SIDS,

Home Air Pollution,

Alternative Heating Methods,

and

Infant Safe Sleep

A Resource Guide for Service Providers

Health and Community Services

Healthy Babies Healthy Start in Kalamazoo, Michigan

Kalamazoo County FIMR Fetal-Infant Mortality Review Program

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COMMUNITY HEALTH BUREAU

Healthy Babies-Healthy Start Project
(269) 373-5162

Healthy Babies-Healthy Start is a community collaboration to lower the community's infant mortality rate. It is supported in part by Project H49MC00047-05-00 from the Healthy Start Initiative, Maternal and Child Health Bureau, Health Resources and Services Administration, the Department of Health and Human Services.

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As winter approaches, we begin to seal up our homes. Screens are exchanged for storm windows, drafty doors are weatherstripped, and we hear the familiar refrain, "Close the door – we're not heating the outside!" The inside air doesn't get freshened in winter like it does in the summer. There have been research studies which link indoor air pollution with an increased risk for Sudden Infant Death Syndrome (SIDS). Kalamazoo County FIMR data consistently show an increase in infant deaths in the winter months.

With heating costs going up, we could see more alternative kinds of home heating as consumers look for less expensive ways to stay warm . Fireplaces, stoves, kerosene heaters, and such could substantially contribute to the risk posed by indoor air pollution.

If cigarettes are being used in the family, encourage the smokers to go outside or into the garage. Second hand tobacco smoke inside the home, particularly in winter, is very harmful to the infant.

Infant Safe Sleep

Let's review the **seven** steps for Safe Sleep for a baby:

1. Baby sleeps by him or herself in a crib, portable crib, or bassinet.
2. Always put baby to sleep on his or her back even when he can roll over.
3. Nothing in sleep area. No pillows, blankets, comforters, stuffed animals, or other soft things.
4. Keep baby's face uncovered during sleep for easy breathing. Use a sleeper instead of a blanket.
5. Don't allow anyone to smoke anything around baby.
6. Don't overheat the baby. Dress the baby in as much or as little clothing as you are wearing.
7. Use a firm mattress with a tightly fitted sheet.

This guide was assembled for health care and human service providers. It is not intended to be a definitive guide. ***For additional assistance, contact the friendly Human Service Specialist at the Kalamazoo County Health and Community Services Department Community Action Agency at 269-373-5066.***

Babies are dying because they are put to sleep in places that are not safe.

Parents whose babies have died want other parents to know:

- Babies are not safe sleeping on a couch, pillow, or anything soft.
- Babies are not safe sleeping with other children, adults, or pets.
- Adult beds are not safe for babies. If you feed your baby in bed, put your baby back into his/her crib to sleep.

Consumer Product Safety Commission

What You Should Know About Combustion Appliances and Indoor Air Pollution

CPSC Document #452

Hazards may be associated with almost all types of appliances. The purpose of this booklet is to answer some common questions you may have about the potential for one specific type of hazard - indoor air pollution - associated with one class of appliances - combustion appliances.

Combustion appliances are those which burn fuels for warmth, cooking, or decorative purposes. Typical fuels are gas, both natural and liquefied petroleum (LP); kerosene; oil; coal; and wood. Examples of the appliances are space heaters, ranges, ovens, stoves, furnaces, fireplaces, water heaters, and clothes dryers. These appliances are usually safe. However, under certain conditions, these appliances can produce combustion pollutants that can damage your health, or even kill you.

POSSIBLE HEALTH EFFECTS range from headaches, dizziness, sleepiness, and watery eyes to breathing difficulties or even death. Similar effects may also occur because of common medical problems or other indoor air pollutants.

This booklet was written:

- to encourage the proper use, maintenance, and installation of combustion appliances;
- to discuss the pollutants produced by these appliances;
- to describe how these pollutants can affect your health; and,
- to tell you how you can reduce your exposure to them.

Should I be concerned about indoor air pollution?

YES. Studies have shown that the air in our homes can be even more polluted than the outdoor air in big cities. Because people spend a lot of time indoors, the quality of the air indoors can affect their health. Infants, young children and the elderly are a group shown to be more susceptible to pollutants. People with chronic respiratory or cardiovascular illness or immune system diseases are also more susceptible than others to pollutants.

Many factors determine whether pollutants in your home will affect your health. They include the presence, use, and condition of pollutant sources, the level of pollutants both indoors and out, the amount of ventilation in your home, and your overall health.

Most homes have more than one source of indoor air pollution. For example, pollutants come from tobacco smoke, building materials, decorating products, home furnishings, and activities such as cooking, heating, cooling, and cleaning. Living in areas with high outdoor levels of pollutants

usually results in high indoor levels. Combustion pollutants are one category of indoor air pollutants.

What are combustion pollutants?

Combustion pollutants are gases or particles that come from burning materials. The combustion pollutants discussed in this booklet come from burning fuels in appliances. The common fuels burned in these appliances are natural or LP gas, fuel oil, kerosene, wood, or coal. The types and amounts of pollutants produced depend upon the type of appliance, how well the appliance is installed, maintained, and vented, and the kind of fuel it uses. Some of the common pollutants produced from burning these fuels are carbon monoxide, nitrogen dioxide, particles, and sulfur dioxide. Particles can have hazardous chemicals attached to them. Other pollutants that can be produced by some appliances are unburned hydrocarbons and aldehydes.

Combustion always produces water vapor. Water vapor is not usually considered a pollutant, but it can act as one. It can result in high humidity and wet surfaces. These conditions encourage the growth of biological pollutants such as house dust mites, molds, and bacteria.

Where do combustion pollutants come from?

Combustion pollutants found indoors include: outdoor air, tobacco smoke, exhaust from car and lawn mower internal combustion engines, and some hobby activities such as welding, woodburning, and soldering. Combustion pollutants can also come from vented or unvented combustion appliances. These appliances include space heaters, gas ranges and ovens, furnaces, gas water heaters, gas clothes dryers, wood or coal-burning stoves, and fireplaces. As a group these are called "combustion appliances."

What is a vented appliance?
What is an unvented appliance?

Vented appliances are appliances designed to be used with a duct, chimney, pipe, or other device that carry the combustion pollutants outside the home. These appliances can release large amounts of pollutants directly into your home, if a vent is not properly installed, or is blocked or leaking.

Unvented appliances do not vent to the outside, so they release combustion pollutants directly into the home.

Look at the box below for typical appliance problems that cause the release of pollutants in your home. Many of these problems are hard for a homeowner to identify. A professional is needed.

COMBUSTION APPLIANCES AND POTENTIAL PROBLEMS

Appliances	Fuel	Typical Potential Problems
Central Furnaces Room Heaters Fireplaces	Natural or Liquefied Petroleum Gas	Cracked heat exchanger; Not enough air to burn fuel properly; Defective/blocked flue; Maladjusted burner
Central Furnaces	Oil	Cracked heat exchanger; Not enough air to burn fuel properly; Defective/blocked flue; Maladjusted burner
Central Heaters Room Heaters	Wood	Cracked heat exchanger; Not enough air to burn fuel properly; Defective/blocked flue; Green or treated wood
Central Furnaces Stoves	Coal	Cracked heat exchanger; Not enough air to burn fuel properly; Defective grate
Room Heaters Central Heaters	Kerosene	Improper adjustment; Wrong fuel (not-K-1); Wrong wick or wick height; Not enough air to burn fuel properly
Water Heaters	Natural or Liquefied Petroleum Gas	Not enough air to burn fuel properly; Defective/blocked flue; Maladjusted burner
Ranges; Ovens	Natural or Liquefied Petroleum Gas	Not enough air to burn fuel properly; Maladjusted burner; Misuse as a room heater
Stoves; Fireplaces	Wood Coal	Not enough air to burn fuel properly; Defective/blocked flue; Green or treated wood; Cracked heat exchanger or firebox

Can I use charcoal grills or charcoal hibachis indoors?

No. Never use these appliances inside homes, trailers, truck-caps, or tents. Carbon monoxide from burning and smoldering charcoal can kill you if you use it indoors for cooking or heating. There are about 25 deaths each year from the use of charcoal grills and hibachis indoors.

NEVER burn charcoal inside homes, trailers, tents, or other enclosures. The carbon monoxide can kill you.

What are the health effects of combustion pollutants?

The health effects of combustion pollutants range from headaches and breathing difficulties to death. The health effects may show up immediately after exposure or occur after being exposed to the pollutants for a long time. The effects depend upon the type and amount of pollutants and the length of time of exposure to them. They also depend upon several factors related to the exposed person. These include the age and any existing health problems. There are still some questions about the level of pollutants or the period of exposure needed to produce specific health effects. Further studies to better define the release of pollutants from combustion appliances and their health effects are needed.

The sections below discuss health problems associated with some common combustion pollutants. These pollutants include carbon monoxide, nitrogen dioxide, particles, and sulfur dioxide. Even if you are healthy, high levels of carbon monoxide can kill you within a short time. The health effects of the other pollutants are generally more subtle and are more likely to affect susceptible people. It is always a good idea to reduce exposure to combustion pollutants by using and maintaining combustion appliances properly.

Carbon Monoxide:

Each year, according to CPSC, there are more than 200 carbon monoxide deaths related to the use of all types of combustion appliances in the home. Exposure to carbon monoxide reduces the blood's ability to carry oxygen. Often a person or an entire family may not recognize that carbon monoxide is poisoning them. The chemical is odorless and some of the symptoms are similar to common illnesses. This is particularly dangerous because carbon monoxide's deadly effects will not be recognized until it is too late to take action against them.

