,427	119,351	2,053,445	541,562	721,023
24	Wheeling, WV-OH	144,637	28,817	25,881	2,564	10,687	5,359	2,965	47,308	13,923	22,162

Notes:
1. Cities are ranked using the highest weighted average for any county within that Combined or Metropolitan Statistical Area.
2. **Total Population** represents the at-risk populations for all counties within the respective Combined or Metropolitan Statistical Area.
3. Those **18 and under** and **65 and over** are vulnerable to $PM_{2.5}$ and are, therefore, included. They should not be used as population denominators for disease estimates.
4. **Pediatric asthma** estimates are for those under 18 years of age and represent the estimated number of people who had asthma in 2009 based on state rates (BRFSS) applied to population estimates (U.S. Census).
5. **Adult asthma** estimates are for those 18 years and older and represent the **estimated** number of people who had asthma during 2009 based on state rates (BRFSS) applied to population estimates (U.S. Census).
6. **Chronic bronchitis** estimates are for adults 18 and over who had been diagnosed in 2009, based on national rates (NHIS) applied to population estimates (U.S. Census).
7. **Emphysema** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on national rates (NHIS) applied to population estimates (U.S. Census).
8. Adding across rows does not produce valid estimates, e.g., summing pediatric and adult asthma and/or emphysema and chronic bronchitis.
9. **CV disease** estimates are based on National Heart Lung and Blood Institute (NHLBI) estimates of cardiovascular disease applied to population estimates (U.S. Census).
10. **Diabetes** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
11. **Poverty** estimates come from the U.S. Census Bureau and are for all ages.

People at Risk In 25 U.S. Cities Most Polluted by Year-Round Particle Pollution (Annual $PM_{2.5}$)

2011 Rank[1]	Metropolitan Statistical Areas	Total Population[2]	Under 18[3]	65 and Over[3]	Pediatric Asthma[4,8]	Adult Asthma[5,8]	Chronic Bronchitis[6,8]	Emphysema[7,8]	CV Disease[9]	Diabetes[10]	Poverty[11]
1	Bakersfield-Delano, CA	807,407	250,561	72,666	16,621	43,747	23,012	10,309	184,959	48,102	170,614
2	Los Angeles-Long Beach-Riverside, CA	17,820,893	4,682,410	1,902,902	310,610	1,030,481	552,457	257,170	4,512,759	1,179,719	2,579,016
2	Phoenix-Mesa-Glendale, AZ	4,364,094	1,187,246	496,355	96,895	347,250	133,817	63,556	1,101,803	255,571	643,772
2	Visalia-Porterville, CA	429,668	141,279	40,393	9,372	22,622	11,998	5,494	97,299	25,326	97,542
5	Hanford-Corcoran, CA	148,764	41,081	11,466	2,725	8,468	4,221	1,721	32,615	8,286	24,546
6	Fresno-Madera, CA	1,063,899	319,551	104,947	21,198	58,379	30,977	14,213	251,405	65,433	221,348
7	Pittsburgh-New Castle, PA	2,445,117	495,068	422,943	51,002	174,497	89,288	48,733	783,055	183,922	290,876
8	Birmingham-Hoover-Cullman, AL	1,212,848	291,846	160,168	25,030	70,273	40,311	20,201	340,136	107,132	177,638
9	Cincinnati-Middletown-Wilmington, OH-KY-IN	2,214,954	543,893	270,380	51,168	166,495	72,691	35,624	607,603	168,199	272,692
10	Louisville-Jefferson County-Elizabethtown-Scottsburg, KY-IN	1,395,634	335,150	177,354	31,918	105,477	46,544	23,133	391,515	118,443	193,601
10	Modesto, CA	510,385	149,225	53,538	9,899	28,322	15,287	7,192	125,454	32,878	85,583
12	Charleston, WV	304,214	66,646	47,487	5,652	20,945	10,797	5,739	93,597	29,594	46,041
12	Cleveland-Akron-Elyria, OH	2,891,988	667,656	424,508	62,599	218,655	100,087	52,255	860,578	231,353	433,633
12	Steubenville-Weirton, OH-WV	120,929	24,249	22,891	2,179	8,953	4,536	2,568	40,483	11,745	18,861
15	Huntington-Ashland, WV-KY-OH	285,624	60,932	46,146	5,479	21,189	10,055	5,339	87,025	26,468	55,531
15	Indianapolis-Anderson-Columbus, IN	2,064,870	529,363	238,784	51,705	139,825	66,093	31,843	548,249	139,402	276,696
17	Detroit-Warren-Flint, MI	5,327,764	1,280,345	673,872	104,036	404,526	178,165	88,632	1,499,596	378,182	851,246
17	Houston-Baytown-Huntsville, TX	5,968,586	1,693,708	507,966	138,409	275,407	177,262	78,010	1,415,731	385,690	897,732
17	St. Louis-St. Charles-Farmington, MO-IL	2,916,789	696,764	383,974	69,317	208,250	97,816	49,155	826,708	178,048	360,713
20	Hagerstown-Martinsburg, MD-WV	266,149	62,604	35,621	6,461	18,296	8,917	4,479	75,308	21,340	30,121
21	New York-Newark-Bridgeport, NY-NJ-CT-PA	22,232,494	5,171,357	2,905,795	513,309	1,559,643	744,517	370,377	6,262,030	1,456,452	2,721,910
22	Dayton-Springfield-Greenville, OH	1,066,261	244,969	160,192	22,968	80,775	36,765	19,252	316,371	85,080	150,147
22	Lancaster, PA	507,766	125,939	75,950	12,974	34,593	17,080	8,988	147,264	34,405	46,401
24	Knoxville-Sevierville-La Follette, TN	1,053,627	231,414	158,809	19,847	66,813	36,686	19,121	315,000	87,170	162,410
24	Parkersburg-Marietta, WV-OH	160,905	34,240	27,442	3,018	11,589	5,818	3,179	51,054	15,220	24,379
24	Philadelphia-Camden-Vineland, PA-NJ-DE-MD	6,533,122	1,535,672	869,965	158,452	438,946	219,155	109,986	1,850,540	428,512	760,156
24	York-Hanover-Gettysburg, PA	531,260	122,145	75,887	12,583	37,060	18,316	9,464	156,758	36,557	44,431

Notes:

1. Cities are ranked using the highest weighted average for any county within that Combined or Metropolitan Statistical Area.
2. **Total Population** represents the at-risk populations for all counties within the respective Combined or Metropolitan Statistical Area.
3. Those **18 and under** and **65 and over** are vulnerable to $PM_{2.5}$ and are, therefore, included. They should not be used as population denominators for disease estimates.
4. **Pediatric asthma** estimates are for those under 18 years of age and represent the estimated number of people who had asthma in 2009 based on state rates (BRFSS) applied to population estimates (U.S. Census).
5. **Adult asthma** estimates are for those 18 years and older and represent the estimated number of people who had asthma during 2009 based on state rates (BRFSS) applied to population estimates (U.S. Census).
6. **Chronic bronchitis** estimates are for adults 18 and over who had been diagnosed in 2009, based on national rates (NHIS) applied to population estimates (U.S. Census).
7. **Emphysema** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on national rates (NHIS) applied to population estimates (U.S. Census).
8. Adding across rows does not produce valid estimates, e.g., summing pediatric and adult asthma and/or emphysema and chronic bronchitis.
9. **CV disease** estimates are based on National Heart Lung and Blood Institute (NHLBI) estimates of cardiovascular disease applied to population estimates (U.S. Census).
10. **Diabetes** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
11. **Poverty** estimates come from the U.S. Census Bureau and are for all ages.

People at Risk In 25 Most Ozone-Polluted Cities

2011 Rank[1]	Metropolitan Statistical Areas	Total Population[2]	Under 18[3]	65 and Over[3]	Pediatric Asthma[4,8]	Adult Asthma[5,8]	Chronic Bronchitis[6,8]	Emphysema[7,8]	Poverty[9]
1	Los Angeles-Long Beach-Riverside, CA	17,820,893	4,682,410	1,902,902	310,610	1,030,481	552,457	257,170	2,579,016
2	Bakersfield-Delano, CA	807,407	250,561	72,666	16,621	43,747	23,012	10,309	170,614
3	Visalia-Porterville, CA	429,668	141,279	40,393	9,372	22,622	11,998	5,494	97,542
4	Fresno-Madera, CA	1,063,899	319,551	104,947	21,198	58,379	30,977	14,213	221,348
5	Sacramento—Arden-Arcade—Yuba City, CA-NV	2,436,109	607,251	300,098	40,307	143,692	79,445	39,034	320,925
6	Hanford-Corcoran, CA	148,764	41,081	11,466	2,725	8,468	4,221	1,721	24,546
7	San Diego-Carlsbad-San Marcos, CA	3,053,793	739,625	347,859	49,063	181,385	97,908	46,204	372,782
8	Houston-Baytown-Huntsville, TX	5,968,586	1,693,708	507,966	138,409	275,407	177,262	78,010	897,732
9	Merced, CA	245,321	78,461	24,167	5,205	13,076	6,948	3,210	59,349
10	Charlotte-Gastonia-Salisbury, NC-SC	2,389,763	615,854	263,236	52,818	139,028	75,668	35,810	332,654
11	San Luis Obispo-Paso Robles, CA	266,971	49,825	39,636	3,305	16,962	9,572	4,880	33,198
12	Dallas-Fort Worth, TX	6,772,276	1,884,196	607,900	153,975	314,809	202,280	89,746	950,677
13	El Centro, CA	166,874	51,337	17,578	3,405	9,042	4,822	2,259	35,368
14	Modesto, CA	510,385	149,225	53,538	9,899	28,322	15,287	7,192	85,583
14	Washington-Baltimore-Northern Virginia, DC-MD-VA-WV	8,394,115	2,017,092	913,919	217,649	558,279	272,776	128,313	700,129
16	Cincinnati-Middletown-Wilmington, OH-KY-IN	2,214,954	543,893	270,380	51,168	166,495	72,691	35,624	272,692
17	New York-Newark-Bridgeport, NY-NJ-CT-PA	22,232,494	5,171,357	2,905,795	513,309	1,559,643	744,517	370,377	2,721,910
18	Knoxville-Sevierville-La Follette, TN	1,053,627	231,414	158,809	19,847	66,813	36,686	19,121	162,410
19	Phoenix-Mesa-Glendale, AZ	4,364,094	1,187,246	496,355	96,895	347,250	133,817	63,556	643,772
20	Philadelphia-Camden-Vineland, PA-NJ-DE-MD	6,533,122	1,535,672	869,965	158,452	438,946	219,155	109,986	760,156
21	Birmingham-Hoover-Cullman, AL	1,212,848	291,846	160,168	25,030	70,273	40,311	20,201	177,638
22	Chico, CA	220,577	46,201	33,001	3,065	13,594	7,643	3,920	39,717
23	Atlanta-Sandy Springs-Gainesville, GA-AL	5,831,778	1,573,677	513,199	155,122	296,754	177,090	78,367	802,336
24	Pittsburgh-New Castle, PA	2,445,117	495,068	422,943	51,002	174,497	89,288	48,733	290,876
25	Las Vegas-Paradise-Pahrump, NV	1,947,068	510,425	214,427	35,278	127,748	60,786	28,636	240,066

Notes:

1. Cities are ranked using the highest weighted average for any county within that Combined or Metropolitan Statistical Area.
2. **Total Population** represents the at-risk populations for all counties within the respective Combined or Metropolitan Statistical Area.
3. Those **18 and under** and **65 and over** are vulnerable to $PM_{2.5}$ and are, therefore, included. They should not be used as population denominators for disease estimates.
4. **Pediatric asthma** estimates are for those under 18 years of age and represent the estimated number of people who had asthma in 2009 based on state rates (BRFSS) applied to population estimates (U.S. Census).
5. **Adult asthma** estimates are for those 18 years and older and represent the estimated number of people who had asthma during 2009 based on state rates (BRFSS) applied to population estimates (U.S. Census).
6. **Chronic bronchitis** estimates are for adults 18 and over who had been diagnosed in 2009, based on national rates (NHIS) applied to population estimates (U.S. Census).
7. **Emphysema** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on national rates (NHIS) applied to population estimates (U.S. Census).
8. Adding across rows does not produce valid estimates, e.g., summing pediatric and adult asthma and/or emphysema and chronic bronchitis.
9. **Poverty** estimates come from the U.S. Census Bureau and are for all ages.

