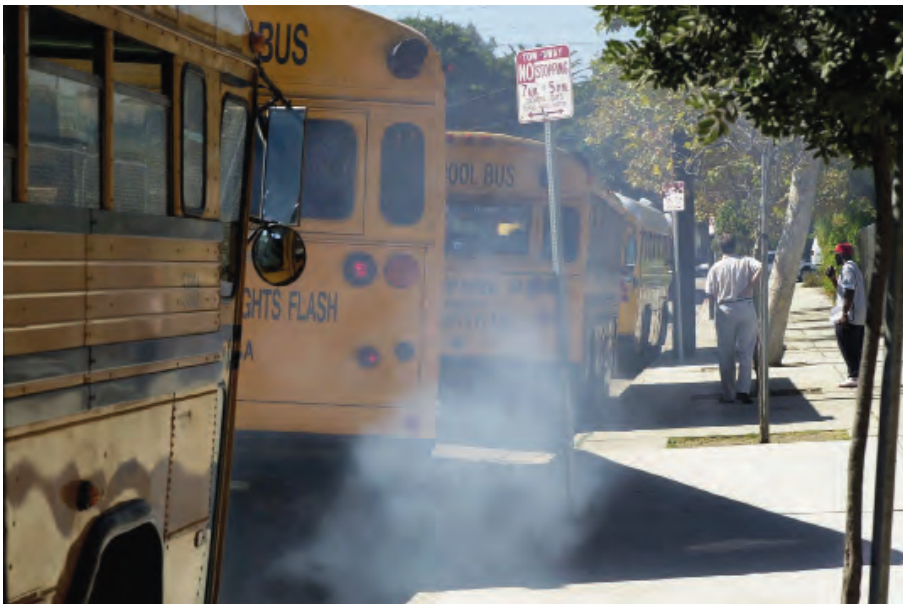
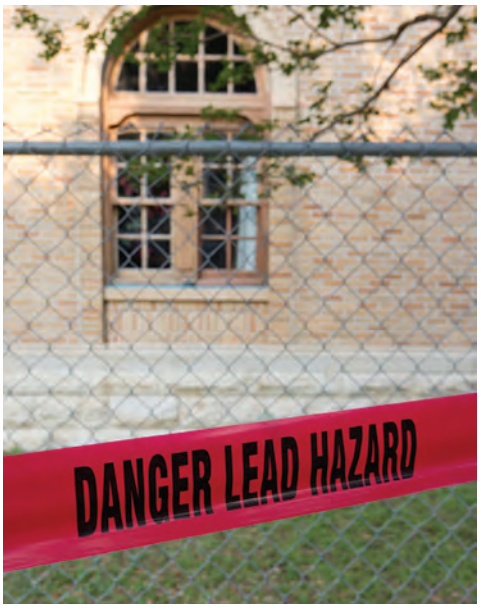
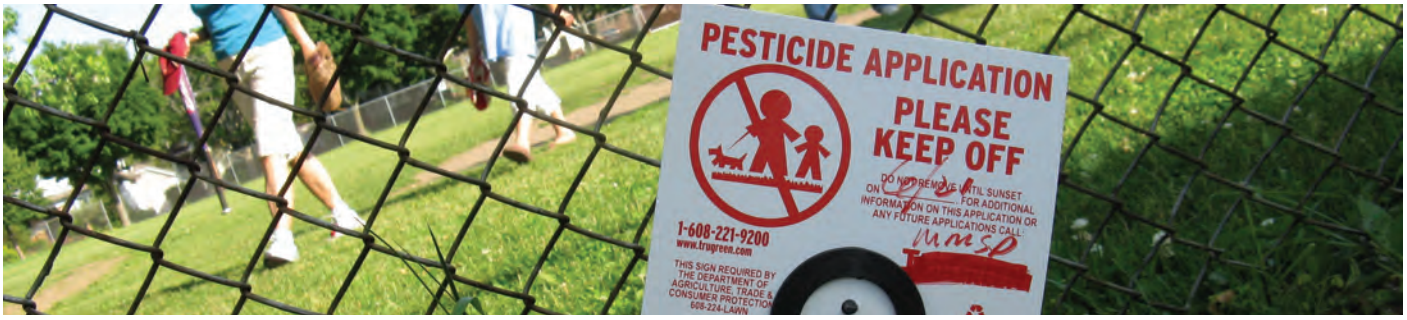
First, Do No Harm

Children's Environmental Health in Schools







At school and at home, in playgrounds and public parks, children (and adults) are constantly exposed to environmental toxins, including vehicle emissions, peeling lead paint, and pesticides, as the photos above show.

