

I. Wood Smoke: Introduction



- Wood smoke poses a serious danger to human health. It is known to cause and exacerbate many pulmonary and cardiovascular diseases, and these illnesses are the primary causes of mortality in the U.S.
- Despite convincing scientific evidence of health hazards, most governments have failed to effectively regulate wood burning, and wood smoke now constitutes nearly 30% of airborne particle pollution in a number of urban areas during winter months.
- Human exposure to wood smoke appears to be increasing, as more people are burning wood within or near their homes. The use of wood for heating purposes increases along with fossil fuel prices, especially in forested parts of the country where wood is both accessible and inexpensive.
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of wood smoke from outdoor burning with indoor concentrations of particulates and gases is misunderstood.

- The ability of very fine particles and gases to enter indoor environments from outdoor burning sources is well documented, and dependent upon indoor-outdoor air exchange rates. This means that those who routinely burn wood should be vigilant that they are not polluting their indoor environments to dangerous levels.
- Emissions from wood burning, diesel fuel combustion, coal power plants, and cigarettes contain remarkably similar chemicals. For areas already out of federal compliance with pollution limits from other sources of particles and volatile organic compounds, the additional contribution of wood smoke can produce dangerous conditions.
- Wood smoke from a single source normally creates a plume of visible pollution, also identifiable by its sweetness of smell. Satellite imagery with extraordinary sensitivity can easily track wood smoke many miles from its origin, along with the buildup of haze under still conditions near the source. If the source is within or near an urban block, condominium or townhouse cluster, hundreds of people may be exposed to elevated levels of particles and gases that can diminish lung function and threaten health.
- The U.S. Environmental Protection Agency has primary federal responsibility to regulate air quality, yet this agency has long-neglected the wood-burning problem, leaving it to state, local, and municipal governments.
- This disregard has led to a patchwork quilt of largely ineffective regulation by lower levels of government, and many communities have no health-protective requirements at all. Poorly funded state and local health departments are often responsible for establishing and regulating wood smoke emissions. Many expect the federal government to establish health-protective standards. When the federal government fails to do so, states and local governments must assume the responsibility as an “unfunded mandate.”

THE GROWTH OF RECREATIONAL WOOD BURNING

- Effective regulation might focus on appliance emission standards; maximum health-protective air pollution levels of particles and gases at the user's property boundary; a maximum number of wood-burning devices allowable within buildings, neighborhoods, or cities; and prohibitions against burning during still weather conditions when air pollution can increase rapidly near the ground. The absence of effective legal protection leaves most individuals to fend for themselves in attempts to persuade neighbors to use cleaner sources of fuel such as natural gas, and more efficient burning appliances for heating and cooking, both indoors and outdoors.
- There is some good news. Mandatory wood smoke reduction programs in California have resulted in significant reductions in ambient PM_{2.5} concentrations and a decrease in measured health effects. This is consistent with a large body of data demonstrating that as particulate air pollution declines, public health improves.¹ A number of state and local governments have prohibited burning during still weather patterns, or certain times of the day.
- Decades of research demonstrate that particles with a diameter of 2.5 micrometers or less can enter the respiratory tract. Small particles created by burning wood remain airborne for longer periods of time than larger particles, meaning that they remain available for human inhalation. Small particles can have a strongly negative effect on human health, causing and exacerbating lung diseases, triggering cardiovascular events, cancers, and premature deaths. Health loss can occur at air pollution levels well below regulatory standards.
- **Long-term exposure** is associated with reduced lung function, chronic bronchitis, and even premature death.² Long-term exposure to fine particles (PM_{2.5}) is linked to atherosclerosis (a condition that underlies many cardiovascular diseases), adverse birth outcomes, and childhood respiratory diseases. Additional studies suggest that long-term exposure to PM_{2.5} also increases risks of diabetes, neurodevelopmental abnormalities, and diminished cognitive function.³ Lung cancer is also a risk of long-term exposure to wood smoke.⁴