People at Risk in 25 Counties Most Polluted by Short-term Particle Pollution (24-hour $PM_{2.5}$)

				At-Risk Groups									High $PM_{2.5}$ Days in Unhealthy Ranges, 2007–2009	
2011 Rank[1]	**County**	**ST**	**Total Population[2]**	**Under 18[3]**	**65 and Over[3]**	**Pediatric Asthma[4,8]**	**Adult Asthma[5,8]**	**Chronic Bronchitis[6,8]**	**Emphysema[7,8]**	**CV Disease[9]**	**Diabetes[10]**	**Poverty[11]**	**Weighted Avg.[12]**	**Grade[13]**
1	Kern	CA	807,407	250,561	72,666	16,621	43,747	23,012	10,309	184,959	48,102	170,614	60.5	F
2	Fresno	CA	915,267	275,906	89,528	18,302	50,145	26,546	12,137	215,107	55,930	192,638	53.7	F
3	Allegheny	PA	1,218,494	242,202	204,401	24,952	88,010	44,083	23,650	383,427	89,816	153,937	32.5	F
4	Riverside	CA	2,125,440	615,621	245,456	40,837	118,086	64,267	31,066	533,297	139,608	290,003	24.5	F
5	Salt Lake	UT	1,034,989	301,147	89,962	21,909	58,207	29,771	12,941	236,201	44,562	108,994	22.5	F
6	Los Angeles	CA	9,848,011	2,500,804	1,042,989	165,892	576,310	306,992	141,524	2,496,934	651,091	1,552,196	20.0	F
7	San Bernardino	CA	2,017,673	601,101	172,905	39,874	111,493	58,546	25,840	467,948	122,008	335,321	17.7	F
8	Utah	UT	545,307	189,454	35,179	13,783	28,166	13,467	5,204	101,731	18,281	75,993	14.8	F
9	Tulare	CA	429,668	141,279	40,393	9,372	22,622	11,998	5,494	97,299	25,326	97,542	14.7	F
10	Jefferson	AL	665,027	158,005	90,242	13,551	38,702	22,191	11,187	187,691	59,012	107,081	14.0	F
11	Sacramento	CA	1,400,949	361,552	157,628	23,984	81,493	44,281	21,049	365,071	95,904	210,786	13.2	F
11	Kings	CA	148,764	41,081	11,466	2,725	8,468	4,221	1,721	32,615	8,286	24,546	13.2	F
11	Cache	UT	115,269	35,491	8,905	2,582	6,320	3,075	1,246	23,661	4,328	18,744	13.2	F
14	Stanislaus	CA	510,385	149,225	53,538	9,899	28,322	15,287	7,192	125,454	32,878	85,583	12.8	F
15	Merced	CA	245,321	78,461	24,167	5,205	13,076	6,948	3,210	56,540	14,704	59,349	11.5	F
16	Orange	CA	3,026,786	755,550	346,897	50,120	178,032	96,766	46,079	798,336	209,664	318,173	11.0	F
16	Lane	OR	351,109	70,025	50,780	3,931	31,083	12,379	6,290	105,086	23,292	58,935	11.0	F
18	San Diego	CA	3,053,793	739,625	347,859	49,063	181,385	97,908	46,204	804,440	210,648	372,782	9.2	F
19	San Joaquin	CA	674,860	202,135	68,180	13,409	37,098	19,982	9,330	163,489	42,864	103,777	8.8	F
19	Plumas	CA	20,122	3,615	4,290	240	1,281	814	483	7,441	2,032	2,453	8.8	F
21	Cook	IL	5,287,037	1,283,145	621,214	119,167	360,936	169,759	80,867	1,400,158	314,356	828,626	8.7	F
22	Snohomish	WA	694,571	171,462	68,364	11,724	45,931	22,398	10,328	182,585	38,690	66,458	8.5	F
23	Fairbanks North Star Borough	AK	98,660	25,640	6,170	1,775	6,482	2,900	1,146	22,185	3,823	7,420	8.3	F
24	Muscatine	IA	42,934	11,301	5,457	538	2,133	1,406	710	11,916	2,352	5,074	7.2	F
25	Philadelphia	PA	1,547,297	362,879	192,683	37,384	110,439	50,004	24,037	413,743	95,348	366,125	7.0	F
25	Sutter	CA	92,614	25,610	11,969	1,699	5,231	2,910	1,462	24,562	6,468	13,511	7.0	F

Notes:

1. Counties are ranked by weighted average. See note 12 below.
2. **Total Population** represents the at-risk populations in counties with $PM_{2.5}$ monitors.
3. Those **18 and under** and **65 and over** are vulnerable to $PM_{2.5}$ and are, therefore, included. They should not be used as population denominators for disease estimates.
4. **Pediatric asthma** estimates are for those under 18 years of age and represent the estimated number of people who had asthma in 2009 based on state rates (BRFSS) applied to population estimates (U.S. Census).
5. **Adult asthma** estimates are for those 18 years and older and represent the estimated number of people who had asthma during 2009 based on state rates (BRFSS) applied to population estimates (U.S. Census).
6. **Chronic bronchitis** estimates are for adults 18 and over who had been diagnosed in 2009, based on national rates (NHIS) applied to population estimates (U.S. Census).
7. **Emphysema** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on national rates (NHIS) applied to population estimates (U.S. Census).
8. Adding across rows does not produce valid estimates, e.g., summing pediatric and adult asthma and/or emphysema and chronic bronchitis.
9. **CV disease** estimates are based on National Heart Lung and Blood Institute (NHLBI) estimates of cardiovascular disease applied to population estimates (U.S. Census).
10. **Diabetes** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
11. **Poverty** estimates come from the U.S. Census Bureau and are for all ages.
12. The **Weighted Average** was derived by counting the number of days in each unhealthful range (orange, red, purple, maroon) in each year (2007-2009), multiplying the total in each range by the assigned standard weights (i.e., 1 for orange, 1.5 for red, 2.0 for purple, 2.5 for maroon), and calculating the average.
13. **Grade** is assigned by weighted average as follows: A=0.0, B=0.3-0.9, C=1.0-2.0, D=2.1-3.2, F=3.3+.

People at Risk in 25 Counties Most Polluted by Year-round Particle Pollution (Annual $PM_{2.5}$)

				At-Risk Groups									$PM_{2.5}$ Annual, 2007–2009	
2011 Rank[1]	County	ST	Total Population[2]	Under 18[3]	65 and Over[3]	Pediatric Asthma[4,8]	Adult Asthma[5,8]	Chronic Bronchitis[6,8]	Emphysema[7,8]	CV Disease[9]	Diabetes[10]	Poverty[11]	Design Value[12]	Grade[13]
1	Kern	CA	807,407	250,561	72,666	16,621	43,747	23,012	10,309	184,959	48,102	170,614	22.6	FAIL
2	Pinal	AZ	340,962	90,261	47,067	7,366	27,072	10,833	5,497	91,770	21,269	44,379	18.8	FAIL
2	Riverside	CA	2,125,440	615,621	245,456	40,837	118,086	64,267	31,066	533,297	139,608	290,003	18.8	FAIL
2	Tulare	CA	429,668	141,279	40,393	9,372	22,622	11,998	5,494	97,299	25,326	97,542	18.8	FAIL
5	Kings	CA	148,764	41,081	11,466	2,725	8,468	4,221	1,721	32,615	8,286	24,546	17.3	FAIL
6	Fresno	CA	915,267	275,906	89,528	18,302	50,145	26,546	12,137	215,107	55,930	192,638	17.1	FAIL
7	Allegheny	PA	1,218,494	242,202	204,401	24,952	88,010	44,083	23,650	383,427	89,816	153,937	17.0	FAIL
8	San Bernardino	CA	2,017,673	601,101	172,905	39,874	111,493	58,546	25,840	467,948	122,008	335,321	16.2	FAIL
9	Los Angeles	CA	9,848,011	2,500,804	1,042,989	165,892	576,310	306,992	141,524	2,496,934	651,091	1,552,196	15.8	FAIL
10	Jefferson	AL	665,027	158,005	90,242	13,551	38,702	22,191	11,187	187,691	59,012	107,081	15.1	FAIL
11	Hamilton	OH	855,062	200,406	115,705	18,790	64,933	28,687	14,447	242,554	65,213	126,872	15.0	PASS
12	Stanislaus	CA	510,385	149,225	53,538	9,899	28,322	15,287	7,192	125,454	32,878	85,583	14.7	PASS
12	Clark	IN	108,634	25,544	14,060	2,495	7,544	3,636	1,809	30,586	7,852	12,743	14.7	PASS
14	Cuyahoga	OH	1,275,709	292,883	194,879	27,461	96,471	44,247	23,347	382,121	102,760	235,014	14.4	PASS
14	Brooke	WV	23,509	4,577	4,557	388	1,659	885	503	7,912	2,504	3,075	14.4	PASS
14	Kanawha	WV	191,663	40,727	31,882	3,454	13,286	6,903	3,738	60,336	19,080	27,060	14.4	PASS
17	Marion	IN	890,879	227,659	96,665	22,236	60,465	27,928	13,035	228,393	57,284	171,860	14.3	PASS
17	Cabell	WV	95,214	19,062	15,496	1,617	6,717	3,341	1,750	28,712	9,053	19,182	14.3	PASS
19	Jefferson	OH	67,691	13,678	12,743	1,282	5,213	2,530	1,430	22,561	6,070	11,524	14.2	PASS
19	Beaver	PA	171,673	34,909	31,392	3,596	12,106	6,388	3,578	56,723	13,375	19,285	14.2	PASS
21	Madison	IL	268,457	61,590	38,074	5,720	18,600	9,147	4,681	77,902	17,531	34,532	14.1	PASS
21	Wayne	MI	1,925,848	487,257	234,767	39,593	143,904	62,834	30,943	526,404	132,430	458,811	14.1	PASS
21	Harris	TX	4,070,989	1,174,860	328,354	96,009	186,211	118,470	51,005	937,343	254,761	686,928	14.1	PASS
24	Butler	OH	363,184	89,746	41,603	8,415	27,375	11,732	5,610	97,011	26,067	46,350	14.0	PASS
24	Berkeley	WV	103,854	25,871	11,828	2,194	6,925	3,363	1,613	27,848	8,781	10,866	14.0	PASS

Notes:

1. Counties are ranked by Design Value. See note 12 below.
2. **Total Population** represents the at-risk populations in counties with $PM_{2.5}$ monitors.
3. Those **18 and under** and **65 and over** are vulnerable to $PM_{2.5}$ and are, therefore, included. They should not be used as population denominators for disease estimates.
4. **Pediatric asthma** estimates are for those under 18 years of age and represent the estimated number of people who had asthma in 2009 based on state rates (BRFSS) applied to population estimates (U.S. Census).
5. **Adult asthma** estimates are for those 18 years and older and represent the estimated number of people who had asthma during 2009 based on state rates (BRFSS) applied to population estimates (U.S. Census).
6. **Chronic bronchitis** estimates are for adults 18 and over who had been diagnosed in 2009, based on national rates (NHIS) applied to population estimates (U.S. Census).
7. **Emphysema** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on national rates (NHIS) applied to population estimates (U.S. Census).
8. Adding across rows does not produce valid estimates, e.g., summing pediatric and adult asthma and/or emphysema and chronic bronchitis.
9. **CV disease** estimates are based on National Heart Lung and Blood Institute (NHLBI) estimates of cardiovascular disease applied to population estimates (U.S. Census).
10. **Diabetes** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
11. **Poverty** estimates come from the U.S. Census Bureau and are for all ages.
12. The **Design Value** is the calculated concentration of a pollutant based on the form of the National Ambient Air Quality Standard, and is used by EPA to determine whether the air quality meets the standard. The source for the Design Values is EPA, communication from the Office of Air Quality Planning & Standards, Mark Schmidt, February 15, 2011.
13. **Grades** are based on EPA's determination of meeting or failure to meet the NAAQS for annual $PM_{2.5}$ levels during 2007-2009. Counties meeting the NAAQS received grades of Pass; counties not meeting the NAAQS received grades of Fail.