By Kevin M. Chatham-Stephens, Mana Mann, Andrea Wershof Schwartz, and Philip J. Landrigan

In the past century, the threats to our children's health have shifted radically. Life-threatening infectious diseases—smallpox, polio, and cholera—have been largely conquered. Babies born in the United States today are expected to live two decades longer than their ancestors did 100 years ago.

But our children are growing up in a world in which environmental toxins are ubiquitous. Measurable levels of hundreds of man-made chemicals are routinely found in the bodies of all Americans, including newborns. Infants are exposed to polychlorinated biphenyls, lead, and mercury in the womb and through breast milk. Baby bottles and toys have been found to contain phthalates, bisphenol A, and lead, all toxins that have been linked to reproductive and developmental disorders.

As harmful elements detected in everyday household items increase, rates of chronic disease have also risen sharply—and these conditions are now the leading causes of childhood illness and death. Air pollution and cigarette smoke contribute to asthma, the most common chronic disease of childhood, which has increased 160 percent in the past 15 years for children under age 5. Chemicals called endocrine disruptors—found in pesti-

Kevin M. Chatham-Stephens and Mana Mann are fellows in Environmental Pediatrics with the Children's Environmental Health Center at the Mount Sinai Medical Center. Andrea Wershof Schwartz is a resident in Internal Medicine at Brigham and Women's Hospital; previously, she was a postdoctoral research fellow in Preventive Medicine at the Mount Sinai School of Medicine. Philip J. Landrigan is the dean for Global Health, chairman of the Department of Preventive Medicine, director of the Children's Environmental Health Center, and professor of Pediatrics at the Mount Sinai School of Medicine and Mount Sinai Medical Center. He also leads the New York–Northern New Jersey National Children's Study (NCS) Center. NCS is the largest study of children's health and the environment ever launched in the United States.

cides, herbicides, some plastics, and air and water—can interfere with the body's hormone signaling system, potentially causing reproductive disorders, neurologic impairments, and immune dysfunction. Cancer, which kills more children under age 15 than any other disease, is linked to solvents and pesticides. Early exposure to lead, mercury, and certain pesticides are suspected to contribute to autism, ADHD, and other developmental conditions, which affect 5 to 10 percent of babies born each year.

A contaminated environment takes an economic toll, costing $76 billion in medical treatment and lost productivity each year. Efforts to improve the health of our population can be successful only if they are tied to strong environmental policies.[1]

Historically, this has paid off. In the 1970s, landmark studies on childhood lead poisoning resulted in the removal of lead from paint and gasoline, producing a 90 percent decline in lead poisoning. Children's average intelligence subsequently rose by five to six IQ points. And in the 1990s, two major pesticides were banned after being shown to have detrimental effects on childhood development.

As harmful elements detected in everyday items increase, rates of chronic disease have also risen sharply—and these conditions are now the leading causes of childhood illness and death.

Responsibility for developing strong environmental policies does not rest with government alone. Other organizations—including schools—also should have carefully developed policies to ensure that they provide clean and safe environments. School-age children can spend anywhere from 35 to 50 hours per week in and around school facilities. As a result, the physical environment of the school plays an important role in children's (and employees') health. The design and maintenance of the school environment should take into consideration that children are not "little adults." Compared with adults, they breathe at a faster rate, their metabolic rates are higher, and they consume more food and water per pound of body weight. Since school-age children are still growing and developing, chemicals in their environment can affect them differently than adults.[2] Because of their unique interaction with their surrounding environment, it is vital to ensure a safe school environment for all children. Teachers and administrators can serve as advocates for children by identifying and addressing environmental hazards in schools. This article highlights common environmental problems in the school setting—lead, pesticides, mercury, arsenic, outdoor and indoor air pollution, mold, asbestos, radon, bisphenol A/phthalates, and polychlorinated biphenyls—and identifies steps teachers and administrators can take to prevent or minimize exposure to these problems.

Deteriorating classrooms are not only unsightly, they are unhealthy. Water damage can cause mold, and peeling paint may contain lead.

Lead

Lead is a heavy metal long recognized as toxic to humans. Although it is used for many industrial purposes, there is no level of lead in the blood considered to be safe for humans. Children are at particularly high risk for lead toxicity because their brains are developing at a rapid pace, and younger children are more likely to ingest lead in dust via hand-to-mouth behavior, such as crawling or playing on the ground and then eating.[3] The adverse health effects of lead on the developing brain are of particular relevance to the school environment, since lead can cause deficits in attention and IQ, as well as behavioral problems, even at low levels of exposure.[4] Children with low levels of lead poisoning will likely not display any acute symptoms, although higher levels of lead can result in constipation, anemia, seizures, and even death. Other populations at elevated risk within the school population include pregnant women, whose fetuses' brains are especially vulnerable to the toxic effects of lead, and children with developmental delays who may have

particularly susceptible brains and may exhibit more hand-to-mouth behavior.

