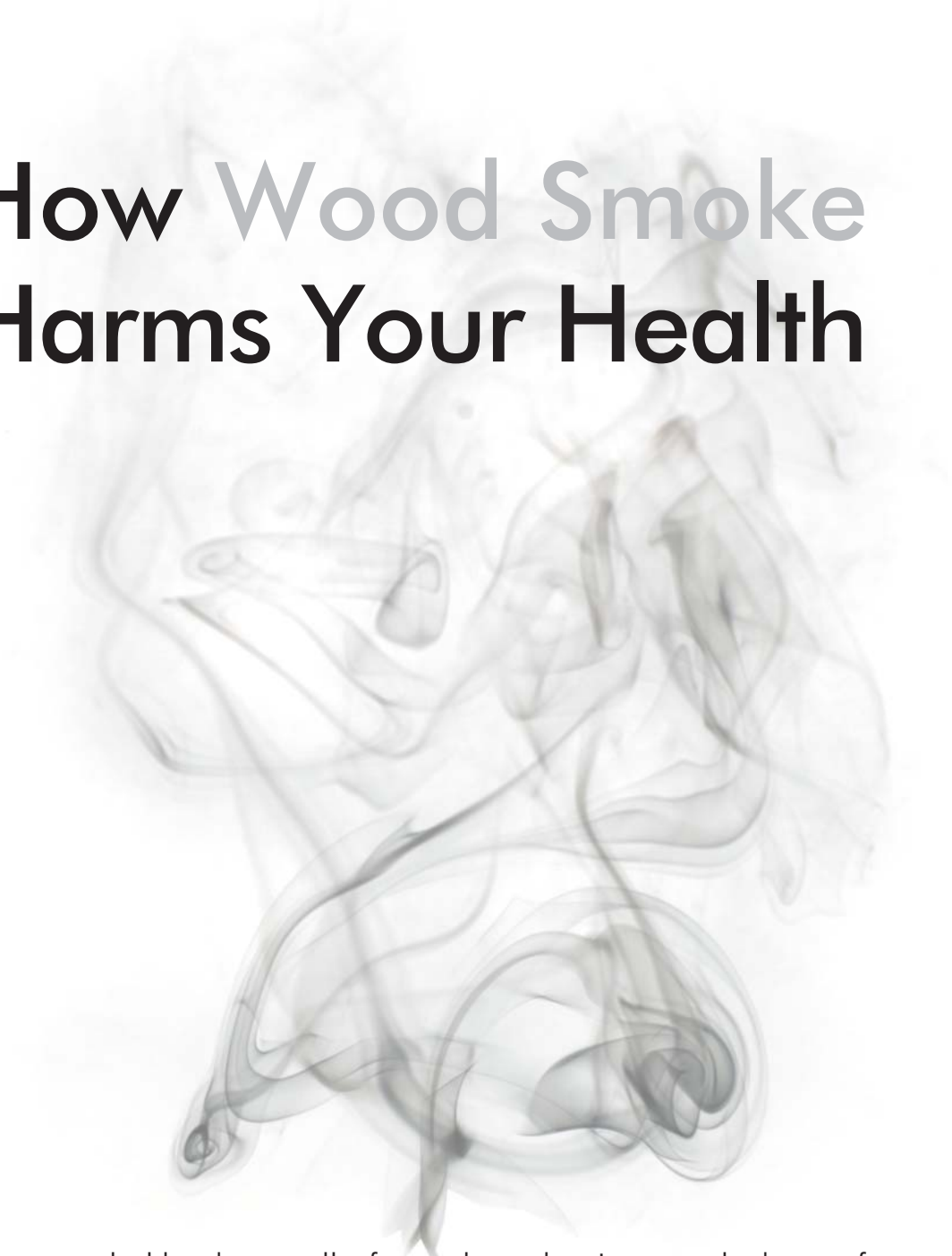
How Wood Smoke Harms Your Health



Some people like the smell of wood smoke. It reminds them of crisp fall days and winter evenings beside a cozy fire. Most people don't realize this smell is a danger sign that means their health is being affected as if they were breathing cigarette smoke. Wood smoke is especially harmful to children, the elderly, and people with lung and heart disease.