People at Risk in 25 Most Ozone-Polluted Counties

				At-Risk Groups							High Ozone Days in Unhealthy Ranges, 2007–2009	
2011 Rank[1]	**County**	**ST**	**Total Population[2]**	**Under 18[3]**	**65 and Over[3]**	**Pediatric Asthma[4,8]**	**Adult Asthma[5,8]**	**Chronic Bronchitis[6,8]**	**Emphysema[7,8]**	**Poverty[9]**	**Weighted Avg.[10]**	**Grade[11]**
1	San Bernardino	CA	2,017,673	601,101	172,905	39,874	111,493	58,546	25,840	335,321	136.8	F
2	Riverside	CA	2,125,440	615,621	245,456	40,837	118,086	64,267	31,066	290,003	126.2	F
3	Kern	CA	807,407	250,561	72,666	16,621	43,747	23,012	10,309	170,614	102.8	F
4	Tulare	CA	429,668	141,279	40,393	9,372	22,622	11,998	5,494	97,542	101.3	F
5	Los Angeles	CA	9,848,011	2,500,804	1,042,989	165,892	576,310	306,992	141,524	1,552,196	91.5	F
6	Fresno	CA	915,267	275,906	89,528	18,302	50,145	26,546	12,137	192,638	58.8	F
7	Sacramento	CA	1,400,949	361,552	157,628	23,984	81,493	44,281	21,049	210,786	42.3	F
8	Kings	CA	148,764	41,081	11,466	2,725	8,468	4,221	1,721	24,546	36.8	F
9	El Dorado	CA	178,447	41,818	21,717	2,774	10,768	6,281	3,177	13,492	35.0	F
10	Nevada	CA	97,751	18,601	18,170	1,234	6,170	3,810	2,163	9,819	30.5	F
11	San Diego	CA	3,053,793	739,625	347,859	49,063	181,385	97,908	46,204	372,782	29.5	F
12	Harris	TX	4,070,989	1,174,860	328,354	96,009	186,211	118,470	51,005	686,928	27.0	F
13	Ventura	CA	802,983	209,334	94,655	13,886	46,559	25,886	12,661	83,323	26.0	F
14	Mariposa	CA	17,792	3,187	3,496	211	1,135	700	401	2,364	24.7	F
15	Placer	CA	348,552	83,608	54,762	5,546	20,640	12,020	6,442	25,053	24.2	F
16	Merced	CA	245,321	78,461	24,167	5,205	13,076	6,948	3,210	59,349	23.8	F
17	Rowan	NC	140,798	33,135	20,938	2,842	8,364	4,817	2,519	22,778	23.7	F
18	San Luis Obispo	CA	266,971	49,825	39,636	3,305	16,962	9,572	4,880	33,198	23.3	F
19	Tarrant	TX	1,789,900	507,390	155,996	41,464	82,590	53,033	23,400	254,582	22.3	F
20	Imperial	CA	166,874	51,337	17,578	3,405	9,042	4,822	2,259	35,368	19.8	F
21	Stanislaus	CA	510,385	149,225	53,538	9,899	28,322	15,287	7,192	85,583	19.3	F
21	Harford	MD	242,514	59,776	29,902	7,135	16,488	8,095	4,027	14,948	19.3	F
21	Mecklenburg	NC	913,639	237,842	78,551	20,398	53,271	27,572	11,905	126,807	19.3	F
24	Hamilton	OH	855,062	200,406	115,705	18,790	64,933	28,687	14,447	126,872	18.7	F
25	Fairfield	CT	901,208	223,771	119,291	26,823	63,497	30,094	15,271	72,291	17.8	F

Notes:
1. Counties are ranked by weighted average.
2. **Total Population** represents the at-risk populations in counties with ozone monitors.
3. Those **18 and under** and **65 and over** are vulnerable to $PM_{2.5}$ and are, therefore, included. They should not be used as population denominators for disease estimates.
4. **Pediatric asthma** estimates are for those under 18 years of age and represent the estimated number of people who had asthma in 2009 based on state rates (BRFSS) applied to population estimates (U.S. Census).
5. **Adult asthma** estimates are for those 18 years and older and represent the estimated number of people who had asthma during 2009 based on state rates (BRFSS) applied to population estimates (U.S. Census).
6. **Chronic bronchitis** estimates are for adults 18 and over who had been diagnosed in 2009, based on national rates (NHIS) applied to population estimates (U.S. Census).
7. **Emphysema** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on national rates (NHIS) applied to population estimates (U.S. Census).
8. Adding across rows does not produce valid estimates, e.g., summing pediatric and adult asthma and/or emphysema and chronic bronchitis.
9. **Poverty** estimates come from the U.S. Census Bureau and are for all ages.
10. The **Weighted Average** was derived by counting the number of days in each unhealthful range (orange, red, purple) in each year (2007-2009), multiplying the total in each range by the assigned standard weights (i.e., 1 for orange, 1.5 for red, 2.0 for purple), and calculating the average.
11. **Grade** is assigned by weighted average as follows: A=0.0, B=0.3-0.9, C=1.0-2.0, D=2.1-3.2, F=3.3+.

Cleanest U.S. Cities for Short-term Particle Pollution (24-hour $PM_{2.5}$)[1]

Metropolitan Statistical Area	Population
Alexandria, LA	154,101
Amarillo, TX	246,474
Asheville-Brevard, NC	442,875
Athens-Clarke County, GA	192,222
Austin-Round Rock-Marble Falls, TX	1,705,075
Bangor, ME	149,419
Billings, MT	154,553
Bloomington-Normal, IL	167,699
Brownsville-Harlingen-Raymondville, TX	416,766
Burlington-South Burlington, VT	208,055
Cape Coral-Fort Myers, FL	586,908
Champaign-Urbana, IL	226,132
Cheyenne, WY	88,854
Colorado Springs, CO	626,227
Corpus Christi-Kingsville, TX	447,111
Farmington, NM	124,131
Fayetteville, NC	360,355
Fort Collins-Loveland, CO	298,382
Greenville-Spartanburg-Anderson, SC	1,264,930
Gulfport-Biloxi-Pascagoula, MS	394,375
Hattiesburg, MS	143,093
Honolulu, HI	907,574
Houma-Bayou Cane-Thibodaux, LA	202,973
Jackson-Yazoo City, MS	568,847
Lafayette-Acadiana, LA	546,834
Lake Charles-Jennings, LA	225,235

Metropolitan Statistical Area	Population
Lake Havasu City-Kingman, AZ	194,825
Lansing-East Lansing-Owosso, MI	523,609
Lincoln, NE	298,012
Longview-Marshall, TX	271,669
McAllen-Edinburg-Pharr, TX	741,152
Mobile-Daphne-Fairhope, AL	591,599
Monroe-Bastrop, LA	202,309
Oklahoma City-Shawnee, OK	1,297,552
Palm Bay-Melbourne-Titusville, FL	536,357
Pensacola-Ferry Pass-Brent, FL	455,102
Pueblo, CO	157,224
Rocky Mount, NC	146,596
Saginaw-Bay City-Saginaw Township North, MI	307,484
Salinas, CA	410,370
San Luis Obispo-Paso Robles, CA	266,971
Santa Fe-Espanola, NM	188,210
Sarasota-Bradenton-Punta Gorda, FL	845,078
Shreveport-Bossier City-Minden, LA	432,060
Spokane, WA	468,684
Springfield, IL	208,182
Springfield, MO	430,900
St. Joseph, MO-KS	126,644
Syracuse-Auburn, NY	725,610
Texarkana, TX-Texarkana, AR	137,486
Tucson, AZ	1,020,200

Note:
1. This list represents cities with the lowest levels of short term $PM_{2.5}$ air pollution. Monitors in these cities reported no days with unhealthful $PM_{2.5}$ levels.

Top 25 Cleanest U.S. Cities for Year-round Particle Pollution (Annual $PM_{2.5}$)[1]

Rank[2]	Design Value[3]	Metropolitan Statistical Area	Population
1	4.2	Cheyenne, WY	88,854
2	4.4	Santa Fe-Espanola, NM	188,210
3	5.6	Tucson, AZ	1,020,200
5	5.8	Great Falls, MT	82,178
5	5.8	Honolulu, HI	907,574
6	5.9	Anchorage, AK	374,553
8	6.0	Albuquerque, NM	857,903
8	6.0	Amarillo, TX	246,474
9	6.3	Redding, CA	181,099
10	6.7	Salinas, CA	410,370
11	6.8	Bismarck, ND	106,286
12	6.9	Boise City-Nampa, ID	606,376
13	7.0	Billings, MT	154,553
18	7.1	Cape Coral-Fort Myers, FL	586,908
18	7.1	Flagstaff, AZ	129,849
18	7.1	Fort Collins-Loveland, CO	298,382
18	7.1	Palm Bay-Melbourne-Titusville, FL	536,357
18	7.1	Sarasota-Bradenton-Punta Gorda, FL	845,078
19	7.2	Claremont-Lebanon, NH-VT	214,431
21	7.4	Port St. Lucie-Sebastian-Vero Beach, FL	541,463
21	7.4	Rapid City, SD	124,766
22	7.5	Duluth, MN-WI	276,368
23	7.8	Fargo-Wahpeton, ND-MN	222,433
26	7.9	Bangor, ME	149,419
26	7.9	Burlington-South Burlington, VT	208,055
26	7.9	Orlando-Deltona-Daytona Beach, FL	2,747,614

Notes:
1. This list represents cities with the lowest levels of annual $PM_{2.5}$ air pollution.
2. Cities are ranked by using the highest design value for any county within that metropolitan area.
3. The **Design Value** is the calculated concentration of a pollutant based on the form of the National Ambient Air Quality Standard, and is used by EPA to determine whether the air quality meets the standard. The source for the Design Values is EPA, communication from the Office of Air Quality Planning & Standards, Mark Schmidt, Febraruy 15, 2011.