Carbon monoxide exposures especially affect unborn babies, infants, and people with anemia or a history of heart disease. Breathing low levels of the chemical can cause fatigue and increase chest pain in people with chronic heart disease. Breathing higher levels of carbon monoxide causes symptoms such as headaches, dizziness, and weakness in healthy people. Carbon monoxide also causes sleepiness, nausea, vomiting, confusion, and disorientation. At very high levels it causes loss of consciousness and death.

Nitrogen Dioxide:

Breathing high levels of nitrogen dioxide causes irritation of the respiratory tract and causes shortness of breath. Compared to healthy people, children, and individuals with respiratory illnesses such as asthma, may be more susceptible to the effects of nitrogen dioxide.

Some studies have shown that children may have more colds and flu when exposed to low levels of nitrogen dioxide. When people with asthma inhale low levels of nitrogen dioxide while exercising, their lung airways can narrow and react more to inhaled materials.

Particles:

Particles suspended in the air can cause eye, nose, throat, and lung irritation. They can increase respiratory symptoms, especially in people with chronic lung disease or heart problems. Certain chemicals attached to particles may cause lung cancer, if they are inhaled. The risk of lung cancer

increases with the amount and length of exposure. The health effects from inhaling particles depend upon many factors, including the size of the particle and its chemical make-up.

Sulfur Dioxide:
Sulfur dioxide at low levels of exposure can cause eye, nose, and respiratory tract irritation. At high exposure levels, it causes the lung airways to narrow. This causes wheezing, chest tightness, or breathing problems. People with asthma are particularly susceptible to the effects of sulfur dioxide. They may have symptoms at levels that are much lower than the rest of the population.

Other Pollutants:
Combustion may release other pollutants. They include unburned hydrocarbons and aldehydes. Little is known about the levels of these pollutants in indoor air and the resulting health effects.

What do I do if I suspect that combustion pollutants are affecting my health?

If you suspect you are being subjected to carbon monoxide poisoning get fresh air immediately. Open windows and doors for more ventilation, turn off any combustion appliances, and leave the house. You could lose consciousness and die from carbon monoxide poisoning if you do nothing. It is also important to contact a doctor IMMEDIATELY for a proper diagnosis. Remember to tell your doctor that you suspect carbon monoxide poisoning is causing your problems. Prompt medical attention is important.

Remember that some symptoms from combustion pollutants - headaches, dizziness, sleepiness, coughing, and watery eyes - may also occur because of common medical problems. These medical problems include colds, the flu, or allergies. Similar symptoms may also occur because of other indoor air pollutants. Contact your doctor for a proper diagnosis.

To help your doctor make the correct diagnosis, try to have answers to the following questions:

- Do your symptoms occur only in the home? Do they disappear or decrease when you leave home, and reappear when you return?
- Is anyone else in your household complaining of similar symptoms, such as headaches, dizziness, or sleepiness? Are they complaining of nausea, watery eyes, coughing, or nose and throat irritation?
- Do you always have symptoms?
- Are your symptoms getting worse?
- Do you often catch colds or get the flu?
- Are you using any combustion appliances in your home?
- Has anyone inspected your appliances lately? Are you certain they are working properly?

Your doctor may take a blood sample to measure the level of carbon monoxide in your blood if he or she suspects carbon monoxide poisoning. This sample will help determine whether carbon monoxide is affecting your health.

Contact qualified appliance service people to have your appliances inspected and adjusted if needed. You should be able to find a qualified person by asking your appliance distributor or your

fuel supplier. In some areas, the local fuel company may be able to inspect and adjust the appliance.

How can I reduce my exposure to combustion pollutants?

Proper selection, installation, inspection and maintenance of your appliances are extremely important in reducing your exposure to these pollutants. Providing good ventilation in your home and correctly using your appliance can also reduce your exposure to these pollutants.

Additionally, there are several different residential carbon monoxide detectors for sale. The CPSC is encouraging the development of detectors that will provide maximum protection. These detectors would warn consumers of harmful carbon monoxide levels in the home. They may soon be widely available to reduce deaths from carbon monoxide poisoning.

APPLIANCE SELECTION

- Choose vented appliances whenever possible.
- Only buy combustion appliances that have been tested and certified to meet current safety standards. Examples of certifying organizations are Underwriters Laboratories (UL) and the American Gas Association (AGA) Laboratories. Look for a label that clearly shows the certification.
- All currently manufactured vented gas heaters are required by industry safety standards to have a safety shut-off device. This device helps protect you from carbon monoxide poisoning by shutting off an improperly vented heater.
- Check your local and state building codes and fire ordinances to see if you can use an unvented space heater, if you consider purchasing one. They are not allowed to be used in some communities, dwellings, or certain rooms in the house.
- If you must replace an unvented gas space heater with another, make it a new one. Heaters made after 1982 have a pilot light safety system called an oxygen depletion sensor (ODS). This system shuts off the heater when there is not enough fresh air, before the heater begins producing large amounts of carbon monoxide. Look for the label that tells you that the appliance has this safety system. Older heaters will not have this protection system.
- Consider buying gas appliances that have electronic ignitions rather than pilot lights. These appliances are usually more energy efficient and eliminate the continuous low-level pollutants from pilot lights.
- Buy appliances that are the correct size for the area you want to heat. Using the wrong size heater may produce more pollutants in your home and is not an efficient use of energy.
- Talk to your dealer to determine the type and size of appliance you will need. You may wish to write to the appliance manufacturer or association for more information on the appliance. Some addresses are in the back of this booklet.
- All new woodstoves are EPA-certified to limit the amounts of pollutants released into the outdoor air. For more information on selecting, installing, operating, and maintaining woodburning stoves, write to the EPA Wood Heater Program. Their address is at the bottom of this booklet. Before buying a woodstove check your local laws about the installation and use of woodstoves.

Proper Installation
You should have your appliances professionally installed. Professionals should follow the installation directions and applicable building codes. Improperly installed appliances can release dangerous pollutants in your home and may create a fire hazard. Be sure that the installer checks for backdrafting on all vented appliances. A qualified installer knows how to do this.

Ventilation
To reduce indoor air pollution, a good supply of fresh outdoor air is needed. The movement of air into and out of your home is very important. Normally, air comes through cracks around doors and windows. This air helps reduce the level of pollutants indoors. This supply of fresh air is also important to help carry pollutants up the chimney, stovepipe, or flue to the outside.
Keep doors open to the rest of the house from the room where you are using an unvented gas space heater or kerosene heater, and crack open a window. This allows enough air for proper combustion and reduces the level of pollutants, especially carbon monoxide.
Use a hood fan, if you are using a range. They reduce the level of pollutants you breath, if they exhaust to the outside. Make sure that enough air is coming into the house when you use an exhaust fan. If needed, slightly open a door or window, especially if other appliances are in use.
For proper operation of most combustion appliances and their venting system, the air pressure in the house should be greater than that outside. If not, the vented appliances could release combustion pollutants into the house rather than outdoors. If you suspect that you have this problem you may need the help of a qualified person to solve it.
Make sure that your vented appliance has the vent connected and that nothing is blocking it. Make sure there are no holes or cracks in the vent. Do not vent gas clothes dryers or water heaters into the house for heating. This is unsafe.
Open the stove's damper when adding wood. This allows more air into the stove. More air helps the wood burn properly and prevents pollutants from being drawn back into the house instead of going up the chimney. Visible smoke or a constant smoky odor inside the home when using a woodburning stove is a sign that the stove is not working properly. Soot on furniture in the rooms where you are using the stove also tells this. Smoke and soot are signs that the stove is releasing pollutants into the indoor air.

Correct Use
Read and follow the instructions for all appliances so you understand how they work. Keep the owner's manual in a convenient place to refer to when needed. Also, read and follow the warning labels because they tell you important safety information that you need to know. Reading and following the instructions and warning labels could save your life.
Always use the correct fuel for the appliance.
Only use water-clear ASTM 1-K kerosene for kerosene heaters. The use of kerosene other than 1-K could lead to a release of more pollutants in your home. Never use gasoline in a kerosene heater because it can cause a fire or an explosion. Using even small amounts of gasoline could cause a fire.
Use seasoned hardwoods (elm, maple, oak) instead of softwoods (cedar, fir, pine) in woodburning stoves and fireplaces. Hardwoods are better because they burn hotter and form less creosote, an oily, black tar that sticks to chimneys and stove pipes. Do not use green or wet woods as the primary wood because they make more creosote and smoke. Never burn painted scrap wood or wood treated with preservatives, because they could release highly toxic pollutants, such as arsenic

or lead. Plastics, charcoal, and colored paper such as comics, also produce pollutants. Never burn anything that the stove or fireplace manufacturer does not recommend.
Never use a range, oven, or dryer to heat your home. When you misuse gas appliances in this way, they can produce fatal amounts of carbon monoxide. They can produce high levels of nitrogen dioxide, too.
Never use an unvented combustion heater overnight or in a room where you are sleeping. Carbon monoxide from combustion heaters can reach dangerous levels.
Never ignore a safety device when it shuts off an appliance. It means that something is wrong. Read your appliance instructions to find out what you should do or have a professional check out the problem.
Never ignore the smell of fuel. This usually indicates that the appliance is not operating properly or is leaking fuel. Leaking fuel will not always be defectible by smell. If you suspect that you have a fuel leak have it fixed as soon as possible. In most cases you should shut off the appliance, extinguish any other flames or pilot lights, shut off other appliances in the area, open windows and doors, call for help, and leave the area.