This booklet discusses how wood smoke affects our health.

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Why is Wood Smoke a Problem?

Many people believe that since wood smoke is a natural substance, it is not harmful. However, smoke from wood stoves and fireplaces is a major part of Washington's air pollution problem. Wood smoke contains tiny particles and gases that can have serious health effects when breathed.

When people use wood stoves and fireplaces, chemicals are released into the air. Some of these chemicals are poisonous, some irritate the respiratory tract (*see Figure 2*), and some may cause cancer. Wood smoke is more of a problem in the winter when cold, stagnant air prevents it from rising and dispersing. As wood burning increases during these cold periods, the pollutants in the smoke are trapped near the ground. In neighborhoods where wood is burned, houses can have higher indoor smoke levels than houses in neighborhoods where wood is not burned. The smoke from your neighbor's wood stove can seep into your house even when your doors and windows are closed; so even if you don't use a wood stove or fireplace, you are breathing smoke.

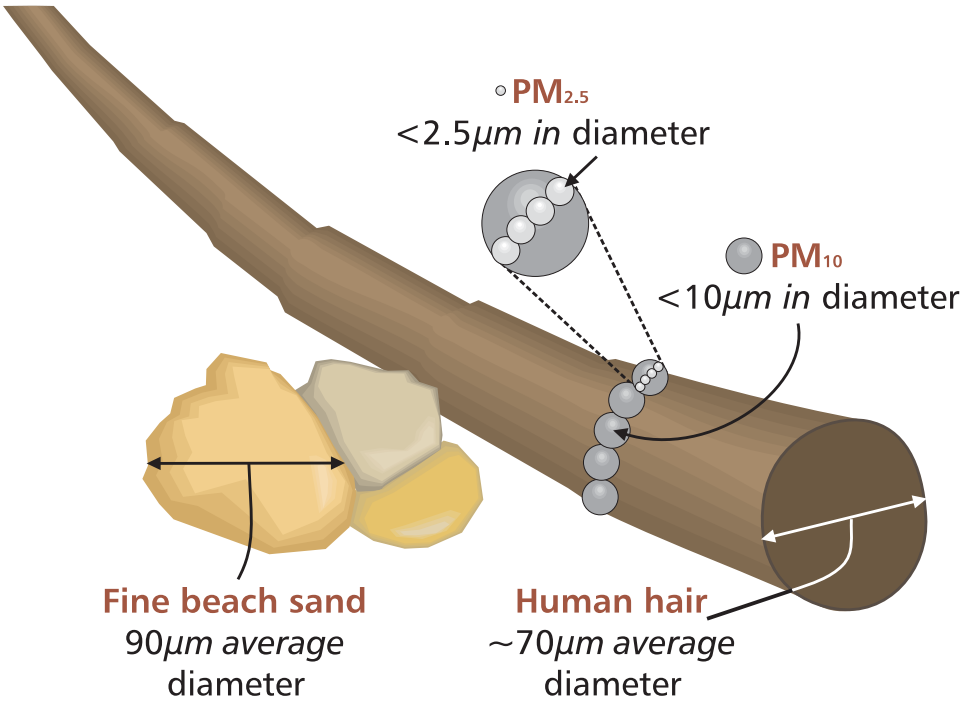
What's in Wood Smoke and How it is Harmful

Wood smoke is a mixture of solids, gases, and liquids. Much like cigarette smoke, wood smoke contains hundreds of air pollutants that can cause cancer and other health problems. One of these pollutants that is of most concern is fine particles.

The particles in smoke are tiny bits of solids and liquids made of partially burned wood. When you breathe air with wood smoke in it, you inhale the fine particles deeply into your lungs. The particles contain toxic substances that can remain in your lungs for months, causing changes that lead to diseases and structural damage.