Sources of Lead in the School Environment
The potential exposure pathways for lead most relevant for schools include deteriorating lead-based paint, lead-contaminated dust and soil, lead-containing art supplies, and lead-lined water pipes and water coolers.[5] Although lead-based paint was banned in the United States in 1977, older school buildings may still contain lead-based paint, which poses a risk particularly if the paint is in poor condition and may flake onto the floor, accumulating as dust that could be inhaled or ingested. Particular caution should be taken in kindergarten and prekindergarten because children in these age groups are more likely to engage in hand-to-mouth behavior. Lead also can be present in dust from vehicle emissions, although the sale of lead-based gasoline for on-road vehicles was phased out through 1986 by the United States Environmental Protection Agency (EPA). Lead in soil is of special concern for school playgrounds that may be near a source of lead, such as a battery plant. Art supplies such as paint and crayons also may contain lead, but are legally required to be labeled as such, according to the Labeling of Hazardous Art Materials Act of 1988. Lead-lined water pipes may leach lead into drinking water, particularly when the water has been sitting overnight, or over weekends or holidays. A 2006 study found that drinking water was not considered an important source of lead at the background levels typically found in schools' drinking water, although specific schools' piping systems may contain higher levels of lead than those studied.[6] Water coolers could be lined with lead, but since 1988 they have been legally required to be lead free.

Lead in soil is of special concern for school playgrounds that may be near a source of lead, such as a battery plant.

The Educator's Role in Preventing Exposure to Lead
There are several ways educators can help avoid lead exposure for themselves and their students. They can contact the principal or building manager to ensure that the school has been inspected for any sources of deteriorating lead-based paint, and that the school system's water has been tested. Special precautions such as closing off rooms or buildings should be taken when renovating or removing lead-based paint, as the dust generated can pose a hazard. Even when renovations are not being done, the school should be wet mopped regularly to minimize dust. Educators also can make sure to purchase safe lead-free art supplies and toys for classroom use by checking labels carefully. Teachers can work together with parents to teach children about lead and safe behaviors that can prevent lead ingestion, such as hand washing before eating to remove dust from hands. For more resources, see **www.leadfreekids.org** or call the National Lead Information Center hotline at 1-800-424-LEAD [5323].