Inspection and Maintenance
Have your combustion appliance regularly inspected and maintained to reduce your exposure to pollutants. Appliances that are not working properly can release harmful and even fatal amounts of pollutants, especially carbon monoxide.
Have chimneys and vents inspected when installing or changing vented heating appliances. Some modifications may be required. For example, if a change was made in your heating system from oil to natural gas, the flue gas produced by the gas system could be hot enough to melt accumulated oil combustion debris in the chimney or vent. This debris could block the vent forcing pollutants into the house. It is important to clean your chimney and vents especially when changing heating systems.

What are the inspection and maintenance procedures?

The best advice is to follow the recommendations of the manufacturer. The same combustion appliance may have different inspection and maintenance requirements, depending upon where you live.
In general, check the flame in the furnace combustion chamber at the beginning of the heating season. Natural gas furnaces should have a blue flame with perhaps only a slight yellow tip. Call your appliance service representative to adjust the burner if there is a lot of yellow in the flame, or call your local utility company for this service. LP units should have a flame with a bright blue center that may have a light yellow tip. Pilot lights on gas water heaters and gas cooking appliances should also have a blue flame. Have a trained service representative adjust the pilot light if it is yellow or orange.

Before each heating season, have flues and chimneys inspected and cleaned before each heating season for leakage and for blockage by creosote or debris. Creosote buildup or leakage could cause black stains on the outside of the chimney or flue. These stains can mean that pollutants are leaking into the house.

For more information:
For a copy of CPSC's booklets What You Should Know About Space Heaters and What You Should Know About Kerosene Heaters, and for information on asbestos, biological pollutants, lead, methylene chloride, humidifiers, and formaldehyde in your home, write to:

U.S. Consumer Product Safety Commission
Washington, D.C. 20207 or send an e-mail to publications@cpsc.gov.

For a copy of The Inside Story: A Guide to Indoor Air Quality, and additional information on indoor air quality call:

EPA's IAQ INFO Clearinghouse
P.O. Box 37133, Washington, DC 20013-7133
1-800-438-4318, or (703) 356-4020
(fax) (703) 356-5386, or e-mail: iaqinfo@aol.com

Information on indoor air quality is also available from local American Lung Association (ALA)

For information on woodstoves write:
Wood Heater Program
U.S. Environmental Protection Agency
Manufacturing, Energy, and Transportation Division (2223A)
OECA/OC/METD
401 M Street, SW
Washington, DC 20460
(202) 564-2300/(202) 564-0050 (fax)

For information on kerosene heaters, write or call:
National Kerosene Heater Association
3100 West End Avenue, Suite 250
Nashville, TN 37203
(Telephone: 615-269-9015)
For information on gas heating appliances, write:
Gas Appliance Manufacturers Association, Inc.
1901 North Moore Street, Suite 1100
Arlington, VA 22209

American Gas Association
1515 Wilson Blvd.
Arlington, VA 22209
For a copy of Straight Answers to Burning Questions or other woodburning information, write:

Wood Heating Alliance
1101 Connecticut Ave NW, Suite 700
Washington, DC 20036

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The U.S. Consumer Product Safety Commission is charged with protecting the public from unreasonable risks of serious injury or death from more than 15,000 types of consumer products under the agency's jurisdiction. Deaths, injuries and property damage from consumer product incidents cost the nation more than $700 billion annually. The CPSC is committed to protecting consumers and families from products that pose a fire, electrical, chemical, or mechanical hazard or can injure children. The CPSC's work to ensure the safety of consumer products - such as toys, cribs, power tools, cigarette lighters, and household chemicals - contributed significantly to the 30 percent decline in the rate of deaths and injuries associated with consumer products over the past 30 years.

To report a dangerous product or a product-related injury, call CPSC's hotline at (800) 638-2772 or CPSC's teletypewriter at (800) 638-8270, or visit CPSC's web site at www.cpsc.gov/talk.html. To join a CPSC email subscription list, please go to www.cpsc.gov/cpsclist.asp. Consumers can obtain this release and recall information at CPSC's Web site at www.cpsc.gov.

It is most important to be sure combustion equipment is maintained and properly adjusted. Vehicular use should be carefully managed adjacent to buildings and in vocational programs. Additional ventilation can be used as a temporary measure when high levels of CO are expected for short periods of time.

- Keep gas appliances properly adjusted.
- Consider purchasing a vented space heater when replacing an unvented one.
- Use proper fuel in kerosene space heaters.
- Install and use an exhaust fan vented to outdoors over gas stoves.
- Open flues when fireplaces are in use.
- Choose properly sized wood stoves that are certified to meet EPA emission standards. Make certain that doors on all wood stoves fit tightly.
- Have a trained professional inspect, clean, and tune-up central heating system (furnaces, flues, and chimneys) annually. Repair any leaks promptly.
- Do not idle the car inside garage.

Health Effects of Combustion Products

In addition to environmental tobacco smoke, other sources of combustion products are unvented kerosene and gas space heaters, woodstoves, fireplaces, and gas stoves. The major pollutants released are carbon monoxide, nitrogen dioxide, and particles. Unvented kerosene heaters may also generate acid aerosols.

Combustion gases and particles also come from chimneys and flues that are improperly installed or maintained and cracked furnace heat exchangers. Pollutants from fireplaces and woodstoves with no dedicated outdoor air supply can be "back-drafted" from the chimney into the living space, particularly in weatherized homes.

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Health Effects of Combustion Products

Carbon monoxide is a colorless, odorless gas that interferes with the delivery of oxygen throughout the body. At high concentrations can cause a range of symptoms from headaches, dizziness, weakness, nausea, confusion, and disorientation, to fatigue in healthy people and episodes of increased chest pain in people with chronic heart disease. The symptoms of carbon monoxide poisoning are sometimes confused with the flu or food poisoning. Fetuses, infants, elderly people, and people with anemia or with a history of heart or respiratory disease can be especially sensitive to carbon monoxide exposures.

Nitrogen dioxide is a colorless, odorless gas that irritates the mucous membranes in the eye, nose, and throat and causes shortness of breath after exposure to high concentrations. There is evidence that high concentrations or continued exposure to low

levels of nitrogen dioxide increases the risk of respiratory infection; there is also evidence from animals studies that repeated exposures to elevated nitrogen dioxide levels may lead, or contribute, to the development of lung disease such as emphysema. People at particular risk from exposure to nitrogen dioxide include children and individuals with asthma and other respiratory diseases.

Particles, released when fuels are incompletely burned, can lodge in the lungs and irritate or damage lung tissue. A number of pollutants, including radon and benzo(a)pyrene, both of which can cause cancer, attach to small particles that are inhaled and then carried deep into the lung.

Reducing Exposure to Combustion Products in Homes

- Take special precautions when operating fuel-burning unvented space heaters.

  Consider potential effects of indoor air pollution if you use an unvented kerosene or gas space heater. Follow the manufacturer's directions, especially instructions on the proper fuel and keeping the heater properly adjusted. A persistent yellow-tipped flame is generally an indication of maladjustment and increased pollutant emissions. While a space heater is in use, open a door from the room where the heater is located to the rest of the house and open a window slightly.

- Install and use exhaust fans over gas cooking stoves and ranges and keep the burners properly adjusted.

  Using a stove hood with a fan vented to the outdoors greatly reduces exposure to pollutants during cooking. Improper adjustment, often indicated by a persistent yellow-tipped flame, causes increased pollutant emissions. Ask your gas company to adjust the burner so that the flame tip is blue. If you purchase a new gas stove or range, consider buying one with pilotless ignition because it does not have a pilot light that burns continuously. Never use a gas stove to heat your home. Always make certain the flue in your gas fireplace is open when the fireplace is in use.

- Keep woodstove emissions to a minimum. Choose properly sized new stoves that are certified as meeting EPA emission standards.

  Make certain that doors in old woodstoves are tight-fitting. Use aged or cured (dried) wood only and follow the manufacturer's directions for starting, stoking, and putting out the fire in woodstoves. Chemicals are used to pressure-treat wood; such wood should never be burned indoors. (Because some old gaskets in woodstove doors contain asbestos, when replacing gaskets refer to the instructions in the CPSC, ALA and EPA booklet, *Asbestos in Your Home*, to avoid creating an Asbestos problem. New gaskets are made of fiberglass.)

Have central air handling systems, including furnaces, flues, and chimneys, inspected annually and properly repair cracks or damaged parts.

Blocked, leaking, or damaged chimneys or flues release harmful combustion gases and particles and even fatal concentrations of carbon monoxide.

Strictly follow all service and maintenance procedures recommended by the manufacturer, including those that tell you how frequently to change the filter. If manufacturer's instructions are not readily available. change filters once every month or two during periods of use. Proper maintenance is important even for new furnaces because they can also corrode and leak combustion gases, including carbon monoxide.

Additional Resources

The Partnership for Clean Indoor Air

The Partnership for Clean Indoor Air was launched at the World Summit on Sustainable Development in Johannesburg to address the increased environmental health risk faced by more than 2 billion people in the developing world who burn traditional biomass fuels indoors for cooking and heating. According to the World Health Organization, their increased exposure results in an estimated 1.6 million premature deaths each year, largely among women and children. The mission of the Partnership is to improve health, livelihood, and quality of life by reducing exposure to air pollution, primarily among women and children, from household energy use. Read more...