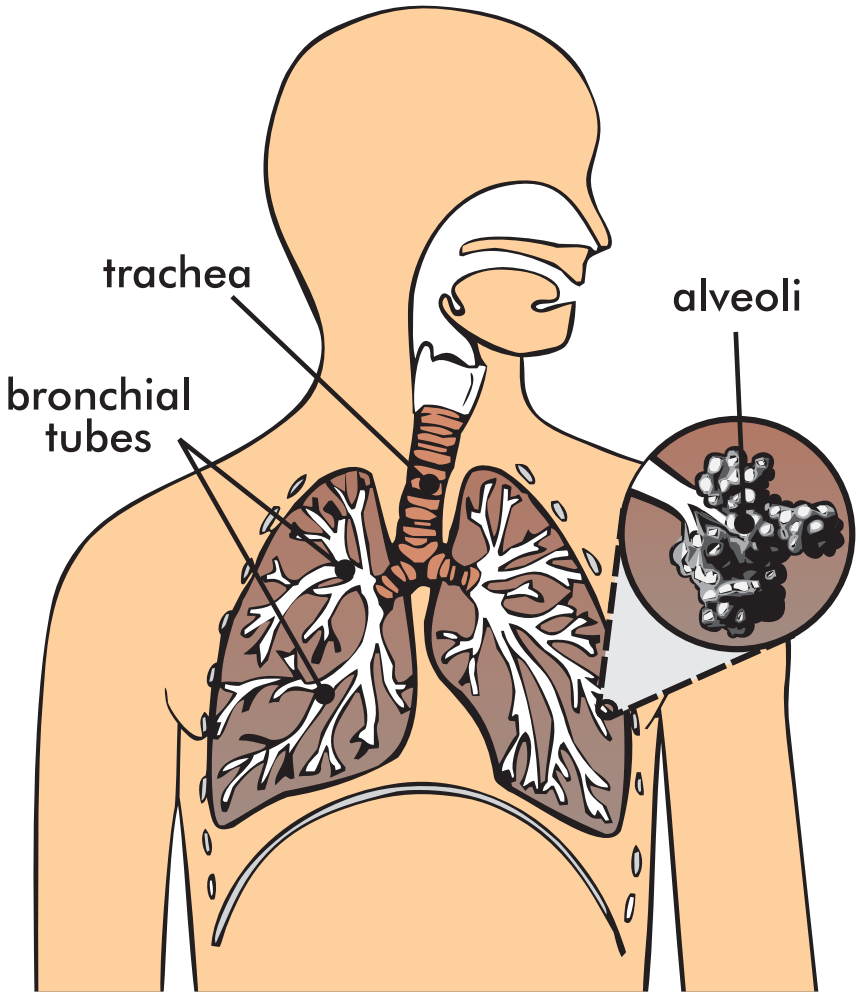
Most wood smoke particles are 2.5 microns (µm) or less in size – smaller in diameter than a human hair (*Figure 1).*

Figure 1: Comparison of a human hair to a grain of sand to wood smoke particles



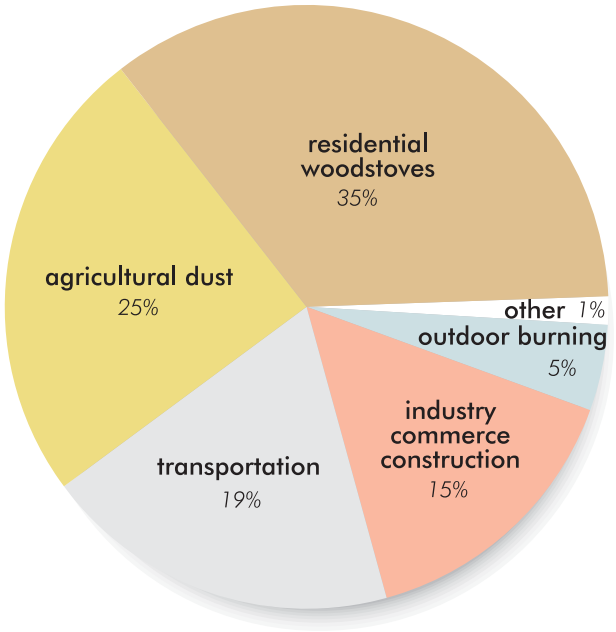
Scientists call these particles PM2.5, also known as "fine particles." These tiny particles are so small that they get past the respiratory tract's defenses and reach the deepest areas of the lungs (the *alveoli*, which are tiny air sacs where oxygen enters the blood stream) (*Figure 2*).