Cleanest U.S. Cities for Ozone Air Pollution[1]

Metropolitan Statistical Area	Population
Bismarck, ND	106,286
Brownsville-Harlingen-Raymondville, TX	416,766
Brunswick, GA	103,841
Coeur d'Alene, ID	139,390
Dothan-Enterprise-Ozark, AL	239,475
Duluth, MN-WI	276,368
Fargo-Wahpeton, ND-MN	222,433
Honolulu, HI	907,574
Laredo, TX	241,438
Lincoln, NE	298,012
Monroe-Bastrop, LA	202,309
Naples-Marco Island, FL	318,537
Port St. Lucie-Sebastian-Vero Beach, FL	541,463
Rapid City, SD	124,766
Rochester, MN	185,618
Santa Fe-Espanola, NM	188,210
Savannah-Hinesville-Fort Stewart, GA	417,512
Sioux Falls, SD	238,122
Spokane, WA	468,684
Topeka, KS	230,824

Note:
1. This list represents cities with no monitored ozone air pollution in unhealthful ranges using the Air Quality Index based on 2008 NAAQS.

Cleanest Counties for Short-term Particle Pollution (24-hour $PM_{2.5}$)[1]

County	State	MSAs and Respective CSA[2]
Anchorage Municipality	AK	Anchorage, AK
Baldwin	AL	Mobile-Daphne-Fairhope, AL
Mobile	AL	Mobile-Daphne-Fairhope, AL
Arkansas	AR	
Ashley	AR	
Faulkner	AR	Little Rock-North Little Rock-Pine Bluff, AR
Polk	AR	
Sebastian	AR	Fort Smith, AR-OK
Cochise	AZ	
Mohave	AZ	Lake Havasu City-Kingman, AZ
Pima	AZ	Tucson, AZ
Humboldt	CA	
Monterey	CA	Salinas, CA
San Benito	CA	San Jose-San Francisco-Oakland, CA
San Luis Obispo	CA	San Luis Obispo-Paso Robles, CA
Santa Cruz	CA	San Jose-San Francisco-Oakland, CA
Sonoma	CA	San Jose-San Francisco-Oakland, CA
El Paso	CO	Colorado Springs, CO
Elbert	CO	Denver-Aurora-Boulder, CO
Larimer	CO	Fort Collins-Loveland, CO
Pueblo	CO	Pueblo, CO
Brevard	FL	Palm Bay-Melbourne-Titusville, FL
Citrus	FL	
Escambia	FL	Pensacola-Ferry Pass-Brent, FL
Lee	FL	Cape Coral-Fort Myers, FL
Sarasota	FL	Sarasota-Bradenton-Punta Gorda, FL
Clarke	GA	Athens-Clarke County, GA
Honolulu	HI	Honolulu, HI
Lee	IA	
Van Buren	IA	
Adams	IL	
Champaign	IL	Champaign-Urbana, IL
Jersey	IL	St. Louis-St. Charles-Farmington, MO-IL
Lake	IL	Chicago-Naperville-Michigan City, IL-IN-WI
Lasalle	IL	
McLean	IL	Bloomington-Normal, IL
Sangamon	IL	Springfield, IL
St. Clair	IL	St. Louis-St. Charles-Farmington, MO-IL
Johnson	KS	Kansas City-Overland Park-Kansas City, MO-KS
Linn	KS	Kansas City-Overland Park-Kansas City, MO-KS
Sumner	KS	Wichita-Winfield, KS
Wyandotte	KS	Kansas City-Overland Park-Kansas City, MO-KS
Campbell	KY	Cincinnati-Middletown-Wilmington, OH-KY-IN
Caddo Parish	LA	Shreveport-Bossier City-Minden, LA
Calcasieu Parish	LA	Lake Charles-Jennings, LA
East Baton Rouge Parish	LA	Baton Rouge-Pierre Part, LA
Iberville Parish	LA	Baton Rouge-Pierre Part, LA
Lafayette Parish	LA	Lafayette-Acadiana, LA
Ouachita Parish	LA	Monroe-Bastrop, LA
Rapides Parish	LA	Alexandria, LA
St. Bernard Parish	LA	New Orleans-Metairie-Bogalusa, LA
Tangipahoa Parish	LA	
Terrebonne Parish	LA	Houma-Bayou Cane-Thibodaux, LA
Bristol	MA	Boston-Worcester-Manchester, MA-RI-NH
Essex	MA	Boston-Worcester-Manchester, MA-RI-NH
Middlesex	MA	Boston-Worcester-Manchester, MA-RI-NH
Harford	MD	Washington-Baltimore-Northern Virginia, DC-MD-VA-WV
Cumberland	ME	Portland-Lewiston-South Portland, ME
Hancock	ME	
Kennebec	ME	
Penobscot	ME	Bangor, ME
Piscataquis	ME	
Bay	MI	Saginaw-Bay City-Saginaw Township North, MI
Genesee	MI	Detroit-Warren-Flint, MI
Ingham	MI	Lansing-East Lansing-Owosso, MI
Macomb	MI	Detroit-Warren-Flint, MI
Manistee	MI	
Missaukee	MI	
Buchanan	MO	St. Joseph, MO-KS
Clay	MO	Kansas City-Overland Park-Kansas City, MO-KS
Greene	MO	Springfield, MO

Notes:
1. This list represents counties with the lowest levels of short term $PM_{2.5}$ air pollution. Monitors in these counties reported no days with unhealthful $PM_{2.5}$ levels.
2. MSA and CSA are terms used by the U.S. Office of Management and Budget for statistical purposes. MSA stands for Metropolitan Statistical Area. CSA stands for Combined Statistical Area, which may include multiple metropolitan statistical areas and individual counties.

Cleanest Counties for Short-term Particle Pollution (24-hour $PM_{2.5}$)[1] (cont.)

County	State	MSAs and Respective CSA[2]
Ste. Genevieve	MO	
Adams	MS	
Bolivar	MS	
Forrest	MS	Hattiesburg, MS
Grenada	MS	
Harrison	MS	Gulfport-Biloxi-Pascagoula, MS
Hinds	MS	Jackson-Yazoo City, MS
Jackson	MS	Gulfport-Biloxi-Pascagoula, MS
Jones	MS	
Lee	MS	
Yellowstone	MT	Billings, MT
Buncombe	NC	Asheville-Brevard, NC
Cumberland	NC	Fayetteville, NC
Duplin	NC	
Durham	NC	Raleigh-Durham-Cary, NC
Edgecombe	NC	Rocky Mount, NC
Gaston	NC	Charlotte-Gastonia-Salisbury, NC-SC
Haywood	NC	Asheville-Brevard, NC
Mcdowell	NC	
Rowan	NC	Charlotte-Gastonia-Salisbury, NC-SC
Watauga	NC	
Billings	ND	
Mercer	ND	
Hall	NE	
Lancaster	NE	Lincoln, NE
Scotts Bluff	NE	
Belknap	NH	Boston-Worcester-Manchester, MA-RI-NH
Rockingham	NH	Boston-Worcester-Manchester, MA-RI-NH
Chaves	NM	
Grant	NM	
Lea	NM	
San Juan	NM	Farmington, NM
Sandoval	NM	Albuquerque, NM
Santa Fe	NM	Santa Fe-Espanola, NM
Essex	NY	

County	State	MSAs and Respective CSA[2]
Onondaga	NY	Syracuse-Auburn, NY
St. Lawrence	NY	
Suffolk	NY	New York-Newark-Bridgeport, NY-NJ-CT-PA
Medina	OH	Cleveland-Akron-Elyria, OH
Caddo	OK	
Mayes	OK	
Oklahoma	OK	Oklahoma City-Shawnee, OK
Ottawa	OK	
Linn	OR	
Umatilla	OR	
Union	OR	
Greenville	SC	Greenville-Spartanburg-Anderson, SC
Oconee	SC	Greenville-Spartanburg-Anderson, SC
Spartanburg	SC	Greenville-Spartanburg-Anderson, SC
Brown	SD	
Bowie	TX	Texarkana, TX-Texarkana, AR
Brewster	TX	
Cameron	TX	Brownsville-Harlingen-Raymondville, TX
Harrison	TX	Longview-Marshall, TX
Hidalgo	TX	McAllen-Edinburg-Pharr, TX
Nueces	TX	Corpus Christi-Kingsville, TX
Orange	TX	Beaumont-Port Arthur, TX
Potter	TX	Amarillo, TX
Travis	TX	Austin-Round Rock-Marble Falls, TX
Bristol City	VA	Johnson City-Kingsport-Bristol (Tri-Cities), TN-VA
Frederick	VA	Washington-Baltimore-Northern Virginia, DC-MD-VA-WV
Page	VA	
Bennington	VT	
Chittenden	VT	Burlington-South Burlington, VT
Spokane	WA	Spokane, WA
Campbell	WY	
Converse	WY	
Laramie	WY	Cheyenne, WY
Teton	WY	

Notes:
1. This list represents counties with the lowest levels of short term $PM_{2.5}$ air pollution. Monitors in these counties reported no days with unhealthful $PM_{2.5}$ levels.
2. MSA and CSA are terms used by the U.S. Office of Management and Budget for statistical purposes. MSA stands for Metropolitan Statistical Area. CSA stands for Combined Statistical Area, which may include multiple metropolitan statistical areas and individual counties.

Top 25 Cleanest Counties for Year-round Particle Pollution (Annual $PM_{2.5}$)[1]

2010 Rank[2]	County	ST	Design Value[3]
1	Converse	WY	3.7
2	Laramie	WY	4.2
3	Elbert	CO	4.4
3	Santa Fe	NM	4.4
5	Billings	ND	4.5
6	Lake	CA	4.7
6	Maui	HI	4.7
9	Hancock	ME	4.8
9	Essex	NY	4.8
10	Jackson	SD	4.9
11	Grant	NM	5.0
12	Custer	SD	5.5
13	Pima	AZ	5.6
13	Piscataquis	ME	5.6
13	Campbell	WY	5.6
18	Honolulu	HI	5.8
18	Cascade	MT	5.8
18	St. Lawrence	NY	5.8
19	Anchorage Municipality	AK	5.9
20	Bernalillo	NM	6.0
20	Potter	TX	6.0
20	Ashland	WI	6.0
23	Douglas	CO	6.1
24	Mercer	ND	6.2
24	San Benito	CA	6.2

Notes:

1. This list represents counties with the lowest levels of monitored long term $PM_{2.5}$ air pollution.
2. Counties are ranked by design value.
3. The Design Value is the calculated concentration of a pollutant based on the form of the National Ambient Air Quality Standard, and is used by EPA to determine whether the air quality meets the standard. The source for the Design Values is EPA, communication from the Office of Air Quality Planning & Standards, Mark Schmidt, February 15, 2011.