What You Should Know About Combustion Appliances and Indoor Air Pollution

Answers commonly-asked questions about the effect of combustion appliances (e.g., fuel-burning furnaces, space heaters, kitchen ranges, and fireplaces) on indoor air quality and human health. Describes other sources of combustion pollutants in and around the home. Suggests ways to reduce exposure to such pollutants and encourages proper installation, use, and maintenance of combustion appliances. This brochure was coauthored with the by the U.S. Consumer Product Safety Commission and the American Lung Association. [EPA **400-F-91-100**, 1993]

National Fire Protection Association - www.nfpa.org
1 Batterymarch Park
Quincy, Massachusetts 02169-7471
Tel: (617) 770-3000
Fax: (617) 770-0700

Sources of Indoor Air Pollution - Nitrogen Dioxide (NO_2)

The two most prevalent oxides of nitrogen are nitrogen dioxide (NO_2) and nitric oxide (NO). Both are toxic gases with NO_2 being a highly reactive oxidant and corrosive. The primary sources indoors are combustion processes, such as unvented combustion appliances, e.g. gas stoves, vented appliances with defective installations, welding, and tobacco smoke.

Definition

Properties: A red-brown gas or yellow liquid; becomes colorless solid at -11.2°C, which exists in varying equilibrium with other oxides of nitrogen as the temperature is varied. A component of automotive exhaust fumes. M.p. (liquid) -9.3°C; b.p. (gas) 21°C. Noncombustible. Derivation: By oxidation of nitric acid, an intermediate stage in the oxidation of ammonia to nitric acid. Hazard: Highly toxic; inhalation may be fatal. Tolerance, 5 ppm in air. Can react strongly with reducing materials.
Source: "The Condensed Chemical Dictionary," 9th ed., revised by Gessner G. Hawley, Van Nostrand Reinhold Co., NY, 1977.

Sources of Nitrogen Dioxide

Kerosene heaters, un-vented gas stoves and heaters. Environmental tobacco smoke.

Health Effects Associated with Nitrogen Dioxide

Eye, nose, and throat irritation. May cause impaired lung function and increased respiratory infections in young children. EPA's Integrated Risk Information System profile for Nitrogen Dioxide - epa.gov/iris/subst/0080.htm NO_2 acts mainly as an irritant affecting the mucosa of the eyes, nose, throat, and respiratory tract. Extremely high-dose exposure (as in a building fire) to NO_2 may result in pulmonary edema and diffuse lung injury. Continued exposure to high NO_2 levels can contribute to the development of acute or chronic bronchitis. Low level NO_2 exposure may cause increased bronchial reactivity in some asthmatics, decreased lung function in patients with chronic obstructive pulmonary disease and increased risk of respiratory infections, especially in young children.

Levels in Homes

Average level in homes without combustion appliances is about half that of outdoors. In homes with gas stoves, kerosene heaters, or un-vented gas space heaters, indoor levels often exceed outdoor levels.

Steps to Reduce Exposure

Venting the NO_2 sources to the outdoors, and assuring that combustion appliances are correctly installed, used, and maintained are the most effective measures to reduce exposures.

(These are the same steps as those used to reduce exposure to carbon monoxide).

- Keep gas appliances properly adjusted.
- Consider purchasing a vented space heater when replacing an un-vented one.
- Use proper fuel in kerosene space heaters.
- Install and use an exhaust fan vented to outdoors over gas stoves.
- Open flues when fireplaces are in use.
- Choose properly sized wood stoves that are certified to meet EPA emission standards. Make certain that doors on all wood stoves fit tightly.
- Have a trained professional inspect, clean, and tune-up central heating system (furnaces, flues, and chimneys) annually. Repair any leaks promptly.
- Do not idle the car inside garage.

Standards or Guidelines

No standards have been agreed upon for nitrogen oxides in indoor air. ASHRAE and the US. EPA National Ambient Air Quality Standards list 0.053 ppm as the average 24-hour limit for NO_2 in outdoor air.

Additional Resources

Office of Air and Radiation page - " NOx - How Nitrogen Oxides Affect the Way We Live and Breathe"

Maine's Department of Environmental Protection's BEAM Chemical Fact Sheet on Nitrogen Dioxide

What You Should Know About Combustion Appliances and Indoor Air Pollution

Answers commonly-asked questions about the effect of combustion appliances (e.g., fuel-burning furnaces, space heaters, kitchen ranges, and fireplaces) on indoor air quality and human health. Describes other sources of combustion pollutants in and around the home. Suggests ways to reduce exposure to such pollutants and encourages proper installation, use, and maintenance of combustion appliances. This brochure was coauthored with the U.S. Consumer Product Safety Commission and the American Lung Association. [EPA **400-F-91-100**, 1993]

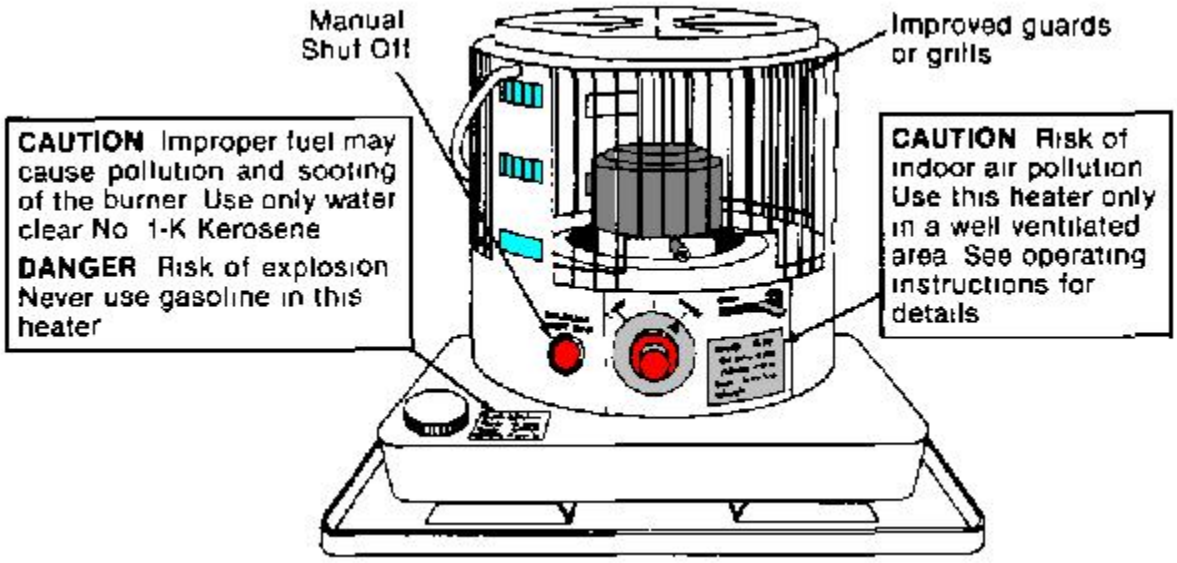
Indoor Air Pollution: An Introduction for Health Professionals

Assists health professionals (especially the primary care physician) in diagnosis of patient symptoms that could be related to an indoor air pollution problem. Addresses the health problems that may be caused by contaminants encountered daily in the home and office. Organized according to pollutant or pollutant groups such as environmental tobacco smoke, VOCs, biological pollutants, and sick building syndrome, this booklet lists key signs and symptoms from exposure to these pollutants, provides a diagnostic checklist and quick reference summary, and includes suggestions for remedial action. Also includes references for information contained in each section. This booklet was coauthored with the American Lung Association, the American Medical Association, and the U.S. Consumer Product Safety Commission. [EPA **402-R-94-007**, 1994]

Consumer Product Safety Commission

CPSC and NKHA Stress Kerosene Heater Safety

CPSC Document #5052



If you are using a kerosene heater, the U.S. Consumer Product Safety Commission and the National Kerosene Heater Association advise you to follow these suggestions in order to minimize the risk of fire and potential health effects from indoor air pollution.

- **Use only water-clear 1 K grade kerosene.** Never use gasoline. Gasoline is not the same as kerosene. Even small amounts of gasoline or other volatile fuels or solvents mixed with kerosene can substantially increase the risk of a fire or an explosion.

- **Always store kerosene in a separate container intended for kerosene,** not in a gasoline can or a can that has contained gasoline. This helps you avoid using contaminated fuel or the wrong fuel by mistake. Kerosene containers are usually blue; gasoline containers are usually red.

- **When purchasing kerosene at the pump, make sure to use the kerosene pump, not the gasoline pump.** Some service stations have separate islands for kerosene. Some oil companies have also established quality control programs to minimize the chances of gasoline contamination of kerosene.

- **1-K grade kerosene should be purchased from a dealer who can certify that what is being sold is 1-K.** State operated and private sector certification programs that ensure the quality of kerosene are established in some states. Grades other than 1-K can lead to a release of more pollutants in your home, posing a possible health risk. Different grades of kerosene can look the same so it is important that the dealer certify that the product sold is 1-K grade kerosene.

- **Never refuel the heater inside the home.** Fill the tank outdoors, away from combustible materials, and only after the heater has been turned off and allowed to cool down. Do not refuel the heater when it is hot or is in operation. Do not fill the fuel tank above the "full" mark. The space above the "full" mark is to allow the fuel room to expand without causing leakage when the heater is operating.

- **In case of flare-up or if uncontrolled flaming occurs, do not attempt to move or carry the heater.** This can make the fire worse. If the heater is equipped with a manual shut-off switch, activate the switch to turn off the heater. If this does not extinguish the fire, leave the house immediately and call the fire department. As an added reminder and precaution, install at least one smoke detector near each sleeping area or on each level of the house.