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- **Short-term exposure** to wood smoke aggravates many types of lung diseases, can cause asthma attacks and acute bronchitis, and may increase susceptibility to respiratory infections.
- Low-level exposure to wood smoke, regardless of its origin, can reduce pulmonary function and lower blood oxygen concentrations. Recent studies show reduced lung function later in life following childhood exposure to wildfire smoke.⁵ Studies also show a higher incidence of breast cancer in women who burn synthetic wood,⁶ and shortened lifespans in women with breast cancer who are exposed to fine particles found in wood smoke.⁷
- Short- and long-term exposures to PM2.5 decrease life expectancy.⁸ A 2017 study of more than 60 million U.S. Medicare beneficiaries found that, for every increase in pollution concentration of 10 $\mu\text{g}/\text{m}^3$ in outdoor PM2.5 (measured as an annual average), mortality increased by 7%. The study included populations from small cities and rural areas. The authors reported that long-term exposure to PM2.5 is associated with an increased risk of death, even at levels below the current regulatory standards.⁹
- The burning of firewood and trash is one of the largest contributors to PM2.5 in many rural, semi-rural, and suburban communities in the U.S.
- Outdoor fireplaces can cause dangerous exposures, especially under still, damp conditions and temperature inversions when smoke continues to concentrate near the ground.
- The history of second-hand cigarette smoke regulation demonstrates that local and state policy efforts are likely to be more successful than federal initiatives. Local and state regulations raised public awareness regarding the health risks of second-hand smoke to non-smokers, increasing support for policy measures to reduce these risks, and changing attitudes and norms regarding the social acceptability of smoking.

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- Local burn-free zones, especially in densely populated environments, could dramatically reduce pollution, exposures and health risks. Wood burning in most societies is viewed as a natural practice to create heat, light, cook food, heat water, and provide a sense of security. Fireplaces, woodstoves, and both indoor and outdoor cooking appliances are often the center of social life and relaxation.
- Wood burning in residential settings has long enjoyed a positive cultural image in the public mind. This favorable impression was reinforced during recent decades of fossil fuel price increases, and by consumer perception that wood burning is both natural and environmentally sustainable.
- The growing scientific consensus that wood smoke causes serious and widespread human illness is disbelieved by many who rely on wood burning for heat or its social comforts at relatively small costs compared with fossil fuels. They believe they have a legitimate right to continue a traditional and natural practice spanning thousands of years. Customary or traditional patterns of wood burning help to explain constituents' resistance to new regulations, and legislators are especially sensitive to their constituents' concerns.

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The report explores efforts in Allegheny County, Pennsylvania,, and in Connecticut to control wood-smoke exposures. It is important to note that Allegheny County has some of the highest levels of particulate air pollution in the U.S.

- This report provides an extensive review of the health effects associated with human exposure to wood smoke. At the present time, there are no accurate estimates of the current number of appliances, frequency of use, or amount of wood burned by geographic location because the data do not exist.
- This report examines state and local government efforts to reduce wood-smoke emissions. As examples, the report explores efforts in Allegheny County, Pennsylvania, and in Connecticut to control wood-smoke exposures. It is important to note that Allegheny County has some of the highest levels of particulate air pollution in the U.S. The report ends with recommendations to reduce exposures from wood-smoke emissions for all levels of government, as well as for individuals.
- The research presented in this report concludes that the health risks associated with wood-smoke exposure are serious. Finally, the report suggests a variety of policy and behavioral changes that could significantly reduce human exposures and health loss from inhaling wood smoke.

THE HARMFUL EFFECTS OF WOOD SMOKE AND



- Individuals should use natural gas-burning appliances instead of wood-burning ones. Even a cleaner or newer wood-burning stove will not necessarily improve the PM levels in your home. The U.S. Department of Energy found that about a third of homes that replaced their wood-burning device did not see indoor air quality improvements. A natural gas stove, if properly vented, will reduce emissions.
- Individuals should avoid burning wood. If they must, they should burn only clean, dry wood. Never burn trash. Most household waste is primarily comprised of plastics, which emit highly toxic compounds. Do not burn building debris, pressure-treated wood, or wood containing waxes, adhesives, or other dangerous additives. Synthetic logs should also be avoided.
- Individuals need to make sure that their wood-smoke emissions are not harming others. If their wood burning is harming others, they need to shut down the wood-burning appliance.
- Individuals should reduce all wood-smoke exposures. If wood smoke enters your home on a regular basis, you and your family need to get out of the smoke. Ask your neighbors to reduce the wood-smoke emissions that are harming you. If that fails, ask your local health department for enforcement help. If others are being harmed by the wood smoke, invite them to join you in asking for enforcement. If all fails, you may consider moving your residence. Obviously, nothing is more important than your family's health.
- Individuals who are experiencing wood smoke in their homes should purchase a HEPA filter while waiting for enforcement. A 2016 study by the Department of Energy found significant benefits from using high-efficiency HEPA air filters to reduce PM from wood smoke in homes. These filters, if properly sized for the volume of space you normally occupy, can reduce indoor particle pollution by as much as 60%.²⁶⁴
- Individuals should work to get their towns to pass ordinances that better protect people from being harmed by other people's wood burning.