Cleanest Counties for Ozone Air Pollution[1]

County	State	Metropolitan Statistical Area
Houston	AL	Dothan-Enterprise-Ozark, AL
Navajo	AZ	
Humboldt	CA	
Lake	CA	
Marin	CA	San Jose-San Francisco-Oakland, CA
Mendocino	CA	
San Francisco	CA	San Jose-San Francisco-Oakland, CA
San Mateo	CA	San Jose-San Francisco-Oakland, CA
Santa Cruz	CA	San Jose-San Francisco-Oakland, CA
Siskiyou	CA	
Sonoma	CA	San Jose-San Francisco-Oakland, CA
Montezuma	CO	
Collier	FL	Naples-Marco Island, FL
Columbia	FL	
Holmes	FL	
St. Lucie	FL	Port St. Lucie-Sebastian-Vero Beach, FL
Chatham	GA	Savannah-Hinesville-Fort Stewart, GA
Glynn	GA	Brunswick, GA
Honolulu	HI	Honolulu, HI
Montgomery	IA	
Palo Alto	IA	
Polk	IA	Des Moines-Newton-Pella, IA
Butte	ID	
Kootenai	ID	Coeur d'Alene, ID
Will	IL	Chicago-Naperville-Michigan City, IL-IN-WI
Linn	KS	Kansas City-Overland Park-Kansas City, MO-KS

County	State	Metropolitan Statistical Area
Shawnee	KS	Topeka, KS
Trego	KS	
Ouachita Parish	LA	Monroe-Bastrop, LA
Becker	MN	
Carlton	MN	Duluth, MN-WI
Lyon	MN	
Olmsted	MN	Rochester, MN
Scott	MN	Minneapolis-St. Paul-St. Cloud, MN-WI
St. Louis	MN	Duluth, MN-WI
Lauderdale	MS	
Flathead	MT	
Swain	NC	
Billings	ND	
Burke	ND	
Burleigh	ND	Bismarck, ND
Cass	ND	Fargo-Wahpeton, ND-MN
Dunn	ND	
McKenzie	ND	
Mercer	ND	
Oliver	ND	
Douglas	NE	Omaha-Council Bluffs-Fremont, NE-IA
Lancaster	NE	Lincoln, NE
Sioux	NE	
Eddy	NM	
Grant	NM	
Lea	NM	
Luna	NM	
Santa Fe	NM	Santa Fe-Espanola, NM
Lyon	NV	Reno-Sparks-Fernley, NV
Adair	OK	

County	State	Metropolitan Statistical Area
Cherokee	OK	
Cleveland	OK	Oklahoma City-Shawnee, OK
Dewey	OK	
Ottawa	OK	
Columbia	OR	Portland-Vancouver-Hillsboro, OR-WA
Umatilla	OR	
Custer	SD	
Jackson	SD	
Meade	SD	Rapid City, SD
Minnehaha	SD	Sioux Falls, SD
Brewster	TX	
Cameron	TX	Brownsville-Harlingen-Raymondville, TX
Harrison	TX	Longview-Marshall, TX
Hunt	TX	Dallas-Fort Worth, TX
Webb	TX	Laredo, TX
San Juan	UT	
Uintah	UT	
Page	VA	
Clallam	WA	
Spokane	WA	Spokane, WA
Ashland	WI	
Washington	WI	Milwaukee-Racine-Waukesha, WI
Waukesha	WI	Milwaukee-Racine-Waukesha, WI
Sublette	WY	
Sweetwater	WY	
Uinta	WY	

Note:
1. This list represents counties with no monitored ozone air pollution in unhealthful ranges using the Air Quality Index based on 2008 NAAQS.

Health Effects of Ozone and Particle Pollution

Ozone and particle pollution are the most widespread air pollutants—and among the most dangerous. Recent research has revealed new insights into how they can harm the body—including taking the lives of infants and altering the lungs of children. All in all, the evidence shows that the risks are greater than we once thought.

Recent findings provide more evidence about the health impacts of these pollutants:

- **Ozone pollution can shorten life, a conclusion confirmed by a 2008 scientific review by the National Research Council.**[1] Evidence warns that some segments of the population may face higher risks from dying prematurely because of ozone pollution, including communities with high unemployment or high public transit use and large Black/African-American populations.[2]
- **Good news: Reducing air pollution has extended life expectancy.** Thanks to a drop in particle pollution between 1980 and 2000, life expectancy in 51 U.S. cities increased by 5 months on average, according to a 2009 analysis.[3]
- **Growing evidence shows that diabetics face a greater risk from air pollution than once believed.** Several studies found increased risk of several factors associated with cardiovascular risks in people with diabetes.[4] Some new research with animals indicates that fine particle pollution may impact insulin resistance and other factors.[5]
- **Lower levels of ozone and particle pollution pose bigger threat than previously thought.** A Canadian study showed that levels well below those considered safe for these pollutants triggered asthma attacks and increased the risk of emergency room visits and hospital admissions for children with asthma.[6] Another study found that low levels of these pollutants increased the risk of hospital treatment for pneumonia and chronic obstructive pulmonary disease (COPD).[7]
    - ❖ Busy highways are high risk zones. Not only may they worsen diseases, but some evidence warns that years of breathing the pollution near busy roads may increase the risk of developing chronic diseases.
    - ❖ A growing body of evidence suggests breathing pollution from heavy traffic may cause new cases of asthma in children.[8]
    - ❖ Some emerging research has found particle pollution associated with increasing the risk of new cases of three chronic diseases in adults: adult-onset asthma,[9] diabetes,[10] and COPD, especially in people who already have asthma or diabetes.[11]
    - ❖ Research had already connected pollution from heavy highway traffic to higher risks for heart attack, allergies, premature births and the death of infants around the time they are born.[12] Evidence of the impact of traffic pollution, even in a city with generally "cleaner" air, expanded the concern over the health effects of chronic exposure to exhaust from heavy traffic.[13]

Two types of air pollution dominate the problem in the U.S.: ozone and particle pollution. They aren't the only serious air pollutants: others include carbon monoxide, lead, nitrogen dioxide, and sulfur dioxide, as well as scores of toxins such as mercury, arsenic, benzene, formaldehyde, and acid gases. However, ozone and particle pollution are the most widespread pollutants.

Ozone Pollution

It may be hard to imagine that pollution could be invisible, but ozone is. The most widespread pollutant in the U.S. is also one of the most dangerous.

Scientists have studied the effects of ozone on health for decades. Hundreds of research studies have confirmed that ozone harms people at levels currently found in the United States. In the last few years, we've learned that it can also be deadly.

What Is Ozone?

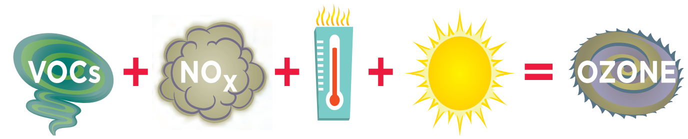
Ozone (O_3) is an extremely reactive gas molecule composed of three oxygen atoms. It is the primary ingredient of smog air pollution and is very harmful to breathe. Ozone attacks lung tissue by reacting chemically with it.

News about ozone can be confusing. Some days you hear that ozone levels are too high and other days that we need to prevent ozone depletion. Basically, the ozone layer found high in the upper atmosphere (the stratosphere) is beneficial because it shields us from much of the sun's ultraviolet radiation. However, ozone air pollution at ground level where we can breathe it (in the troposphere) is harmful. It causes serious health problems.

Where Does Ozone Come From?

What you see coming out of the tailpipe on a car or a truck isn't ozone, but the raw ingredients for making ozone. Ozone is formed by chemical reactions in the atmosphere from two raw gases that do come out of tailpipes, smokestacks and many other sources. These essential raw ingredients for ozone are nitrogen oxides (NO_x) and hydrocarbons, also called volatile organic compounds (VOC_s). They are produced primarily when fossil fuels like gasoline, oil or coal are burned or when some chemicals, like solvents, evaporate.

When NO_x and VOC_s come in contact with both heat and sunlight, they react to form ozone smog. NO_x is emitted from power plants, motor vehicles and other sources of high-heat combustion. VOCs are emitted from motor vehicles, chemical plants, refineries, factories, gas stations, paint and other sources. The formula for ozone is simple, and like any formula, the ingredients must all be present and in the right proportions to make the final product.



You may have wondered why "ozone action day" warnings are sometimes followed by recommendations to avoid activities such as mowing your lawn or refilling your gas tank during daylight hours. Lawn mower exhaust and gasoline vapors are VOCs that help produce ozone in the heat and sun. Take away the sunlight and ozone doesn't form, so refilling your gas tank after dark is better on high ozone days. Since we can't control sunlight and heat, we must reduce the chemical raw ingredients if we want to reduce ozone.

Who Is at Risk from Breathing Ozone?

Five groups of people are especially vulnerable to the effects of breathing ozone:

- children and teens;
- anyone 65 and older;
- people who work or exercise outdoors;
- people with existing lung diseases, such as asthma and chronic obstructive pulmonary disease (also known as COPD, which includes emphysema and chronic bronchitis); and
- "responders" who are otherwise healthy but for some reason react more strongly to ozone.[14]

The impact on your health can depend on many factors, however. For example, the risks would be greater if ozone levels are higher, if you are breathing faster because you're working outdoors or if you spend more time outdoors.

Lifeguards in Galveston, Texas, provided evidence of the impact of even short-term exposure to ozone on healthy, active adults in a study published in 2008. Testing the breathing capacity of these outdoor workers several times a day, researchers found that many lifeguards had greater obstruction in their airways when ozone levels were high. Because of this research, Galveston became the first city in the nation to install an air quality warning flag system on the beach.[15]

How Ozone Pollution Harms Your Health

Breathing ozone can shorten your life. Two early studies published in 2004 found strong evidence of the deadly impact of ozone in cities across the U.S. and in Europe. Even on days when ozone levels were low, the researchers found that the risk of premature death increased with higher levels of ozone. They estimated that over 3,700 deaths annually in the U.S. could be attributed to a 10-parts-per-billion increase in ozone levels.[16] Another study, published the same week, looked at 23 European cities and found similar effects on mortality from short-term exposure to ozone.[17]

Confirmation came in the summer of 2005. Three groups of researchers working independently reviewed and analyzed the research around deaths associated with short-term exposures to ozone. The three teams—at Harvard, Johns Hopkins and New York University—used different approaches but all came to similar conclusions. All three studies reported a small but robust association between daily ozone levels and increased deaths.[18] Writing a commentary on these reviews, David Bates, MD, explained how these premature deaths could occur:

> "Ozone is capable of causing inflammation in the lung at lower concentrations than any other gas. Such an effect would be a hazard to anyone with heart failure and pulmonary congestion, and would worsen the function of anyone with advanced lung disease."[19]

In 2008 a committee of the National Research Council, a division of the National Academy of Sciences, reviewed the evidence again and concluded that "short-term exposure to ambient ozone is likely to contribute to premature deaths." They recommended that preventing early death be included in any future estimates of the benefits of reducing ozone.[20]

New research has begun to identify which groups face higher risk of death from ozone. A study published in 2010 examined records from ten cities in Italy and found women, diabetics and older adults to have a higher risk of premature death from high ozone.[21]

Ozone at levels currently in the U.S. causes immediate health problems. Many areas in the United States produce enough ground-level ozone during the summer months to cause health problems that can be felt right away. Immediate problems—in addition to increased risk of premature death—include:

- shortness of breath;
- chest pain when inhaling;
- wheezing and coughing;
- asthma attacks;
- increased susceptibility to respiratory infections;
- increased susceptibility to pulmonary inflammation; and
- increased need for people with lung diseases, like asthma or chronic obstructive pulmonary disease (COPD), to receive medical treatment and to go to the hospital.[22]

Breathing ozone for longer periods can alter the lungs' ability to function. Two studies published in 2005 explored ozone's ability to reduce the lung's ability to work efficiently, a term called "lung function." Each study looked at otherwise healthy groups who were exposed to ozone for long periods: outdoor postal workers in Taiwan and college freshmen who were lifelong residents of Los Angeles or the San Francisco Bay area. Both studies found that the long exposure to elevated ozone levels had decreased their lung function.[23]

Inhaling ozone may affect the heart as well as the lungs. A 2006 study linked exposures to high ozone levels for as little as one hour to a particular type of cardiac arrhythmia that itself increases the risk of premature death and stroke.[24] A French study found that exposure to elevated ozone levels for one to two days increased the risk of heart attacks for middle-aged adults without heart disease.[25]

New studies warn of serious effects from breathing ozone over longer periods. With more long-term data, scientists are finding that long-term exposure—that is, for periods longer than 8-hours, including days, months or years—may increase the risk of early death. Examining the records from a long-term national database, researchers found a higher risk of death from respiratory diseases associated with increases in ozone.[26] New York researchers looking at hospital records for children's asthma found that the risk of admission to hospitals for asthma increased with chronic exposure to ozone. Younger children and children from low income families were more likely to need hospital admissions even during the same time periods than other children.[27] California researchers digging into data from their long-term Southern California Children's Health Study found that some children with certain genes were more likely to develop asthma as adolescents in response to the variations in ozone levels in their communities.[28]

Breathing other pollutants in the air may make your lungs more responsive to ozone—and breathing ozone may increase your body's response to other pollutants. For example, research warns that breathing sulfur dioxide and nitrogen oxide—two pollutants common in the eastern U.S.—can make the lungs react more strongly to ozone than to just breathing ozone alone. Breathing ozone may also increase the response to allergens in people with allergies. A large study published in 2009 found that children were more likely to suffer from hay fever and respiratory allergies when ozone and $PM_{2.5}$ levels were high.[29]

Even low levels of ozone may be deadly. A large study of 48 U.S. cities looked at the association between ozone and all-cause mortality during the summer months. Ozone concentrations by city in the summer months ranged from 16 percent to 80 percent lower than EPA currently considers safe. Researchers found that ozone at those lower levels was associated with deaths from cardiovascular disease, strokes, and respiratory causes.[30]

Particle Pollution

Ever look at dirty truck exhaust?