Pesticides

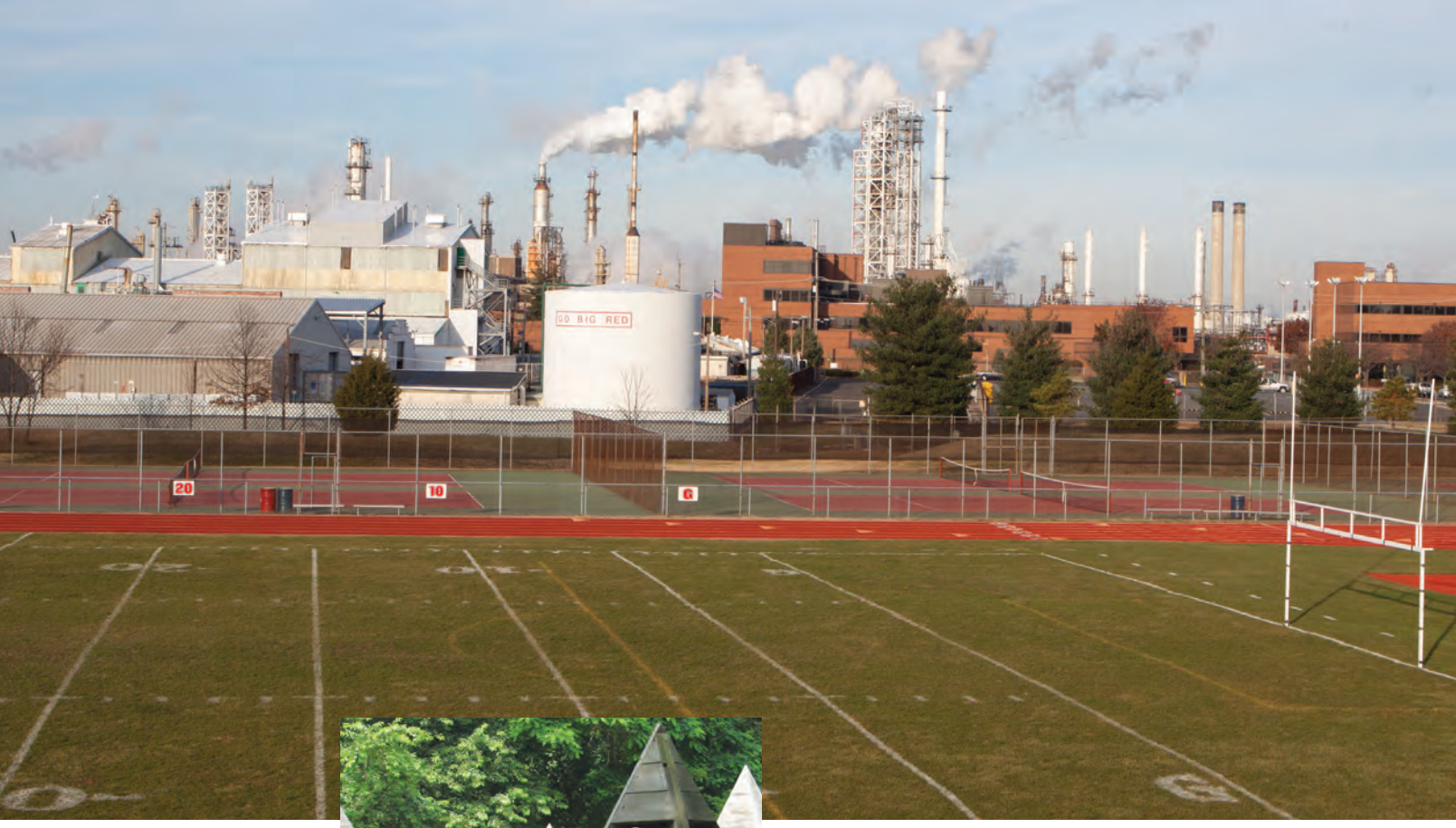
Pesticides, such as insecticides, herbicides, fungicides, and disinfectants, are used in schools to maintain hygienic conditions and control rodents and insects. While they play a role in protecting the food supply and controlling disease, there is increasing scientific evidence that pesticides can be harmful to humans, especially children. Children are particularly vulnerable because they have less-developed detoxification pathways as well as a longer life expectancy, thereby permitting a greater time in which to develop diseases with long dormancy periods.

Pesticide exposure can cause both acute and chronic health effects. The acute health effects are cough, shortness of breath, nausea, vomiting, eye irritation, and headaches. There is also increasing evidence of an association between pesticide use and health problems such as cancer, as well as neurologic and reproductive health problems. Pesticide exposure at schools has been linked to illnesses among employees and students, albeit rarely. Higher rates of illness occur in school staff than in students because staff members more commonly handle pesticides.[7]

Sources of Pesticides in the School Environment
Children and adults are exposed to pesticides through inhalation, ingestion, and dermal contact. Children can be exposed to pesticides that have been applied in school buildings and on playgrounds. Pesticides can be inhaled during or after application, and children may absorb pesticide residues through their skin by touching surfaces that have been treated. Pesticides also can accumulate in the soil around the school and be ingested when a child plays in this soil (especially through the hand-to-mouth activity common among younger children). In addition, pesticide residues may be found on fruits and vegetables, highlighting the importance of thoroughly washing fruits and vegetables to decrease pesticide exposure. There is also a risk of a child swallowing pesticides that are stored in their environment.

The Educator's Role in Preventing Exposure to Pesticides
Implementation of Integrated Pest Management (IPM) programs can reduce exposure to pesticides among children and school staff. IPM is a technique that controls pests by preventing their access to food, water, and shelter. IPM programs can be more cost-efficient than, and as effective as, traditional pest-control techniques using pesticides.

The first step of initiating an IPM project is to create a team to develop written policy and procedure guidelines for school pest management. These guidelines should include appointing a pest manager, monitoring and identifying the nature of the pest problems, and eliminating the source of the problems without pesticides (e.g., repairing cracks or crevices, sealing doors, moving trash receptacles away from the building, and ensuring sanitary conditions). As part of the program, the school community should be educated about pesticides and IPM. If nontoxic methods fail or are impractical to control pests, the least-toxic pesticides may be used (pesticides without labels such as "Warning" or "Danger"), and only trained workers should handle and apply pesticides, following the directions on the pesticide container and wearing protective equipment. The school community should be notified and provided with reentry recommendations when pesticides are used. After implementing IPM, records of



Above, toxins from a chemical plant blow right over a school's athletic field, putting players and fans at risk. Right, wooden playgrounds may look inviting, but some have been built with wood treated with a form of arsenic.

pest control should be reviewed and the IPM program evaluated to address limitations and improve effectiveness. For further information, visit the National Institute for Occupational Safety and Health's website at **www.cdc.gov/niosh/docs/2007-150**.