- **Reduce your exposure to indoor air pollutants by properly operating and maintaining your portable kerosene heater.** Although portable kerosene heaters are very efficient in the burning of fuel to produce heat, low levels of certain pollutants such as carbon monoxide and nitrogen dioxide are produced. Exposure to low levels of these pollutants may be harmful, especially to individuals with chronic respiratory or circulatory health problems. To assure that you and family members are not exposed to significant levels of these pollutants, you should follow carefully the following rules of safe operation:

  Operate your heater in a room with a door open to the rest of the house.

  If you must operate your heater in a room with the door closed to the rest of the house, open an outside window approximately an inch to permit fresh air to effectively dilute the pollutants below a level of concern.

  Always operate your heater according to the manufacturer's instructions, making sure that the wick is set at the proper level as instructed by your manufacturer.

  Keep the wick in your heater clean and in good operating condition by following the cleaning and maintenance procedures recommended by the manufacturer.

  Keep an outside window opened approximately an inch to insure adequate fresh air infiltration. This is true regardless of whether you use a kerosene heater or some other conventional method of heating, if your home is relatively new and tight, or if it is older but has been winterized to reduce air infiltration from the outside.

CAUTION: Improper fuel may cause pollution and sooting of the burner. Use only water clear No. 1-K Kerosene.

DANGER: Risk of explosion. Never use gasoline in this heater.

CAUTION: Risk of indoor air pollution. Use this heater only in a well ventilated area. See operating instructions for details.

009403

U.S. Govt Printing Office: 1996 - 402-314/39054

The U.S. Consumer Product Safety Commission is charged with protecting the public from unreasonable risks of serious injury or death from more than 15,000 types of consumer products under the agency's jurisdiction. Deaths, injuries and property damage from consumer product incidents cost the nation more than $700 billion annually. The CPSC is committed to protecting consumers and families from products that pose a fire, electrical, chemical, or mechanical hazard or can injure children. The CPSC's work to ensure the safety of consumer products - such as toys, cribs, power tools, cigarette lighters, and household chemicals - contributed significantly to the 30 percent decline in the rate of deaths and injuries associated with consumer products over the past 30 years.
To report a dangerous product or a product-related injury, call CPSC's hotline at (800) 638-2772 or CPSC's teletypewriter at (800) 638-8270, or visit CPSC's web site at www.cpsc.gov/talk.html. To join a CPSC email subscription list, please go to www.cpsc.gov/cpsclist.asp. Consumers can obtain this release and recall information at CPSC's Web site at www.cpsc.gov.

INDOOR AIR POLLUTION:
AN EVALUATION OF THREE AGENTS

In general combustion or burning is a chemical reaction in which a fuel combines with oxygen. When there is insufficient oxygen, burns incompletely and produces by-products of combustion. Incomplete combustion by-products of carbon-based material often have a color (red nitrogen dioxide) or an odor (aldehydes). Toxic and other harmful products;

- Carbon monoxide
- Polynuclear aromatic hydrocarbons (PAHs)
- Formaldehydes
- Sulfur dioxide
- Nitrogen dioxides
- Particulates

There are a lot of combustion appliances including space heaters, gas ranges and ovens, furnaces, gas water heaters, gas clothes dryers, wood or coal-burning stoves, and fireplaces. The common fuels burned in these appliances are natural or LP gas, fuel oil, kerosene, wood, or coal.

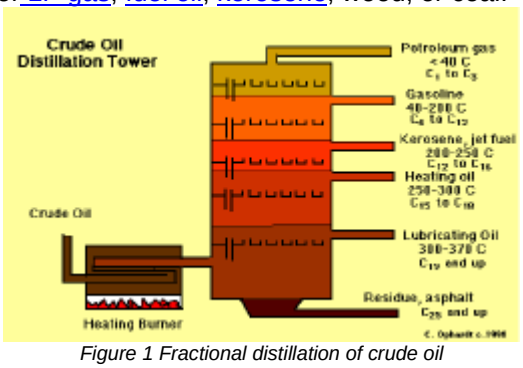


Figure 1 Fractional distillation of crude oil

Therefore, the types and amounts of pollutants produced depend upon the type of appliance, how well the appliance is installed, maintained, and vented, and the kind of fuel it uses.

References

An Introduction to Indoor Air Quality (IAQ)

Sources

Combustion by-products are coming from un-vented kerosene and gas space heaters, woodstoves, fireplaces, and gas stoves. Un-vented kerosene heaters may also generate acid aerosols. Combustion gases and particles also come from chimneys and flues that are improperly installed or maintained and cracked furnace heat exchangers. Pollutants from fireplaces and woodstoves with no dedicated outdoor air supply can be "back-drafted" from the chimney into the living space, particularly in weatherized homes.

Wood-Burning Appliances

There are a large variety of wood-burning stoves. Typically, they are classified as two basic types: conventional and airtight. Conventional stoves have low combustion efficiencies, commonly in the range of 25-50 %. Combustion efficiencies in airtight exceed 50 %.

The major impact of wood appliance operation on indoor air quality is a source of particulate matters. Associated with increased particulate matter levels in homes heated with wood is an increase in carcinogenic polynuclear aromatic hydrocarbons (PAHs). For example, lowest and highest PAHs indoor concentrations from a series of measurements for a variety of wood heater types, as well as outdoor concentrations are as follows.

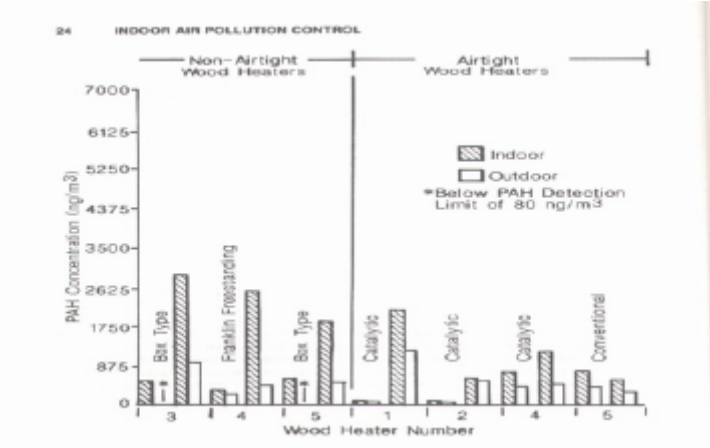


Figure 2 Indoor PAH concentrations (high and low 12-hr concentrations) associated with wood heater use compared to ambient level

Emission rates of pollutants are also dependent on the type of wood and the appliance used to burn it. Knight et al. measured the concentration of CO, NO and NO2 during the operation of different types of airtight and non-airtight woodstoves. Their results are shown in Table 1.

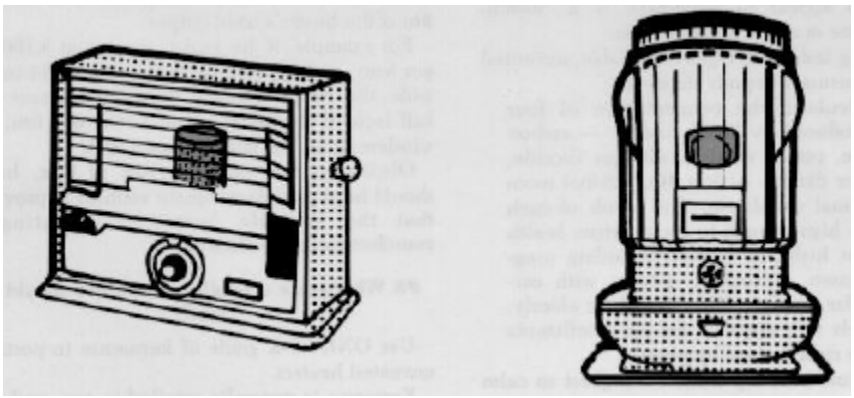
Table 1. Emission Rates from Airtight and Non-airtight Wood Heaters

Investigators	Type	Emission Rate of pollutants (mg/h)				
		CO	NO	NO_2	TSP	RSP
Knight et al. (1986)	Airtight					
	Radiant heater	55-182[a] 70-375[b]	0.4-2.6[a] 0.6-0.8[b]	0.9[a] 0.3-0.7[b]	4.1-7.5[a] 4.2-42.9[b]	2.3-3.6[a] 7.5[b]
	Conventional	69[a] 95[b]	3.2[a] 0.7[b]	2.4[a] 0.2[b]	4.3[a] 5.7[b]	3.4[a] 2.3[b]
	Non-airtight					
	Box type	210-416[a]	2-4[a]	2.1-3.6[a]	11.9-12.7[a]	5.5-6.9[a]
	Franklin freestanding	530[b]	9.4[a]	3.1[a]	20.6[a]	11.1[a]
Imhoff (1984)	Clean woodstove	86	1.2	1.3	2.6	-
	Dirty woodstove	560	3.9	7.0	100.0	-

a, 12-h tests b, 24-h tests -, no data reported; TSP, total suspended particles; RSP, respirable suspended particles

Un-vented Kerosene and Gas Space Heaters

Kerosene heaters are sold over ten million units in the United States by 1985. Kerosene heaters are of three basic designs: convective, radiant and two-stage.



Convective heaters employ a cylindrical wick and operate at relatively high combustion temperatures. Radiant heaters have a cylindrical wick whose flames extend up into a perforated metal baffle, which grows red hot, releasing infrared or radiant heat. Radiant heaters operate at a low temperature than convective ones. The two-stage heater is similar in design to the radiant type except that there is a second chamber above the radiant element. This second chamber is intended to further combust CO and unburned hydrocarbons.