Figure 2: The human respiratory tract



Residential wood burning greatly increases the amount of fine particles in the air. Studies have shown that fine particles, even at low levels, are harmful to human health.[1] Since research shows that most of Washington's wintertime fine particle pollution comes from wood smoke (*see Figure 3*), many of the health effects caused by fine particles may be related to wood smoke.

Figure 3: Statewide sources of fine particle pollution in Washington, Winter 2012[2]



Many other harmful substances, such as toxic *organic chemicals*, can be carried into the lungs by fine particles. An organic chemical is any chemical made of both carbon and hydrogen. Many organic chemicals in wood smoke contribute to health problems in the respiratory tract. Examples of harmful organic chemicals in wood smoke include:

- benzene,
- formaldehyde,
- acetaldehyde,
- acrolein, and
- polycyclic aromatic hydrocarbons (PAHs).

General Health Effects of Wood Smoke

Breathing wood smoke can have short- and long-term effects. Some of the short-term effects may be:

- irritated eyes, throat, sinuses, and lungs;
- headaches;
- reduced lung function, especially in children;
- lung inflammation or swelling;
- increased risk of lower respiratory diseases;
- more severe or frequent symptoms from existing lung diseases (such as asthma, emphysema, pneumonia, and bronchitis); and
- risk of heart attack and stroke.

Some long-term effects can be:

- chronic lung disease including bronchitis and emphysema;
- chemical and structural changes in lungs; and
- cancer.

Adults with normal health generally have better resistance to most effects of wood smoke. However, they may feel short of breath and notice it is more difficult to exercise. They may also notice irritated eyes, sore throats, phlegm, chest tightness, headaches, and allergy symptoms. Although anyone can have health effects from wood smoke, those most likely to be affected even at low levels are:

- infants and children,
- the elderly, and
- adults with existing heart or lung conditions.[3]

Infants and children: Children breathe more air in proportion to their size than adults. Their lungs are also still developing. Because of this, children can experience more health effects from polluted air than adults. Children who regularly breathe wood smoke are more likely to have shortness of breath, coughing, wheezing, asthma, disrupted sleep, inflamed respiratory tracts, and pneumonia.

University of Washington researchers have found more symptoms of respiratory disease in Seattle preschool children living in residential areas with high levels of wood smoke than in children living in areas with lower wood smoke levels.[4] Other studies have found that use of wood stoves increases the risk of lower respiratory tract infections such as bronchiolitis and pneumonia in young children.[5,6,7] Childhood lower respiratory tract infections have been linked with chronic lung disease later in life.[8]

The elderly: Older adults are at greater risk from wood smoke if they have common chronic health problems, which can be worsened by exposure to fine particles. Studies show lower heart rate variability (meaning the heart is less able to respond to changes in activity levels) when people breathe increased levels of fine particle air pollution.[9] Young people and older adults are more susceptible to this.[10]

Adults with existing heart or lung conditions: People with existing heart or lung conditions, as well as smokers and ex-smokers, have less resistance to the effects of wood smoke. They may have more severe symptoms of their existing condition(s). For example, wood smoke worsens asthma, emphysema, pneumonia, and bronchitis.

How Much Wood Smoke Are You Exposed To?

Both the amount of wood smoke you are exposed to and the levels of harmful chemicals in the smoke depend on:

- how well the wood is burning (smoldering versus burning hot);
- how quickly the smoke rises and spreads; and
- the amount of time you spend breathing wood smoke, both indoors and outdoors.

How well the wood is burning

How well the wood burns depends on:

- the type of wood burning device;
- temperature and amount of oxygen; and
- moisture content of the wood.

Type of wood burning device: There are hundreds of models of wood stoves. They may operate differently based on altitude and chimney conditions, which vary from home to home. Using proper operating techniques, newer, certified wood stoves burn more cleanly than older, uncertified stoves. A stove should also be the right size for the home and properly installed.