Mercury

As with lead, there is no safe level of mercury in the human body. High levels of mercury can cause acute neurological symptoms such as hallucinations, flushing, vomiting, and vision changes. Pregnant women, fetuses, and children are particularly at risk for harm from exposure to even low levels of mercury, since it can increase the risk of miscarriage as well as cause damage to the developing brain, leading to decreased IQ and impaired memory and attention. Mercury also can damage the kidneys and heart.

Sources of Mercury in the School Environment

Mercury occurs naturally in coal and petroleum, and enters the environment when these fuels are burned. This mercury deposits in rivers, lakes, and the ocean. The most common way people are exposed to mercury is by consuming fish that lived in contaminated water, with bigger fish such as tuna and shark containing the highest levels of mercury. Mercury is a silvery liquid at room temperature and is used in many places in the school environment, including lab equipment, thermometers, thermostats, batteries, and fluorescent light bulbs.[8] If not discarded properly, these items can release mercury into the air or ground, which can then be inhaled or ingested. For example, compact fluorescent light bulbs (CFLs), which are increasingly popular in schools and homes because of their increased efficiency compared with incandescent bulbs, can release vaporized mercury if broken.[9] Latex paints contained some mercury in the past, but since 1991 mercury has been banned from paints intended for indoor use.

The Educator's Role in Preventing Exposure to Mercury

Even small mercury spills in the school environment should be cleaned up by a specialist—and never with a vacuum cleaner—since small amounts of mercury can vaporize and spread through the air if not disposed of properly.[10] Teachers should be educated about and cautious in the storage and use of any mercury-containing equipment to prevent breakages and spills.[11] Educators can learn about the safe disposal and clean-up process for broken CFLs or mercury-containing thermometers. They also should be ready to contact local public health authorities immediately in the case of a mercury spill. Schools can make an effort to eliminate unnecessary use of items containing mercury by replacing devices with safer alternatives. Since a more common source of mercury exposure is ingestion of contaminated fish, school cafeterias

should work with local authorities to avoid serving species of fish known to contain high levels of mercury. For more resources, see the EPA's special website for mercury in schools at **www.epa.gov/hg/schools.htm** or visit **www.mercuryinschools.uwex.edu**.

Arsenic

A child's developing body is particularly vulnerable to arsenic, a dangerous toxin that can affect every organ system. Exposure to arsenic can increase the risk of cancer and diabetes, cause skin and nervous system problems, and interfere with the body's hormones. Arsenic can be inhaled or ingested and can affect developing fetuses when pregnant women are exposed, increasing the risk of miscarriages and birth defects.

Sources of Arsenic in the School Environment

Arsenic occurs naturally in the earth's crust, and has been used for many industrial purposes, from pest control to smelting, that emit it into water, soil, or air.[12] For instance, a school using well water contaminated with arsenic, or a school situated near a smelter that emits arsenic into the air, would be at higher risk. The best-known potential exposure to arsenic in a school environment is from playgrounds made from wood treated with a type of arsenic known as chromated copper arsenate (CCA) to kill pests and preserve the wood. A 2004 Canadian study found that children who played on CCA-treated wooden playgrounds, or on the ground around them, did indeed have higher levels of arsenic on their hands than children who played on playgrounds made of other materials. However, the study also found that the overall exposure was lower than the amount of arsenic typically ingested from food and water.[13] A 2010 study confirmed these findings and found no difference in the level of arsenic in the urine and saliva of children playing on CCA-treated wooden playgrounds compared with children playing on other playgrounds.[14]

The Educator's Role in Preventing Exposure to Arsenic

As research continues about the impact of CCA-treated wooden playgrounds, educators can encourage children to wash their hands after playing on such playgrounds or on the ground around them, especially before eating. The Safe Playgrounds Project, through the Center for Environmental Health, has successfully lobbied to remove arsenic from wood intended for new playgrounds as of 2003. The project's website provides more information about how to minimize arsenic exposure when playing on older playgrounds (visit **www.safe2play.org**). Educators also can work with school administrators to ensure that the school's water has been tested for arsenic.