The magnitude of emissions depends on heater type, heater operation parameters, and the type of fuel. The air contamination potential for both un-vented gas and kerosene space heaters is CO, CO2, NO, NO2, RSPs, SO2, and formaldehydes.

Table 2. Emission Rates from Well-Tuned Kerosene Space Heaters

Type	No. of Heaters	Emission Rates (ug/KJ)				
		CO	NO	NO_2	HCHO	Particles
Convective	3	25.0	14.1	16.3	0.31	-
Radiant	4	64.0	1.3	4.7	0.29	0.49
Two-stage	2	9.2	4.3	2.2	0.20	1.70

Laboratory results by Leaderer et al. are also illustrated in Figure 3.

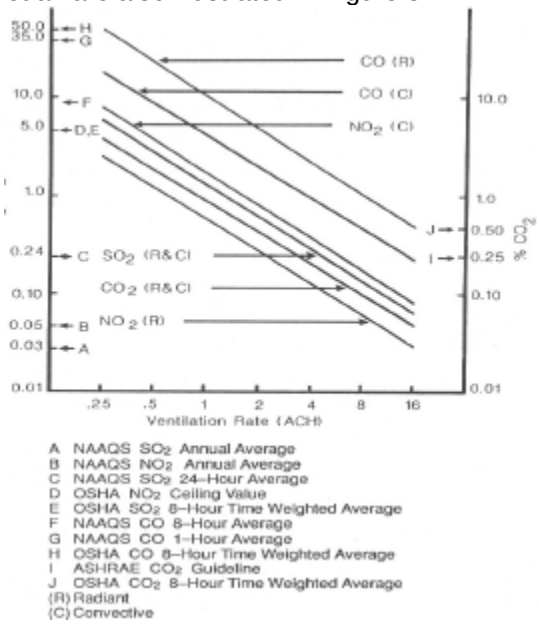


Figure 3 Steady-state concentrations of contaminants associated with kerosene heater operation

Gas Cooking Stoves and Ovens

Gas cooking stoves and ovens are potential sources of CO, CO2, NO and NO2. They may also release aldehydes, a variety of organic gases, and RSPs. A number of experimental studies have been conducted to measure emission rates of pollutants from gas stoves and ovens. For example, their results by Hollowell et at. (1976) are shown in Table 3.

Table 3. Emission Rates from Gas Range and Oven with Cooking Pots

Type	Fuel consumption	Average Emission Rates (mg/h)						
		CO	CO_2	NO	NO_2	SO_2	HCN	HCHO
Gas-fired oven at 350°F for 1h	7970 Btu/h	1898	358-680	56	85	0.92	0.126	2.3
Gas-fired burner for 16 min	8730 Btu/h	1840	416-944	89	136	1.47	4.6-3.8	16

Flue Gas Spillage/Backdrafting

Under normal operating conditions, vented gas-fired forced-air furnaces and gas-fired water heaters should not result in measurable effects on indoor air quality. However, as a result of a variety of operating and climatic circumstances, substantial spillage of flue gases can occur with gas furnace, gas water heaters and wood-burning appliances. Under the extreme circumstances, such flue gas spillage and backdrafting can cause carbon monoxide poisoning.

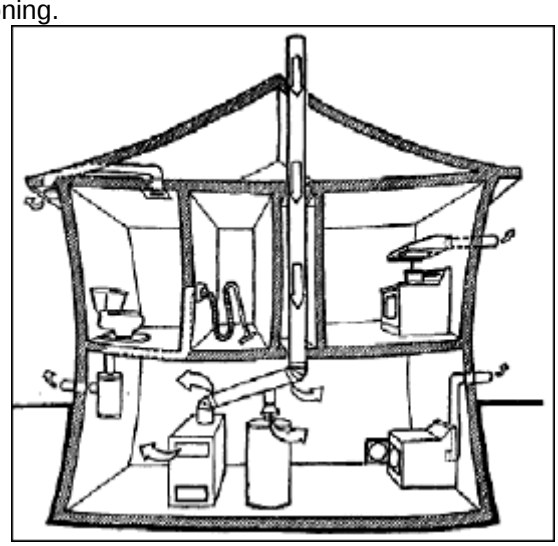


Fig. 4 Backdrafting due to depressurization

References

Combustion gases in your home, http://www.cmhc-schl.gc.ca/en/burema/gesein/abhose/abhose_ce02.cfm
Godish, T. *Indoor Air Pollution Control.* Lewis Publishers, Chelsia, Michigan (1989). p.21-28.
Hines A. et al. Indoor Air Quality and Control . PTR Prentice Hall, Englewood Cliffs, New Jersey,(1993). p.74-85.

Measurements of Combustion Gases

As mentioned above, combustion pollutants are generated in according to the type of combustion appliances, operation parameters and the type of fuel. Sampling and analytical methods of them depend on a substance interested because these pollutants are composed of different chemicals. Therefore, we summarize measurements of exposure to a chemical based on the major pollutants related to adverse health effects.

Concentration of combustion gases in home

Ideally, carbon monoxide level indoors should be the same as outdoors. Average levels in homes without

gas stoves vary from 0.5 to 5 parts per million (ppm). Levels near properly adjusted gas stoves are often 5 to 15 ppm and those near poorly adjusted stoves may be 30 ppm or higher. Traynor et al.(1985) reported that CO concentration ranged from 0.4 to 2.8 ppm in nonairtight stoves.
Carbon dioxide ambient level is 340 ppm to 370 ppm and carbon dioxide level in homes should be the same as outdoors. In indoor air, the primary source of carbon dioxide is human expelled air that builds up in airtight buildings, confined air spaces, overcrowded spaces and high activity area. Other sources are by-product of combustion by gas cooking appliances, space heaters, and wood-burning appliances.
Nitrogen dioxide Average level in homes without combustion appliances is about half that of outdoors. In homes with gas stoves, kerosene heaters, or un-vented gas space heaters, indoor levels often exceed outdoor levels. For example, Traynor et al.(1984) reported that nitrogen dioxide levels in three kerosene-heated homes ranged from 25 to 117 ppb and Leaderer et al.(1984) reported that NO2 levels averaged 19.6 ppb in those homes with one heater and 37 ppb in those with two.
Sulfur dioxide levels indoors may be exceed outdoor levels. Cooper and Alberti (1984) monitored 14 homes with kerosene heaters in suburban Richmond, Virginia and sulfur dioxide levels averaged 0.4 ppm with a range of 0 to 1.0 ppm.

Measurements of combustion pollutants in home

The measurements protocol depends on largely on the objectives. Personal and area sampling are available for CO, NO2 and SO2. Personal samplers can work in either the passive or active mode.
Direct reading instruments or colorimetric detectors are used as a tool of area monitoring. Both methods provide instantaneous data, and the direct reading instruments provide on-going data. Direct reading instruments incur a high initial cost, and colorimetric detectors involve a low cost per sample. The choice of method should be based on desired number of samples and accessibility of equipment.
A brief note of concentrations and measurements of combustion gases is shown in table 4.

Table 4. Concentrations and Measurements of Combustion Gases

Pollutants	Exposure Level	Guidelines or Standards	Measurements
Carbon monoxide	0.5 to 5 ppm without gas stoves 5 to 15 ppm if proper use of gas stove 30 ppm or higher if improper use	ACGIH : 25 ppm (8hr-TWA) EPA (national ambient air quality standards) : 9 ppm (8hr); 35 ppm (1hr)	Direct reading instrument or colorimetric detector
Nitrogen dioxide	25 to 117 ppb : Traynor et al.(1984) 19.6 to 37 ppb : Leaderer et al.(1984) 27 ppb in Boston area : Quackenboss et al.(1986)	ACGIH : 5 ppm (STEL) EPA (National Ambient Air Quality Standard) : 0.053 ppm (annual arithmetic mean)	Direct reading instrument or Visible absorption spectrophotometry
Sulfur dioxide	0 to 1.0 ppm : Cooper and Alberti (1984)	ACGIH : 2 ppm (8hr-TWA); 5 ppm (STEL) EPA (National Ambient Air Quality Standard) : 0.030 ppm (annual arithmetic mean); 0.14 ppm (24hr); 0.50 ppm (3hr)	Direct reading instrument or Colorimetric detector, Ion chromatography

Additional Links
NIOSH Manual of Analytical Method
EPA Environmental test methods and guidelines
OSHA Technical Manual
International Organization for Standardization
ASTM

References

Hess-Kosa, K. *Indoor Air Quality - Sampling and Methodology-*. CRC Press, Boca Raton, NewYork,(2002). p.187-188. Godish, Thad. *Indoor Air Pollution Control.* Lewis Publishers, Chelsia, Michigan (1989). p.21-28.

Hines A. et al. *Indoor Air Quality and Contro*l . PTR Prentice Hall, Englewood Cliffs, New Jersey,(1993). p.85-90.

Strategy for Control of Combustion Pollutants

A strategy for control the combustion pollutants is (1) limitation of source contaminants that prevent combustion contaminants occurring or releasing, (2) dilution of contaminants that prevent contaminants exceeding the exposure criteria for human health, (3) and maintenance of combustion appliances for a good conditions. (4) Additionally, residential carbon monoxide gas detectors may use to reduce deaths from carbon monoxide poisoning

Source control

Appliance selection: Choose vented appliances whenever possible and choose combustion appliances that have been tested and certified to meet current safety standards.