The dirty, smoky part of that stream of exhaust is made of particle pollution. Overwhelming evidence shows that particle pollution—like that coming from that exhaust smoke—can kill. Particle pollution can increase the risk of heart disease, lung cancer and asthma attacks and can interfere with the growth and work of the lungs.

What Is Particle Pollution?

Particle pollution refers to a mix of very tiny solid and liquid particles that are in the air we breathe. But nothing about particle pollution is simple. First of all, the particles themselves are different sizes. Some are one-tenth the diameter of a strand of hair. Many are even tinier; some are so small they can only be seen with an electron microscope. Because of their size, you can't see the individual particles. You can only see the haze that forms when millions of particles blur the spread of sunlight. You may not be able to tell when you're breathing particle pollution. Yet it is so dangerous it can shorten your life.

The differences in size make a big difference in how they affect us. Our natural defenses help us to cough or sneeze larger particles out of our bodies. But those defenses don't keep out smaller particles, those that are smaller than 10 microns (or micrometers) in diameter, or about one-seventh the diameter of a single human hair. These particles get trapped in the lungs, while the smallest are so minute that they can pass through the lungs into the bloodstream, just like the essential oxygen molecules we need to survive.

Researchers categorize particles according to size, grouping them as coarse, fine and ultrafine. Coarse particles fall between 2.5 microns and 10 microns in diameter and are called $PM_{10-2.5}$. Fine particles are 2.5 microns in diameter or smaller and are called $PM_{2.5}$. Ultrafine particles are smaller than 0.1 micron in diameter[31] and are small enough to pass through the lung tissue into the blood stream, circulating like the oxygen molecules themselves. No matter what the size, particles can be harmful to your health.

Because particles are formed in so many different ways, they can be composed of many different compounds. Although we often think of particles as solids, not all are. Some are completely liquid; some are solids suspended in liquids. As the U.S. Environmental Protection Agency puts it, particles are really "a mixture of mixtures."[32] The mixtures differ between the eastern and western United States and in different times of the year. For example, the Midwest, Southeast and Northeast states have more sulfate particles than the West on average, largely due to the high levels of sulfur dioxide emitted by large, coal-fired power plants. By contrast, nitrate particles from motor vehicle exhaust form a larger proportion of the unhealthful mix in the winter in the Northeast, Southern California, the Northwest, and North Central U.S.[33]

Where Does Particle Pollution Come From?

Particle pollution is produced through two separate processes—mechanical and chemical.

Mechanical processes break down bigger bits into smaller bits with the material remaining essentially the same, only becoming smaller. Mechanical processes primarily create coarse particles.[34] Dust storms, construction and demolition, mining operations, and agriculture are among the activities that produce coarse particles. Tire, brake pad and road wear can also create coarse particles. Bacteria, pollen, mold, and plant and animal debris are also included as coarse particles.[35]

By contrast, chemical processes in the atmosphere create most of the tiniest fine and ultrafine particles. Combustion sources burn fuels and emit gases. These gases can vaporize and then condense to become a particle of the same chemical compound. Or, they can react with other gases or particles in the atmosphere to form a particle of a different chemical compound. Particles formed by this latter process come from the reaction of elemental carbon (soot), heavy metals, sulfur dioxide (SO_2), nitrogen oxides (NO_x) and volatile organic compounds with water and other compounds in the atmosphere.[36] Burning fossil fuels in factories, power plants, steel mills, smelters, diesel- and gasoline-powered motor vehicles (cars and trucks) and equipment generate a large part of the raw materials for fine particles. So does burning wood in residential fireplaces and wood stoves or burning agricultural fields or forests.

What Can Particles Do to Your Health?

Particle pollution can be very dangerous to breathe. Breathing particle pollution may trigger illness, hospitalization and premature death, risks confirmed in new studies that validate earlier research.[37]

Good news came this year from researchers who looked at the impact of the drop in year-round levels of particle pollution between 1980 and 2000 in 51 US cities. They found that, thanks to reductions in particle pollution, people living in these cities had 5 months added to their life expectancy on average.[38] This study adds to the growing research that cleaning up air pollution improves life and health. Other researchers estimated that reductions in air pollution can be expected to produce rapid improvements in public health, with fewer deaths occurring within the first two years after reductions.[39]

Researchers these days are exploring possible differences in health effects of the three sizes of particles and particles from different sources, such as diesel particles from trucks and buses or sulfates from coal-fired power plants. So far, the evidence remains clear that all particles from all sources are dangerous.[40]

Particle pollution can damage the body in ways similar to cigarette smoking. A recent review of the research on how particles cause harm found that the body responds to particles in similar ways to its response to cigarette smoke. These findings help explain why particle pollution can cause heart attacks and strokes.[41]

Short-Term Exposure Can Be Deadly

First and foremost, short-term exposure to particle pollution can kill. Peaks or spikes in particle pollution can last for hours to days. Deaths can occur on the very day that particle levels are high, or within one to two months afterward. Particle pollution does not just make people die a few days earlier than they might otherwise—these are deaths that would not have occurred if the air were cleaner.[42]

Researchers from Harvard University recently tripled the estimated risk of premature death following a review of the newer evidence from fine particle monitors ($PM_{2.5}$) in 27 US cities.[43]

Particle pollution also diminishes lung function, causes greater use of asthma medications and increased rates of school absenteeism, emergency room visits and hospital admissions. Other adverse effects can be coughing, wheezing, cardiac arrhythmias and heart attacks. According to the findings from some of the latest studies, short-term increases in particle pollution have been linked to:

- death from respiratory and cardiovascular causes, including strokes;[44,45,46,47]
- increased mortality in infants and young children;[48]
- increased numbers of heart attacks, especially among the elderly and in people with heart conditions;[49]
- inflammation of lung tissue in young, healthy adults;[50]
- increased hospitalization for cardiovascular disease, including strokes and congestive heart failure;[51,52,53]
- increased emergency room visits for patients suffering from acute respiratory ailments;[54]
- increased hospitalization for asthma among children;[55,56,57] and
- increased severity of asthma attacks in children.[58]

Again, the impact of even short-term exposure to particle pollution on healthy adults showed up in the Galveston lifeguard study, in addition to the harmful effects of ozone pollution. Lifeguards had reduced lung volume at the end of the day when fine particle levels were high.[59]

Year-Round Exposure

Breathing high levels of particle pollution day in and day out also can be deadly, as landmark studies in the 1990s conclusively showed.[60] Chronic exposure to particle pollution can shorten life by one to three years.[61] Other impacts range from premature births to serious respiratory disorders, even when the particle levels are very low.

Year-round exposure to particle pollution has also been linked to:

- increased hospitalization for asthma attacks for children living near roads with heavy truck or trailer traffic;[62,63]
- slowed lung function growth in children and teenagers;[64,65]
- significant damage to the small airways of the lungs;[66]
- increased risk of dying from lung cancer; and[67]
- increased risk of death from cardiovascular disease.[68]

The evidence warns that the death toll is high. Although no national tally exists, California just completed an analysis that estimates that 9,200 people in California die annually from breathing particle pollution.[69] An updated computer modeling of deaths from pollution caused by coal-fired power plant emissions, exposures which are more predominant outside of California, estimates roughly 13,200 deaths from particle pollution in the Midwest, New England and the Southeast.[70]

Research into the health risks of 65,000 women over age 50 found that those who lived in areas with higher levels of particle pollution faced a much greater risk of dying from heart disease than had been previously estimated. Even women who lived within the same city faced differing risks depending on the annual levels of pollution in their neighborhood.[71]

The Environmental Protection Agency released the most thorough review of the current research on particle pollution in December 2009.[72] The Agency had engaged a panel of expert scientists, the Clean Air Scientific Advisory Committee, to help them assess the evidence, in particular research published between 2002 and May 2009. EPA concluded that particle pollution caused multiple, serious threats to health. Their findings are highlighted in the box below.

EPA Concludes Fine Particle Pollution Poses Serious Health Threats

- Causes early death (both short-term and long-term exposure)
- Causes cardiovascular harm (e.g. heart attacks, strokes, heart disease, congestive heart failure)
- Likely to cause respiratory harm (e.g. worsened asthma, worsened COPD, inflammation)
- May cause cancer
- May cause reproductive and developmental harm

—U.S. Environmental Protection Agency, *Integrated Science Assessment for Particulate Matter*, December 2009. EPA 600/R-08/139F.

Who Is at Risk?

Anyone living in an area with a high level of particle pollution is at risk (you can take a look at levels in your state in this report). People at the greatest risk from particle pollution exposure include those with lung disease such as asthma and chronic obstructive pulmonary disease (COPD), which includes chronic bronchitis and emphysema; people with sensitive airways, where exposure to particle pollution can cause wheezing, coughing and respiratory irritation; the elderly; people with heart disease; and children. New research points to ever-larger groups at higher risk, including diabetics, and most recently, women over 50.[73]

Diabetics face increased risk at least in part because of their higher risk for cardiovascular disease. A 2010 study examined prevalence of diagnosed diabetes in relation to fine particle pollution in 2004-2005. The evidence suggested that air pollution is a risk factor for diabetes.[74] Traffic-related air pollution was implicated in two studies. A German study of nondiabetic women found that new cases of diabetes were more likely as levels of traffic-related pollution and particle pollution increased.[75] A similar finding of an increased risk for diabetes in women who lived near roadways came in a large study of nurses and health professionals, although that study did not find a strong association with levels of particle pollution.[76]

Researchers are identifying increased risk for workers whose jobs expose them to heavy diesel exhaust as a routine part of their job. The risk of dying from lung cancer and heart disease is markedly higher in truck drivers than in the general population in the U.S., according to a study by Harvard University researchers.[77] This study of over 50,000 members of the Teamsters Union employed from 1985 to 2000 looked at the cause of death of workers classified by job category. Truckers are exposed to traffic pollution and diesel engine emissions, while dockworkers are exposed to exhaust from forklifts and trucks in the shipyard. The study found that death rates for heart disease were 49 percent higher among truck drivers, and 32 percent higher among dockworkers than in the general U.S. population. Lung cancer death rates were 10 percent higher in the both the drivers and the dockworkers. Railroad workers have also faced higher risks of death from lung cancer and COPD, according to two studies looking at historical data for those workers. Although these studies examined historical data, both found that even accounting for smoking among the workers, the findings showed the impact of the diesel exposures.[78]

Focusing on Children's Health

Children may look like miniature adults, but they're not. Air pollution is especially dangerous to them because their lungs are growing and because they are so active.