There are also wide variations in the way different people operate wood burning devices. (See the section "*What Can You Do*" for information about how to burn properly.)

Temperature and amount of oxygen: The hotter the fire, the less smoke and pollution it produces and the more efficiently it heats your home. Even though a smoldering fire may use less wood, it produces less heat and more smoke. Fires that are getting enough oxygen burn hotter than those that don't get enough. Burning moist wood, overloading the firebox, or not giving your fire enough air all greatly increase the fine particle pollution.[11, 12] When fire tempera-

ture is higher, more of the smoke itself burns so that less visible smoke is produced. Hotter fires release more of the energy that is stored in the wood.

Moisture content of the wood: Wood burns best if its moisture content is 20 percent or less. Wood that is split, stacked, covered, and then dried for at least a year burns best.

How well smoke rises and spreads

Since people burn more when it is cold, wood smoke is mainly a problem in the winter. Winter weather conditions involving stagnant air and temperature inversions limit air movement, trap air pollution close to the ground, and keep the air pollution in our breathing space.

A study done in Seattle during the winters of 2001-2005 is an example of winter wood smoke problems. This study showed wood smoke added to fine particle levels. Fine particle levels were highest in neighborhoods where residential wood burning occurred. The study's residential site had a much higher increase in fine particles from wood smoke (67 percent increase) compared to a site in the business district (9 percent increase).[13]

In a study done in a Tacoma neighborhood, the amount of fine particles (averaged over a full year) from wood smoke increased by nearly 52 percent. On some days, residential wood burning was the cause of as much as 90 percent of fine particle pollution in this neighborhood.[14]

The amount of time you spend around wood smoke

Wood stove use worsens air quality, both inside and outside. Wood smoke does not rise and spread during winter temperature inversions. It hangs close to the ground and enters neighbors' yards and houses, schools, hospitals, etc. Downwind areas, areas with temperature inversions, and valleys with poor air circulation are most affected. Wood smoke particles are so tiny that they remain in the air for long periods and easily get into buildings with incoming cold air. The

amount of wood smoke we breathe depends on how much time we spend outdoors during smoky conditions and how much smoke is indoors when we are there.

In houses without current wood burning, fine particle levels are usually lower than outdoor levels. But in areas with high levels of wood smoke, even houses not using wood stoves or fireplaces have higher indoor wood smoke levels. [15] Indoor fine particle levels from wood smoke in homes without wood stoves can be 50 to 70 percent of outdoor levels, according to a study in Seattle.[16]

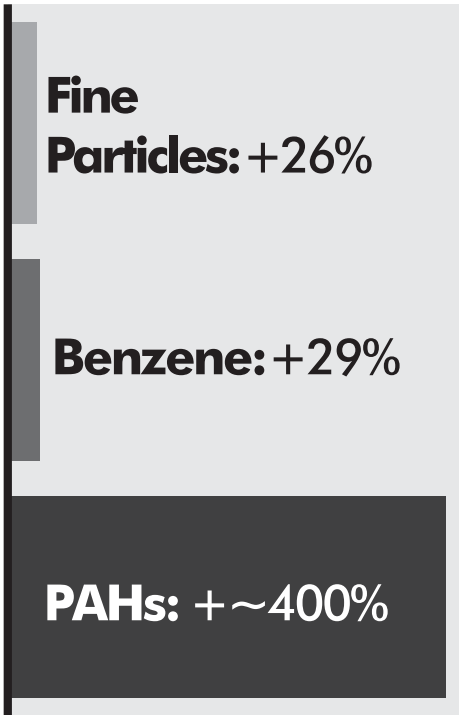
Both drafty houses and air-tight houses with indoor/outdoor air exchange allow wood smoke to come inside.[17]

During the winter months, Seattle residents spend roughly 90 percent of their time indoors. In one study, 64% of outdoor fine particle pollution came indoors.[18]

How much air pollution is in the house with a working stove?