Proper Installation: You should have your appliances professionally installed. Professionals should follow the installation directions and applicable building codes. Improperly installed appliances can release dangerous pollutants in your home and may create a fire hazard. Be sure that the installer checks for backdrafting on all vented appliances. A qualified installer knows how to do this.

Ventilation

To reduce combustion pollutants, a good supply of fresh outdoor air is needed. Normally, air comes through cracks around doors and windows. This air helps reduce the level of pollutants indoors. This supply of fresh air is also important to help carry pollutants up the chimney, stovepipe, or flue to the outside.

Keep doors open to the rest of the house from the room where you are using an unvented gas space heater or kerosene heater, and crack open a window.

Use a hood fan, if you are using a range. They reduce the level of pollutants you breath, if they exhaust to the outside. Make sure that enough air is coming into the house when you use an exhaust fan. If needed, slightly open a door or window, especially if other appliances are in use

Make sure that your vented appliance has the vent connected and that nothing is blocking it. Make sure there are no holes or cracks in the vent

Inspection and Maintenance

Combustion appliance regularly inspected and maintained to reduce your exposure to pollutants. Appliances that are not working properly can release harmful and even fatal amounts of pollutants, especially carbon monoxide.

References

What you should know about combustion appliances and indoor air pollution
http://www.cpsc.gov/cpscpub/pubs/452.html

Sudden Infant death Syndrome and Air Pollution: Selected Annotated Bibliography

ACCN: SIDS-07298

Nevas M, Lindstrom M, Virtanen A, Hielm S, Kuusi M, Arnon SS, Vuor Korkeala H.

Infant botulism acquired from household dust presenting as sudden infant death syndrome

J Clin Microbiol. 2005 Jan: 43(1): 511-3.

Clostridium botulinum type B was detected by multiplex PCR in the intestinal contents of a suddenly deceased 11-week-old infant and in vacuum cleaner dust from the patient's household. C. botulinum was also isolated from the deceased infant's intestinal contents and from the household dust. The genetic similarity of the two isolates was demonstrated by pulsed-field gel electrophoresis and randomly amplified polymorphic DNA analysis, thereby confirming that dust may act as a vehicle for infant botulism that results in sudden death.

ACCN: SIDS-07052

Centers for Disease Control and Prevention (CDC).

Indoor air quality in hospitality venues before and after implementation of a clean indoor air law—Western New York, 2003.
MMWR Morb Mortal Wkly Rep. 2004 Nov 12; 53(44):1038-41.

Secondhand smoke (SHS) contains more than 50 carcinogens. SHS exposure is responsible for an estimated 3,000 lung cancer deaths and more than 35,000 coronary heart disease deaths among never smokers in the United States each year, and for lower respiratory infections, asthma, sudden infant death syndrome, and chronic ear infections among children. Even short-term exposures to SHS, such as those that might be experienced by a patron in a restaurant or bar that allows smoking, can increase the risk of experiencing an acute cardiovascular event. Although population-based data indicate declining SHS exposure in the United States over time, SHS exposure remains a common but preventable public health hazard. Policies requiring smoke-free environments are the most effective method of reducing SHS exposure. Effective July 24, 2003, New York implemented a comprehensive state law requiring almost all indoor workplaces and public places (e.g., restaurants, bars, and other hospitality venues) to be smoke-free. This report describes an assessment of changes in indoor air quality that occurred in 20 hospitality venues in western New York where smoking or indirect SHS exposure from an adjoining room was observed at baseline. The findings indicate that, on average, levels of respirable suspended particles (RSPs), an accepted marker for SHS levels, decreased 84% in these venues after the law took effect. Comprehensive clean indoor air policies can rapidly and effectively reduce SHS exposure in hospitality venues.

For full-text: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5344a3.htm

ACCN: SIDS-07023

Glinianaia SV, Rankin J, Bell R, Pless-Mulloli T, Howel D.

Does particulate air pollution contribute to infant death? A systematic review.

Environ Health Perspect 2004 Oct; 112(14):1365-71.

There is now substantial evidence that both short- and long-term increases in ambient air pollution are associated with increased mortality and morbidity in adults and children. Children's health is particularly vulnerable to environmental pollution, and infant mortality is still a major contributor to childhood mortality. In this systematic review we summarize and evaluate the current level of epidemiologic evidence of an association between particulate air pollution and infant mortality. We identified relevant publications using database searches with a comprehensive list of search terms and other established search methods. We included articles in the review according to specified inclusion criteria. Fifteen studies met our inclusion criteria. Evidence of an association between particulate air pollution and infant mortality in general was inconsistent, being reported from locations with largely comparable pollution levels. There was some evidence that the strength of association with particulate matter differed by subgroups of infant mortality. It was more consistent for postneonatal mortality due to respiratory causes and sudden infant death syndrome. Differential findings for various mortality subgroups within studies suggest a stronger association of particulate air pollution with some causes of infant death. Research is needed to confirm and clarify these links, using the most appropriate methodologies for exposure assessment and control of confounders. Key words: infant mortality, particulate air pollution, postneonatal respiratory mortality, sudden infant death syndrome, systematic review.

ACCN: SIDS-07008

Tong S, Colditz P.

Air pollution and sudden infant death syndrome: A literature review.

Paediatr Perinat Epidemiol Sep 2004; 18(5): 327-35.
Although the rate of sudden infant death syndrome (SIDS) has been reduced with the 'Back to Sleep' campaign, SIDS is still a common cause of death in infancy. A range of environmental factors may interact to contribute to the adverse health conditions conducive to SIDS. Nine studies have evaluated the association between exposure to air pollution and the incidence of SIDS. The available evidence is inadequate to come to any conclusion about a relationship between air pollution and SIDS, although the body of evidence appears to suggest that air pollution (especially

particles and some gaseous pollutants) may play a certain role in the occurrence of SIDS. We suggest that future studies should focus on the research design, role of indoor air quality and the effect of smaller particles, particularly those in the ultrafine range

ACCN: SIDS-06935

Sundell HW

SIDS Prevention--Good progress, but now we need to focus on avoiding Nicotine.

Acta Paediatria 2004; 93(4): 450-2.

Chong et al. examined risk factors for sudden infant death syndrome (SIDS) before and after the start of the Swedish campaign to reduce the risk of SIDS. They found that maternal smoking was the strongest risk factor for SIDS in the post-campaign compared to the pre-campaign period. Conclusion: After successful results of the SIDS campaigns to prevent prone sleeping, strong efforts need to be undertaken to eliminate maternal smoking during pregnancy altogether without replacing cigarette smoking with other nicotine delivery devices such as snuff, gum or patches.

ACCN: SIDS-06928

Dales R, Burnett RT, et al.

Air Pollution and Sudden Infant Death Syndrome.

Pediatrics 2004 Jun; 113(6): e628-631.

Background: Sudden infant death syndrome (SIDS) affects 1 in 1000 live births and is the most common cause of infant death after the perinatal period. Objective: To determine the influence of air pollution on the incidence of SIDS. Methods: Time-series analyses were performed to compare the daily mortality rates for SIDS and the daily air pollution concentrations in each of 12 Canadian cities during the period of 1984-1999. Serial autocorrelation was controlled for by city, and then the city-specific estimates were pooled. Increased daily rates of SIDS were associated with increases, on the previous day, in the levels of sulfur dioxide (SO2), nitrogen dioxide (NO2), and carbon monoxide but not ozone or fine particles measured every sixth day. Effects persisted despite adjustments for season alone or the combination of daily mean temperature, relative humidity, and changes in barometric pressure for NO2 and SO2 but not carbon monoxide. Results: Increases in both SO2 and NO2, equivalent to their interquartile ranges, were associated with a 17.72% increase in SIDS incidence. Conclusion: Ambient SO2 and NO2 may be important risk factors for SIDS

ACCN: SIDS-06916

Kaiser R, Romieu I, et al.

Air Pollution attributable Postneonatal Infant Mortality in U.S. metropolitan areas: A risk assessment study.

Environmental Health 2004 May 5; 3(1):18.

Background: The impact of outdoor air pollution on infant mortality has not been quantified. Methods:Based on exposure-response functions from a U.S. cohort study, we assessed the attributable risk of postneonatal infant mortality in 23 U.S. metropolitan areas related to particulate matter <10 mum in diameter (PM10) as a surrogate of total air pollution. Results: The estimated proportion of all cause mortality, sudden infant death syndrome (normal birth weight infants only) and respiratory disease mortality (normal birth weight) attributable to PM10 above a chosen reference value of 12.0 mug/m3 PM10 was 6% (95% confidence interval 3-11%), 16% (95% confidence interval 9-23%) and 24% (95% confidence interval 7-44%), respectively. The expected number of infant deaths per year in the selected areas was 106 (95% confidence interval 53-185), 79 (95% confidence interval 46-111) and 15 (95% confidence interval 5-27), respectively. Approximately 75% of cases were from areas where the current levels are at or below the new U.S. PM2.5 standard of 15 mug/m3 (equivalent to 25 mug/m3 PM10). In a country where infant mortality rates and air pollution levels are relatively low, ambient air pollution as measured by particulate matter contributes to a substantial fraction of infant death, especially for those due to sudden infant death syndrome and respiratory disease. Even if all counties would comply to the new PM2.5 standard, the majority of the estimated burden would remain. Conclusion: Given the inherent limitations of risk assessments, further studies are needed to support and quantify the relationship between infant mortality and air pollution.

ACCN: SIDS-06427

Tutka P, Wielosz M, Zatonski W.

Exposure to environmental tobacco smoke and children health.

Int J Occup Med Environ Health. 2002; 5(4): 325-35.