Just like the arms and legs, the largest portion of a child's lungs will grow long after he or she is born. Eighty percent of their tiny air sacs develop after birth. Those sacs, called the alveoli, are where the life-sustaining transfer of oxygen to the blood takes place. The lungs and their alveoli aren't fully grown until children become adults.[79] In addition, the body's defenses that help adults fight off infections are still developing in young bodies.[80] Children have more respiratory infections than adults, which also seems to increase their susceptibility to air pollution.[81]

Furthermore, children don't behave like adults, and their behavior also affects their vulnerability. They are outside for longer periods and are usually more active when outdoors. Consequently, they inhale more polluted outdoor air than adults typically do.[82]

In 2004, the American Academy of Pediatrics issued a special statement on the dangers of outdoor air pollution on children's health, pointing out the special differences for children.[83]

Air Pollution Increases Risk of Underdeveloped Lungs

Another finding from the Southern California Children's Health study looked at the long-term effects of particle pollution on teenagers. Tracking 1,759 children between ages 10 and 18, researchers found that those who grew up in more polluted areas face the increased risk of having underdeveloped lungs, which may never recover to their full capacity. The average drop in lung function was 20 percent below what was expected for the child's age, similar to the impact of growing up in a home with parents who smoked.[84]

Community health studies are pointing to less obvious, but serious effects from year-round exposure to ozone, especially for children. Scientists followed 500 Yale University students and determined that living just four years in a region with high levels of ozone and related co-pollutants was associated with diminished lung function and frequent reports of respiratory symptoms.[85] A much larger study of 3,300 school children in Southern California found reduced lung function in girls with asthma and boys who spent more time outdoors in areas with high levels of ozone.[86]

Cleaning Up Pollution Can Reduce Risk to Children

There is also real-world evidence that reducing air pollution can help protect children. Two studies published in 2005 added more weight to the argument.

Changes in air pollution from the reunification of Germany proved a real-life laboratory. Both East and West Germany had different levels and sources of particles. Outdoor particle levels were much higher in East Germany, where they came from factories and homes. West Germany had higher concentrations of traffic-generated particles. After reunification, emissions from the factories and homes dropped, but traffic increased. A German study explored the impact on the lungs of six-year olds from both East and West Germany. Total lung capacity improved with the lower particle levels. However, for those children living near busy roads, the increased pollution from the increased traffic kept them from benefiting from the overall cleaner air.[87]

In Switzerland, particle pollution dropped during a period in the 1990s. Researchers there tracked 9,000 children over a nine-year period, following their respiratory symptoms. After taking other factors such as family characteristics and indoor air pollution into account, the researchers noted that during the years with less pollution, the children had fewer episodes of chronic cough, bronchitis, common cold, and conjunctivitis symptoms.[88]

Disparities in the Impact of Air Pollution

The burden of air pollution is not evenly shared. Poorer people and some racial and ethnic groups are among those who often face higher exposure to pollutants and who may experience greater responses to such pollution. Many studies have explored the differences in harm from air pollution to racial or ethnic groups and people who are in a low socioeconomic position, have less education, or live nearer to major sources,[89] including a workshop the American Lung Association held in 2001 that focused on urban air pollution and health inequities.[90]

Many studies have looked at differences in the impact on premature death. Results have varied widely, particularly for effects between racial groups. Some studies have found no differences among races,[91] while others found greater responsiveness for Whites and Hispanics, but not Blacks/African-Americans,[92] or for Blacks/African-Americans but not other races or ethnic groups.[93] Other researchers have found greater risk for Blacks/African-Americans from air toxics, including those pollutants that also come from traffic sources.[94]

Socioeconomic position has been more consistently associated with harm from air pollution. Recent studies show evidence of that link. Low socioeconomic status consistently increased the risk of premature death from fine particle pollution among 13.2 million Medicare recipients studied in the largest examination of particle pollution mortality nationwide.[95] In the 2008 study that found greater risk for premature death for Blacks/African-Americans, researchers also found greater risk for people living in areas with higher unemployment or higher use of public transportation.[96] A 2008 study of Washington, DC found that while poor air quality and worsened asthma went hand-in-hand in areas where Medicaid enrollment was high, the areas with the highest Medicaid enrollment did not always have the strongest association of high air pollution and asthma attacks.[97] However, two other recent studies in France have found no association with lower income and asthma attacks.[98]

Scientists have speculated that there are three broad reasons why disparities may exist. First, groups may face greater exposure to pollution because of factors ranging from racism to class bias to housing market dynamics and land costs. For example, pollution sources may be located near disadvantaged communities, increasing exposure to harmful pollutants. Second, low social position may make some groups more susceptible to health threats because of factors related to their disadvantage. Lack of access to health care, grocery stores and good jobs, poorer job opportunities, dirtier workplaces or higher traffic exposure are among the factors that could handicap groups and increase the risk of harm. Finally, existing health conditions, behaviors, or traits may predispose some groups to greater risk. For example, diabetics are among the groups most at risk from air pollutants, and the elderly, Blacks/African-Americans, Mexican-Americans and people living near a central city have higher incidence of diabetes.[99]

Highways May Be Especially Dangerous for Breathing

Being in heavy traffic, or living near a road, may be even more dangerous than being in other places in a community. Growing evidence shows that the vehicle emissions coming directly from those highways may be higher than in the community as a whole, increasing the risk of harm to people who live or work near busy roads.

The number of people living "next to a busy road" may include 30 to 45 percent of the population in North America, according to the most recent review of the evidence. In January 2010, the Health Effects Institute published a major review of the evidence by a panel of expert scientists. The panel looked at over 700 studies from around the world, examining the health effects. They concluded that traffic pollution causes asthma attacks in children, and may cause a wide range of other effects including: the onset of childhood asthma, impaired lung function, premature death and death from cardiovascular diseases, and cardiovascular morbidity. The area most affected, they concluded, was roughly 0.2 mile to 0.3 mile (300 to 500 meters) from the highway.[100]

Children and teenagers are among the most vulnerable—though not the only ones at risk. A Danish study found that long-term exposure to traffic air pollution may increase the risk of developing chronic obstructive pulmonary disease (COPD). They found that those most at risk were people who already had asthma or diabetes.[101] Studies have found increased risk of premature death from living near a major highway or an urban road.[102] Another study found an increase in risk of heart attacks from being in traffic, whether driving or taking public transportation.[103] Urban women in a Boston study experienced decreased lung function associated with traffic-related pollution.[104]

How to Protect Yourself from Ozone, Particle Pollution

To minimize your exposure to ozone and particle pollution:

- Pay attention to forecasts for high air pollution days to know when to take precautions;
- Avoid exercising near high-traffic areas;
- Avoid exercising outdoors when pollution levels are high, or substitute an activity that requires less exertion;
- Do not let anyone smoke indoors and support measures to make all places smokefree; and
- Reduce the use of fireplaces and wood-burning stoves.

Bottom line: Help yourself and everyone else breathe easier. Support national, state and local efforts to clean up sources of pollution. Your life and the life of someone you love may depend on it.

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Methodology

Statistical Methodology: The Air Quality Data

Data Sources

The data on air quality throughout the United States were obtained from the U.S. Environmental Protection Agency's Air Quality System (AQS), formerly called Aerometric Information Retrieval System (AIRS) database. The American Lung Association contracted with Dr. Allen S. Lefohn, A.S.L. & Associates, Helena, Montana, to characterize the hourly averaged ozone concentration information and the 24-hour averaged $PM_{2.5}$ concentration information for the 3-year period for 2007-2009 for each monitoring site.

Design values for the annual $PM_{2.5}$ concentrations by county were collected from data previously summarized by the U.S. Environmental Protection Agency (EPA) and were originally downloaded on October 25, 2010 from EPA's website at http://www.epa.gov/air/airtrends/values.html. However, EPA began reviewing these design values in January, 2011 and provided a draft of the revised design values to the Lung Association by email on February 15, 2011. That set of data became the basis for the data included in this report.

Ozone Data Analysis

The 2007, 2008, and 2009 AQS hourly ozone data were used to calculate the daily 8-hour maximum concentration for each ozone-monitoring site. The hourly averaged ozone data were downloaded on June 29, 2010. The data were considered for a 3-year period for the same reason that EPA uses 3 years of data to determine compliance with the ozone: to prevent a situation in any single year, where anomalies of weather or other factors create air pollution levels, which inaccurately reflect the normal conditions. The highest 8-hour daily maximum concentration in each county for 2007, 2008, and 2009, based on the EPA-defined ozone season, was identified.

The current national ambient air quality standard for ozone is 0.075 ppm measured over 8-hours. Although EPA is reconsidering that standard, the Agency has postponed a final decision until July 2011. EPA's Air Quality Index reflects the 0.075 ppm standard. A.S.L. & Associates prepared a table by county that summarized, for each of the 3 years, the number of days the ozone level was within the ranges identified by EPA based on the EPA Air Quality Index:

8-hour Ozone Concentration	Air Quality Index Levels
0.000 – 0.059 ppm	Good (Green)
0.060 – 0.075 ppm	Moderate (Yellow)
0.076 – 0.095 ppm	Unhealthy for Sensitive Groups (Orange)
0.096 – 0.115 ppm	Unhealthy (Red)
0.116 – 0.374 ppm	Very Unhealthy (Purple)
>0.374 ppm	Hazardous (Maroon)

The goal of this report was to identify the number of days that 8-hour daily maximum concentrations occurred within the defined ranges, not just those days that would fall under the requirements for attaining the national ambient air quality standards. Therefore, no data capture criteria were applied to eliminate monitoring sites or to require a number of valid days for the ozone season. All valid days of data within the ozone season were used in the analysis. However, for computing an 8-hour average, at least 75 percent of the hourly concentrations (i.e., 6-8 hours) had to be available for the 8-hour period. In addition, an 8-hour daily maximum average was identified if valid 8-hour averages were available for at least 75 percent of possible hours in the day (i.e., at least 18 of the possible 24 8-hour averages). Because the EPA includes days with inadequate data if the standard value is exceeded, our data capture methodology may result at times in underestimations of the number of 8-hour averages within the higher concentration ranges. However, our experience is that underestimates are infrequent.

Following receipt of the above information, the American Lung Association identified the number of days each county, with at least one ozone monitor, experienced air quality designated as orange (Unhealthy for Sensitive Groups), red (Unhealthy), or purple (Very Unhealthy).

Short-term Particle Pollution Data Analysis

A.S.L. & Associates identified the maximum daily 24-hour AQS $PM_{2.5}$ concentration for each county in 2007, 2008, and 2009 with monitoring information. The 24-hour $PM_{2.5}$ data were downloaded on August 9, 2010. Using these results, A.S.L. & Associates prepared a table by county that summarized, for each of the 3 years, the number of days the maximum of the ***daily*** $PM_{2.5}$ concentration was within the ranges identified by EPA based on the EPA Air Quality Index, adjusted by the American Lung Association as discussed below:

24-hour $PM_{2.5}$ Concentration	Air Quality Index Levels
0.0 μg/m³ to 15.4 μg/m³	Good (Green)
15.5 μg/m³ to 35.0 μg/m³	Moderate (Yellow)
35.1 μg/m³ to 65.4 μg/m³	Unhealthy for Sensitive Groups (Orange)
65.5 μg/m³ to 150.4 μg/m³	Unhealthy (Red)
150.5 μg/m³ to 250.4 μg/m³	Very Unhealthy (Purple)
greater than or equal to 250.5 μg/m³	Hazardous (Maroon)

In 2006, the EPA revised the 24-hour National Ambient Air Quality standard for $PM_{2.5}$, changing the standard to 35 μg/m³ from 65 μg/m³. As of December 2010, the EPA had not announced changes to the Air Quality Index based on that standard. The Lung Association adjusted the level of the category "Unhealthy for Sensitive Groups" to reflect the 2006 standard, making that category range from 35.1 μg/m³ to 65.4 μg/m³.