Outdoor Air Pollution

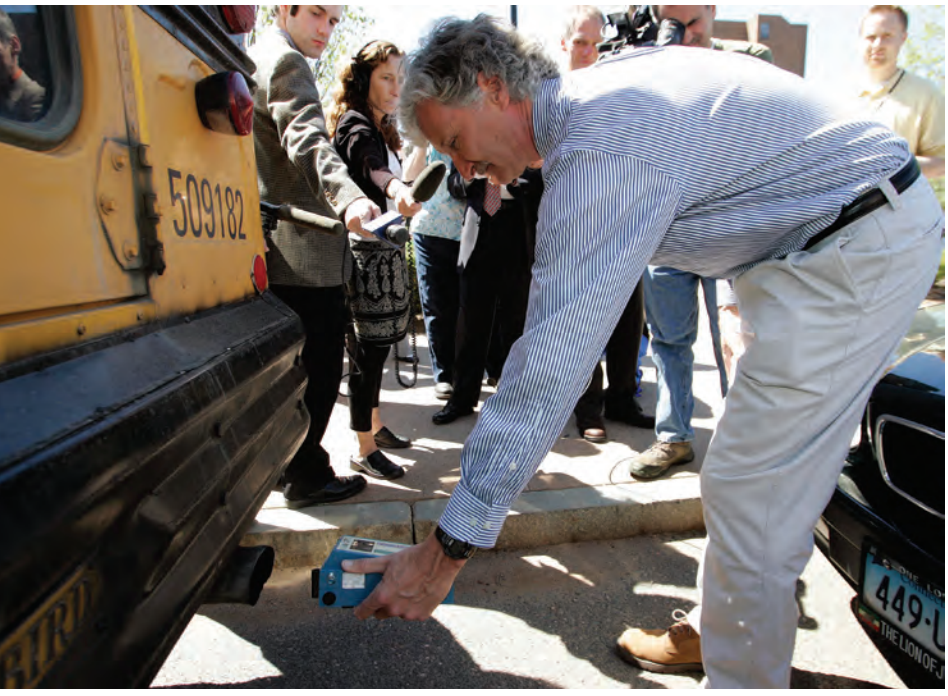
Acute health effects associated with outdoor air pollution are increased respiratory symptoms (e.g., wheezing, cough, and transient decrease in lung function) and increased school absenteeism due to respiratory illnesses. Children with asthma in particular are at risk for more respiratory symptoms, increased medication use, chronic phlegm, and more bronchitis following exposure to high levels of particulate pollution. In urban areas, a decrease in air quality can result in an increased number of hospitalizations among asthmatics. Living near areas of high traffic-related pollution has been linked to increased incidences of wheezing, bronchitis, and asthma hospitalization. Furthermore, attending schools in areas with high levels of traffic-related pollution has been implicated in higher rates of asthma diagnoses in children.[15] Diesel exhaust, specifically, may worsen allergic and inflammatory responses to antigens (e.g., pollen) and may lead to the development of new allergies.[16]

Children are particularly sensitive to outdoor air pollution because they spend more time outside and are more active than adults, breathing more rapidly and inhaling more pollutants per pound. Furthermore, because children's airway passages are smaller, irritation by air pollutants can cause a proportionally greater level of airway obstruction.

Sources of Outdoor Air Pollution in the School Environment

The sources of outdoor air pollution include both stationary and mobile sources that may be located adjacent to school buildings. Stationary sources of air pollution are factories, power plants, and smelters, as well as smaller sources such as dry cleaners and degreasing operations. The mobile sources of outdoor air pollution are cars, buses, trucks, trains, and airplanes. Naturally occurring sources (windblown dust and volcanic eruptions) also contribute to outdoor air pollution. These pollution sources can emit a wide variety of pollutants and affect air quality.

The EPA, as well as national, state, and local organizations, monitors air quality by measuring the levels of six pollutants (ground-level ozone, carbon monoxide, particulate matter, sulfur dioxide, lead, and nitrogen dioxide). Of these six, ground-