Figure 4 shows the increased amount of pollution in homes that heat with wood compared to those that don't. Houses using wood heat have higher levels of fine particles, benzene, PAHs, and other chemicals. For example, a study showed that average fine particle levels were up to 26 percent higher in wood-burning houses compared to non-wood burning houses.[17] Benzene levels were 29 percent higher.[19] Average levels of cancer-causing PAHs were 300 to 500 percent higher.[20]

Figure 4: Pollutant increases inside wood-heated homes



Health Costs of Wood Smoke

Many national and international studies show that higher levels of fine particles in the air are associated with diseases and premature deaths. In 2009, Ecology analyzed the health and economic impacts of fine particle pollution, including wood smoke, in Washington.[21] Ecology's analysis estimates that fine particle pollution causes about 1,100 deaths in Washington each year. In addition, the analysis shows that every year in Washington, fine particle pollution contributes to health problems as shown in the table below:

Health Problem	Approximate Number of Cases
Worsened asthma symptoms	Thousands
Acute bronchitis	1,900
Non-fatal heart attacks	1,500
Heart disease not resulting in heart attacks	450
Emergency room visits for asthma	400
Pneumonia	250
Chronic lung disease	100

Ecology estimates that the total cost of these diseases (not counting premature deaths) for citizens, businesses, and state health care institutions is about $190 million each year.[21] Total cost includes medical care, prescription drugs, reduced productivity, lost work time, and missed school days.

What Can You Do?

When choosing how to heat your home:

- Be sure your house is properly weatherized to keep in heat.
- Instead of wood heat, consider cleaner heating fuels such as gas, electricity, or heating oil.

If you must burn wood:

Burn dry wood:

- Split wood before you stack it. Wood pieces 3½ to 6 inches in diameter dry easiest and burn best.
- Stack wood loosely in alternating directions to help it dry.
- Store wood at least 6 inches off the ground to reduce exposure to ground moisture.
- Cover your wood to protect it from the weather.
- Give it a year. Wood that has been split, dried, and stored under cover for at least a year burns best.

Burn properly:

- Build small fires to help the wood burn completely. Adding too much wood at one time cuts down on the air to the fire and leaves unburned wood.
- Keep your fire hot. Dampering down your stove cuts off the air, which wastes wood, creates a lot of smoke, and produces very little heat.

Check your chimney smoke:

- If you can see smoke coming from your chimney, you're wasting fuel and your fire needs more air and/or drier wood.

Use the right wood stove, pellet stove, or fireplace for your home:

- Use a wood stove or pellet stove that is certified in Washington, the right size, and properly installed. For details, go to the Ecology's web site at *www.ecy.wa.gov/programs/air/airhome.html*.

Obey burn bans:

- Go to *www.waburnbans.net* to see if there is a burn ban where you live. If there is, don't burn. Burning during a ban can harm your family's and your neighbors' health or cause a fire danger. It is also illegal and you can get a fine.

If wood smoke is a problem in your neighborhood:

Reduce the amount of smoke you breathe by:

- Exercising or doing other physical activities at times when less smoke is in the air;
- Choosing a less strenuous activity when the air is smoky (for example, walking instead of jogging);
- Exercising for shorter periods of time when the air is smoky;
- Closing windows, vents, doors, and plugging drafts.

Some local governments have enacted "nuisance laws" to deal with problems such as illegal burning, dust, and odors. If smoke or other air pollution is affecting you, contact your local clean air agency to ask about nuisance laws in your area.

Any time:

- When using air cleaners in your home, make sure they have high efficiency particulate-absorbing (HEPA) filters. Find information about air cleaners and filters at *www.arb.ca.gov/research/indoor/particles.htm*.
- Use a vacuum cleaner that has a HEPA filter.
- Make sure filters are clean.
- For information about cleaner sources of heat: *http://www.commerce.wa.gov/Programs/Energy/Pages/default.aspx*.

For more information, contact:

Department of Ecology, *Air Quality Program,*
email: *AQcomments@ecy.wa.gov*; phone: *360-407-6800*

Washington clean air agencies online:
http://www.ecy.wa.gov/programs/air/local.html.

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