The goal of this report was to identify the number of days that the maximum in each county of the ***daily*** $PM_{2.5}$ concentration occurred within the defined ranges, not just those days that would fall under the requirements for attaining the national ambient air quality standards. Therefore, no data capture criteria were used to eliminate monitoring sites. Only 24-hour averaged PM data were used. Included in the analysis are data collected using only FRM and FEM methods, which reported 24-hour averaged data. As instructed by the Lung Association, A.S.L. & Associates included the exceptional and natural events that were identified in the database and identified for the Lung Association the dates and monitoring sites that experienced such events.

Following receipt of the above information, the American Lung Association identified the number of days each county, with at least one $PM_{2.5}$ monitor, experienced air quality designated as orange (Unhealthy for Sensitive Groups), red (Unhealthy), purple (Very Unhealthy) or maroon (Hazardous).

Description of County Grading System

Ozone and short-term particle pollution (24-hour $PM_{2.5}$)

The grades for ozone and short-term particle pollution (24-hour $PM_{2.5}$) were based on a weighted average for each county. To determine the weighted average, the Lung Association followed these steps:

1. First, assigned weighting factors to each category of the Air Quality Index. The number of orange days experienced by each county received a factor of 1; red days, a factor of 1.5; purple days, a factor of 2; and maroon days, a factor of 2.5. This allowed days where the air pollution levels were higher to receive greater weight.
2. Next, multiplied the total number of days within each

category by their assigned factor, then summed all the categories to calculate a total.

3. Finally, divided the total by three to determine the weighted average, since the monitoring data were collected over a three-year period.

The weighted average determined each county's grades for ozone and 24-hour $PM_{2.5}$.

- All counties with a weighted average of zero (corresponding to no exceedances of the standard over the three-year period) were given a grade of "A."
- For ozone, an "F" grade was set to generally correlate with the number of unhealthy air days that would place a county in nonattainment for the ozone standard.
- For short-term particle pollution, fewer unhealthy air days are required for an F than for nonattainment under the $PM_{2.5}$ standard. The national air quality standard is set to allow 2 percent of the days during the 3 years to exceed 35 $\mu g/m^3$ (called a "98th percentile" form) before violating the standard. That would be roughly 21 unhealthy days in 3 years. The grading used in this report would allow only about 1 percent of the days to be over 35 $\mu g/m^3$ (called a "99th percentile" form) of the $PM_{2.5}$. The American Lung Association supports using the tighter limits in a 99th percentile form as a more appropriate standard that is intended to protect the public from short-term spikes in pollution.

Weighted averages allow comparisons to be drawn based on severity of air pollution. For example, if one county had 9 orange days and 0 red days, it would earn a weighted average of 3.0 and a D grade. However, another county which had only 8 orange days but also 2 red days, which signify days with more serious air pollution, would receive a F. That second county would have a weighted average of 3.7.

Grading System

Grade	Weighted Average	Approximate Number of Allowable Orange/Red/Purple/Maroon days
A	0.0	None
B	0.3 to 0.9	1 to 2 orange days with no red
C	1.0 to 2.0	3 to 6 days over the standard: 3 to 5 orange with no more than 1 red OR 6 orange with no red
D	2.1 to 3.2	7 to 9 days over the standard: 7 total (including up to 2 red) to 9 orange with no red
F	3.3 or higher	9 days or more over the standard: 10 orange days or 9 total including at least 1 or more red, purple or maroon

Note that this system differs significantly from the methodology EPA uses to determine violations of both the ozone and the 24-hour $PM_{2.5}$ standards. EPA determines whether a county violates the standard based on the 4th maximum daily 8-hour ozone reading each year averaged over three years. Multiple days of unhealthy air beyond the highest four in each year are not considered. By contrast, the system used in this report recognizes when a community's air quality repeatedly results in unhealthy air throughout the three years. Consequently, some counties will receive grades of "F" in this report, showing repeated instances of unhealthy air, while still meeting EPA's 2008 or 1997 ozone standard. EPA is currently reconsidering the 2008 standard based on evidence that that standard failed to protect the health of the public.

Counties were ranked by weighted average. Metropolitan areas were ranked by the highest weighted average among the counties within a given Metropolitan Statistical Area as of 2009 as defined by the White House Office of Management and Budget (OMB).

Year-round particle pollution (Annual $PM_{2.5}$)

Since no comparable Air Quality Index exists for year-round particle pollution (annual $PM_{2.5}$), the grading was based on

EPA's determination of design value for the national ambient air quality standard for annual $PM_{2.5}$ of 15 μg/m^3, as described earlier. Counties that EPA listed as being at 15.0 μg/m^3 or lower were given grades of "Pass." Counties EPA listed at 15.1 μg/m^3 or higher were given grades of "Fail." Where insufficient data existed for EPA to determine a design value, those counties received a grade of "Incomplete."

Design value is the calculated concentration of a pollutant based on the form of the national ambient air quality standard and is used by EPA to determine whether or not the air quality in a county meets the standard. Counties were ranked by design value. Metropolitan areas were ranked by the highest design value among the counties within a given Metropolitan Statistical Area as of 2009 as defined by the OMB. In 2003, the OMB published revised definitions for the nation's Metropolitan Statistical Areas. Therefore, comparisons between MSAs in the *State of the Air* reports from 2000 to 2003 and the *State of the Air* reports from 2004 and later should be made with caution.

The Lung Association received critical assistance from members of the National Association of Clean Air Administrators, formerly known as the State and Territorial Air Pollution Control Administrators and the Association of Local Air Pollution Control Administrators. With their assistance, all state and local agencies were provided the opportunity to review and comment on the data in draft tabular form. The Lung Association reviewed all discrepancies with the agencies and, if needed, with Dr. Lefohn at A.S.L. and Associates. Questions about the annual PM design values were referred to Mr. Schmidt of EPA, who reviewed and had final decision on those determinations. The American Lung Association wishes to express its continued appreciation to the state and local air directors for their willingness to assist in ensuring that the characterized data used in this report are correct.

Calculations of Populations-at-Risk

Presently county-specific measurements of the number of persons with chronic lung disease and other chronic conditions are not generally available. In order to assess the magnitude of lung disease and other chronic conditions at the state and county levels, we have employed a synthetic estimation technique originally developed by the U.S. Census Bureau. This method uses age-specific national estimates of self-reported lung disease and other conditions to project disease prevalence to the county level. The primary exceptions to this are asthma and diabetes, as state-specific estimates for asthma and diabetes are available through one national survey discussed below, and poverty, for which estimates are available at the county level.

Population Estimates

The U.S. Census Bureau estimated data on the total population of each county in the United States for 2009. The Census Bureau also estimated the age-specific breakdown of the population and how many individuals were living in poverty by county. These estimates are the best information on population demographics available between decennial censuses.

Poverty estimates came from the Census Bureau's Small Area Income and Poverty Estimates (SAIPE) program. SAIPE was created to provide accurate income and poverty estimates between decennial censuses. The program does not use direct counts or estimates from sample surveys, as these methods would not provide sufficient data for all counties. Instead, a model based on estimates of income or poverty from the Annual Social and Economic Supplement (ASEC) to the Current Population Survey (CPS) is used to develop estimates for all states and counties.

Prevalence Estimates

Chronic Bronchitis and Emphysema. In 2009, the National Health Interview Survey (NHIS) estimated the nationwide annual prevalence of diagnosed chronic bronchitis at 9.9 million; the nationwide lifetime prevalence of diagnosed emphysema was estimated at 4.9 million.

Due to the revision of the NHIS questionnaire, prevalence estimates from the *American Lung Association State of the Air 2000* cannot be compared to later publications. Estimates for chronic bronchitis and emphysema can be compared to the *State of the Air* reports for 2001 through 2009. Furthermore, estimates for chronic bronchitis and emphysema should not be combined as they represent different types of prevalence estimates.

Local area prevalence of chronic bronchitis and emphysema are estimated by applying age-specific national prevalence rates from the 2009 NHIS to age-specific county-level resident populations obtained from the U.S. Census Bureau web site. Prevalence estimates for chronic bronchitis and emphysema are calculated for those aged 18-44 years, 45-64 years and 65 years and older.

Asthma and Diabetes. In 2009, the Behavioral Risk Factor Surveillance System (BRFSS) survey indicated that approximately 8.4 percent of adults residing in the United States and 15.4 percent of children from twenty-nine states and Washington, D.C. reported currently having asthma. The BRFSS indicated that 9.0 percent of adults in the United States had ever been diagnosed with diabetes in 2009.

The prevalence estimate for pediatric asthma is calculated for those younger than 18 years; adult asthma and diabetes are calculated for those aged 18-44 years, 45-64 years and 65 years and older. Local area prevalence of pediatric asthma is estimated by applying the most recent state prevalence rates, or if none are available, the national rate from the BRFSS to pediatric county-level resident populations obtained from the U.S. Census Bureau web site. Pediatric asthma data from the 2009 BRFSS were available for twenty-nine states and Washington D.C., eleven states[1] from 2008, and one state each[2] for 2007 and 2006. National data were used for the eight states[3] that had no data available since 2006. Local area prevalence of adult asthma and diabetes is estimated by applying age-specific state prevalence rates from the 2009 BRFSS to age-specific county-level resident populations obtained from the U.S. Census Bureau web site.

Cardiovascular Disease Estimates. All cardiovascular disease estimates are based on the 2005 National Health and Nutrition Examination Survey and were obtained from the National Heart Lung and Blood Institute (NHBLI). According to their estimate, 79.8 million Americans suffer from one or more types of cardiovascular disease, including coronary heart disease, hypertension, stroke and heart failure. Local area prevalence of cardiovascular disease is estimated by applying age-specific prevalence rates for those aged 18-44 years, 45-64 years and 65 years and older., provided by NHLBI, to age-specific county-level resident populations obtained from the U.S. Census Bureau web site.

Limitations of Estimates. Since the statistics presented by the NHIS, BRFSS and NHANES are based on a sample, they will differ (due to random sampling variability) from figures that would be derived from a complete census or case registry of people in the U.S. with these diseases. The results are also subject to reporting, non-response and processing errors. These types of errors are kept to a minimum by methods built into the survey.

Additionally, a major limitation of both surveys is that the information collected represents self-reports of medically diagnosed conditions, which may underestimate disease preva-

1 Arizona, Colorado, Kentucky, Maine, Missouri, New Hampshire, New Mexico, Ohio, Oklahoma, Oregon and Wyoming.
2 Alaska for 2007 and Minnesota for 2006.
3 Alabama, Arkansas, Florida, Massachusetts, North Carolina, South Carolina, South Dakota, and Tennessee.

lence since not all individuals with these conditions have been properly diagnosed. However, the NHIS is the best available source that depicts the magnitude of chronic disease on the national level and the BRFSS is the best available source for state-specific asthma and diabetes information. The conditions covered in the survey may vary considerably in the accuracy and completeness with which they are reported.

Local estimates of chronic diseases are scaled in direct proportion to the base population of the county and its age distribution. No adjustments are made for other factors that may affect local prevalence (e.g. local prevalence of cigarette smokers or occupational exposures) since the health surveys that obtain such data are rarely conducted on the county level. Because the estimates do not account for geographic differences in the prevalence of chronic and acute diseases, the sum of the estimates for each of the counties in the United States may not exactly reflect the national estimate derived by the NHIS or state estimates derived by the BRFSS.

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