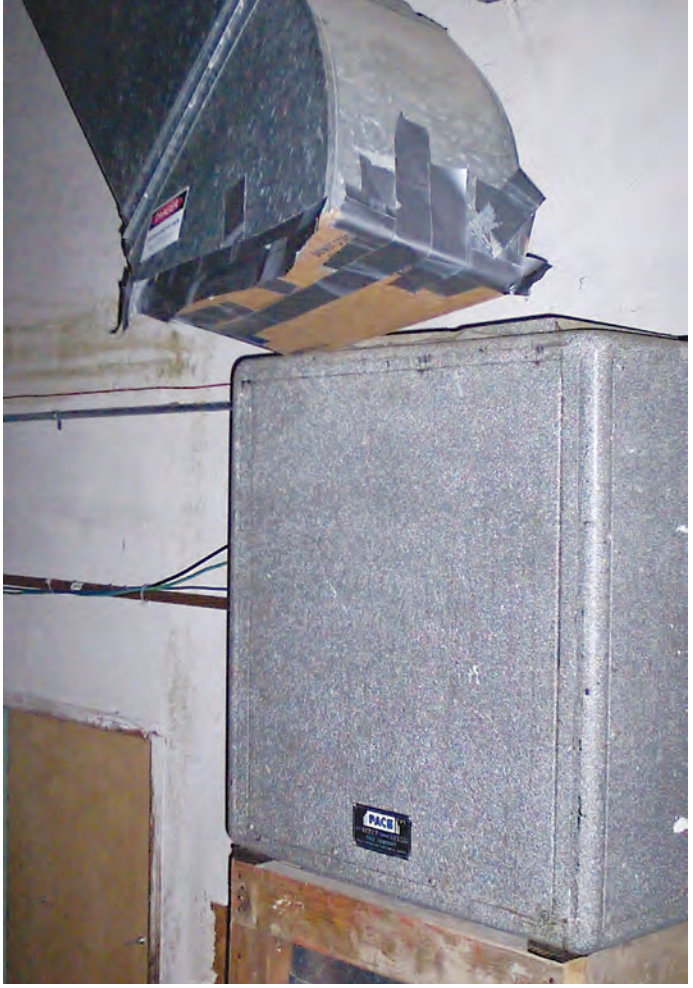
As the article states, "attending schools in areas with high levels of traffic-related pollution has been implicated in higher rates of asthma diagnoses in children." Above, a scientist measures the diesel particulate pollution from a school bus.

level ozone and particulate matter are the most hazardous to humans. Ozone is the principal component of urban smog, formed in the atmosphere from a chemical reaction involving sunlight and exhaust from motor vehicles and power plants. The movement of chemical emissions from these sources can affect ozone levels hundreds of miles downwind from the original sources. Ozone levels are highest on hot, dry, stagnant summer days and increase in the late afternoon. Particulate matter consists of a mixture of solid particles and liquid droplets. Particulate matter smaller than 10 micrometers in diameter (called PM_{10}) can be seen as a general haze that impairs visibility.

The Educator's Role in Preventing Exposure to Outdoor Air Pollution
There are several steps schools can take to minimize the exposure of students to outdoor air pollution. For example, many states have instituted idling laws for vehicles. These laws require the driver of a school bus, transit bus, or other commercial heavy-duty vehicle to minimize idling at public and private schools. Schools can work with officials to limit truck traffic near classrooms during school hours if the nearby roads are under local jurisdiction. Schools also can develop a policy to minimize idling of cars at the school, especially during drop-off and pickup times when many children are nearby. The school community can promote the purchase of clean, low-emitting fuels for buses when replacing old diesel school buses, and can equip existing buses with exhaust particle filters. In addition, schools near busy roads can decrease children's exposure by ensuring proper installation and maintenance of heating, ventilation, and air conditioning (HVAC) systems, and can try to avoid locating air-intake vents close to busy roads. Furthermore, schools can upgrade their current HVAC filters to higher-efficiency ones. During peak traffic hours, windows and doors should be closed to reduce traffic pollution. Also, if possible, outdoor school activities should occur in areas farther from high-traffic roads, especially during peak traffic hours.

Schools near busy roads can decrease children's exposure by ensuring proper installation and maintenance of heating, ventilation, and air conditioning systems.

A school nurse (which all schools should have) may want to check the daily air quality index, a color-coded scale that reports levels of air pollutants, and recommend precautions for asthmatics on days when the air quality is forecasted to be poor. Some examples of precautions include staying indoors, limiting outdoor activities as much as possible, or venturing outdoors only in the early morning when pollutant levels are often lower. If the air quality forecast calls for poor air quality, the nurse can discuss with physical education teachers and administrators whether scheduled outdoor activities should be held indoors for the day. For further information, visit **www.oehha.ca.gov/eastbaykids/factsheetschoolsfinal.pdf** and **www.dnr.wi.gov/air/aq/health/healthprofessionals.htm**.