This paper reviews the investigations of the effects of pre- and/or postnatal exposure to environmental tobacco smoke (ETS) on children health reported in the literature. The evidence from epidemiological studies demonstrate that children's exposure to ETS is a risk factor for a variety of diseases, including respiratory disorders and middle ear disease. However, the current research base on the ETS-associated risks is still inadequate to fully support strategies, programs and policy development in this area. For example, it is not definitively determined what methods should be used for assessing ETS exposure and predicting potential health risks of exposed children. Based on the available data, we tried to find out which methods seem to be most

desirable for quantifying ETS exposure in children. It is our opinion that among all biomarkers, the measurements of blood, saliva or urinary cotinine and hair nicotine are, as for today, the most specific and sensitive methods for an objective assessment of ETS exposure in children. A combination of the measurement of body fluids cotinine and hair nicotine with the questionnaire and interview-derived information seems to be the optimal method for assessing ETS exposure in children.

ACCN: SIDS-06391

Quinn JB.

Baby's bedding: is it creating toxic nerve gases?

Midwifery Today Int Midwife 2002 Spr; 61:21-22.

The author discusses the research done by Barry Richardson in Great Britain and T.J. Sprott in New Zealand on chemicals used in the manufacture of baby mattresses. There are three substances of concern: phosphorus, arsenic, and antimony. Their theory is that a common household fungus, Scopularis brevicaulis, establishes itself in the mattresses and by consuming the three substances creates three nerve gases: phosphine, arsine, and stibine. When the baby sleeps on the mattress, warming it to body temperature, the gases are released from the mattress, and the baby breathes in these gases. It is suggested that to prevent this from occuring, mattresses should be wrapped in a gas-impermeable plastic, and only cotton bedding should be used.

ACCN: SIDS-06351

Wahlgren DR, Hovell MF, Meltzer EO, Meltzer SB.

Involuntary smoking and asthma.

Curr Opin Pulm Med 2000 Jan; 6(1): 31-36.

Involuntary smoking is the third leading preventable cause of death, and among children it causes lower respiratory infections, middle ear disease, sudden infant death syndrome, and asthma. Half the world's children may be exposed to environmental tobacco smoke (ETS), exacerbating symptoms in 20% of children with asthma. Recent studies have reinforced previous conclusions that ETS exposure causes onset of childhood asthma and exacerbation of symptoms throughout life. The exact mechanisms by which this is accomplished are still unclear, as are the relative contributions of prenatal versus postnatal exposure. However, favorable health outcomes can be attained with reduced exposure. Among the few studies of ETS exposure reduction interventions, low-intensity advice methods appeared ineffective, and counseling parent smokers appeared successful. Direct counseling of school-aged children to avoid ETS has yet to be tested.

Community norms may need to shift further in favor of protecting children and others from ETS before minimal interventions can be successful. This will require combined and ongoing efforts of the medical and public health establishments, in concert with legislation mandating tobacco-free public places and with ETS-related media campaigns.

ACCN: SIDS-06332

Lipfert FW, Zhang J, Wyzga RE.

Infant mortality and air pollution: a comprehensive analysis of U.S. data for 1990.

J Air Waste Manag Assoc 2000 Aug; 50(8):1350-1366.

This paper uses U.S. linked birth and death records to explore associations between infant mortality and environmental factors, based on spatial relationships. The analysis considers a range of infant mortality end points, regression models, and environmental and socioeconomic variables. The basic analysis involves logistic regression modeling of individuals; the cohort comprises all infants born in the United States in 1990 for whom the required data are available from the matched birth and death records. These individual data include sex, race, month of birth, and birth weight of the infant, and personal data on the mother, including age, adequacy of prenatal care, and smoking and education in most instances. Ecological variables from Census and other sources are matched on the county of usual residence and include ambient air quality, elevation above sea level, climate, number of physicians per capita, median income, racial and ethnic distribution, unemployment, and population density. The air quality variables considered were 1990 annual averages of PM10, CO, SO2, SO4(2-), and "non-sulfate PM10" (NSPM10--obtained by subtracting the estimated SO4(2-) mass from PM10). Because all variables were not available for all counties (especially maternal smoking), it was necessary to consider various subsets of the total cohort. We examined all infant deaths and deaths by age (neonatal and postneonatal), by birth weight (normal and low [< 2500 g]), and by specific causes within these categories. Special attention was given to sudden infant death syndrome (SIDS). For comparable modeling assumptions, the results for PM10 agreed with previously published estimates; however, the associations with PM10 were not specific to probable exposures or causes of death and were not robust to changes in the model and/or the locations considered. Significant negative mortality associations were found for SO4(2-). There was no indication of a role for outdoor PM2.5, but possible contributions from indoor air pollution sources cannot be ruled out, given higher SIDS rates in winter, in the north and west, and outside of large cities.

ACCN: SIDS-06201

Ferng,SF, Lee LW.

Indoor air quality assessment of daycare facilities with carbon dioxide, temperature, and humidity as indicators.

J Environ Health 2002 Nov; 65(4): 14-18, 22.

Poor indoor air quality (IAQ) in daycare facilities affects both attending children and care providers. Incident rates of upper-respiratory-tract infections have been reported to be higher in children who attend daycare. Excessive carbon dioxide (CO2) exposure can cause several health effects and even sudden infant death. For this study, 26 facilities were randomly selected in a Midwestern county of the United States. CO2, room temperature, and relative humidity were used as indicators for IAQ and comfort levels. These IAQ parameters were continuously monitored for eight hours at each facility by a direct-reading instrument that was calibrated before each measurement. More than 50 percent of the facilities had an average CO2 level over the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) standard of 1,000 parts per million (ppm). For temperature and relative humidity, respectively, 42.3 percent and 15.4 percent of facilities were outside of the ASHRAE-recommended comfort zones. The nap-time average CO2 level was about 117 ppm higher than the non-nap-time level. The increment of the nap-time CO2 level in the sleeping-only room over the level in multipurpose rooms was statistically significant ($p < .05$). According to stepwise multiple regression analysis, nap-time CO2 level was predicted by CO2 level before occupancy, nap-time average temperature, carbon monoxide, and child density ($R2 = .83$). It is recommended that an appropriate IAQ standard for daycare facilities be established and that children should not be placed in a completely isolated room during nap time.

ACCN: SIDS-06057

George M, Wiklund L, Aastrup M, et al.

Incidence and geographical distribution of Sudden Infant Death Syndrome in relation to content of nitrate in drinking water and groundwater levels.

Eur J Clin Invest 2001 Dec; 31(12):1083-94.

Previous studies indicate that the enteral bacterial urease is inhibited in victims of sudden infant death syndrome (SIDS). One possible inhibitor of this bacterial activity is nitrate. If ambient pollution by nitrate is involved in the etiology of SIDS, only a fraction of the nitrate concentration not infrequently found in drinking water would be enough for this inhibition. Occurrence of SIDS (n=636) in Sweden during the period 1990 through 1996 were analysed regarding geographical and seasonal distribution in relation to the nitrate concentration in drinking water and changes in the groundwater level.Both the birth rate and the incidence of SIDS decreased during the study period. One quarter of the municipalities constituting 11 percent of the population had no cases, the maximum incidence when the rest of the country had its lowest incidence, and the occurrence of individual deaths was associated with the recharge of groundwater, which increases its nitrate content. The local incidence of SIDS was correlated (rs=0.34-0.87) to maximally recorded

concentrations of nitrate in drinking water.The seasonal distribution of SIDS was widely different from the south to the north of the country and seems to be associated with differences in the groundwater level changes subsequent to precipitation, frost penetration, and melting of snow. Use of drinking water with high peak concentrations or great variations in nitrate concentration was correlated to the incidence of SIDS.

ACCN: SIDS-05118

Woodruff TJ, Grillo J, Schoendorf KC.

The relationship between selected causes of Postneonatal Infant Mortality and particulate Air Pollution in the United States.

Environ Health Perspect 1997 Jun; 105(6):608-612.

Recent studies have found associations between particulate air pollution and total and adult mortality. The relationship between particulate air pollution and mortality among infants has not been examined in the United States. This study evaluates the relationship between postneonatal infant mortality and particulate matter in the United States. Our study involved analysis of cohorts consisting of approximately 4 million infants born between 1989 and 1991 in states that report relevant covariates; this included 86 metropolitan statistical areas (MSAs) in the United States. Data from the National Center for Health Statistics-linked birth/infant death records were combined at the MSA level with measurements of particulate matter 10 um or less (PM 10) from the EPA's Aerometric Database. Infants were categorized as having high, medium, or low exposures based on textiles of PM10. Total and cause-specific postneonatal mortality rates were examined using logistic regression to control for demographic and environmental factors. Overall postneonatal mortality rates were 3.1 among infants with low PM10 exposures, 3.5 among infants with medium PM10 exposures, and 3.7 among highly exposed infants. After adjustment for other covariates, the odds ratio (OR) and 95% confidence intervals (CI) for total postneonatal mortality for the high exposure versus the low exposure group was 1.10 (1.04, 1.16). In normal birth weight infants, high PM10 exposure was associated with respiratory causes [OR = 1.40, (1.05, 1.85)] and sudden infant death syndrome [OR = 1.26, (1.14, 1.39)]. For low birth weight babies, high PM10 exposure was associated, but not significantly, with mortality from respiratory causes [OR = 1.18, (0.86, 1.61)]. This study suggests that particulate matter is associated with risk of postneonatal mortality. Continued attention should be paid to air quality to ensure optimal health of infants in the United States.