Indoor Air Pollution

Indoor air quality problems often cause nonspecific symptoms rather than clearly defined illnesses. Indoor air pollutants can irritate the skin, eyes, nose, throat, and upper airways. They may also cause redness or inflammation of the skin, headache, and abnormal taste. Exposure to these chemicals can result in respiratory effects such as rapid breathing, exacerbation of asthma and allergies, and flu-like symptoms. Asthmatics may be particularly susceptible to indoor pollutants. Central nervous system effects from carbon monoxide, one example of an indoor air pollutant, may include headache, fatigue, nausea, and if severe, lack of coordination, impaired judgment, and blurred vision.

Sources of Indoor Air Pollution in the School Environment
Many schools are in old, ill-maintained buildings that are at risk for poor indoor air quality. The levels of specific contaminants in indoor air can be significantly higher than outdoor levels. Some examples of indoor air pollutants are formaldehyde and other volatile organic compounds (which include highly scented products, paints and lacquers, rug cleaners, and paint strippers), pesticides, molds and bacteria, and byproducts of combustion such as solid particles, carbon monoxide, and nitrogen oxides. Other factors that affect the quality of indoor air include the activities of building occupants (including maintenance activities), types of building materials, furnishings and equipment, levels of outdoor contamination, seasons, indoor humidity and tempera-

ture, and ventilation rates. Secondhand cigarette smoke is also an important source of indoor air pollution.

The Educator's Role in Preventing Exposure to Indoor Air Pollution

Teachers and staff should protect students' health and set a positive example by not smoking. In addition, it is important for students, teachers, and staff to be trained to take precautions in storing and handling toxic materials used in school (such as formaldehyde for animal specimen preservation). Furthermore, instructional facilities and equipment, including exhaust systems, need to be properly designed to avoid exposing students and staff to pollutants. All schools must have an effective way to ventilate the building by supplying outdoor air to the occupied areas within the school to remove pollutants.[17] For more information, see the EPA's Indoor Air Quality (IAQ) Tools for Schools website at **www.epa.gov/iaq/schools/index.html**. The site's Action Kit includes a variety of resources, checklists, and other means to evaluate and optimize air quality in schools.

Above, this water-damaged ceiling could be growing mold, causing allergy-like symptoms and asthma attacks. Right, asbestos, found in a variety of construction materials, is very dangerous when disturbed—for instance, when floor tiles with asbestos are broken. Removal must be done by trained specialists.

Mold

The main way that mold causes health problems is through inhalation of airborne mold spores. Research has shown that exposure to mold can result in allergic symptoms (e.g., runny nose and red, itchy eyes), common cold–type symptoms (e.g., nasal congestion and cough), and asthma attacks.[18] Some individuals are allergic to certain types of mold, which places them at higher risk for having symptoms. Children with difficult-to-control asthma may benefit from allergy testing, including evaluating for mold allergy. Families of children with asthma should discuss this issue with their health care provider. In addition, children with compromised immune systems, including those with cancer or receiving chemotherapy, also may be more susceptible to health problems from mold.

Sources of Mold in the School Environment

While typically thought of as a problem with forgotten food in the back of the refrigerator, mold can grow in any room in any type of building, including schools, where there is too much moisture or inadequate ventilation. Molds are fungi that occur naturally throughout the world. While you cannot see mold spores (the reproductive units of molds) with the naked eye, they are usually present in both outdoor and indoor air.

The Educator's Role in Preventing Exposure to Mold

Where there is a mold problem, there is a moisture problem. If mold is found, then the area should be cleaned appropriately, and the source of moisture that led to the mold must be identified and dealt with. The area should not just be painted over without addressing the source of water. Not all mold problems are directly visible, since mold can grow in hidden locations, such as underneath carpets and above ceiling tiles. Therefore, school staff should be aware of musty odors and water damage, both of which could be signs of mold. Areas of mold covering less than 10 square feet can be cleaned with water and soap, while larger areas should be addressed by trained individuals. The EPA has a fact sheet regarding mold in schools that lists several preventive strategies, including fixing any water leaks promptly, avoiding installing carpets in areas prone to getting wet, and ensuring rooms are adequately ventilated.[19] In addition, relative humidity in the school should be maintained at 30 to 50 percent.

Air testing to determine the specific type of mold generally is not warranted, as the area should be cleaned regardless of the testing results. Complicating the question of whether to perform air testing are the facts that molds occur naturally, specific health levels have not been determined for the various types of mold, and individuals may react to certain types but not to others. If sampling for mold is deemed necessary, perhaps due to a persistent moldy odor of unknown source, then this should be performed by experienced contractors who adhere to recommended methods. Schools should consider hiring separate contractors to perform testing and remediation to reduce conflicts of interest. For further information, see **www.cdc.gov/mold** and **www.epa.gov/mold/moldresources.html**.

Asbestos

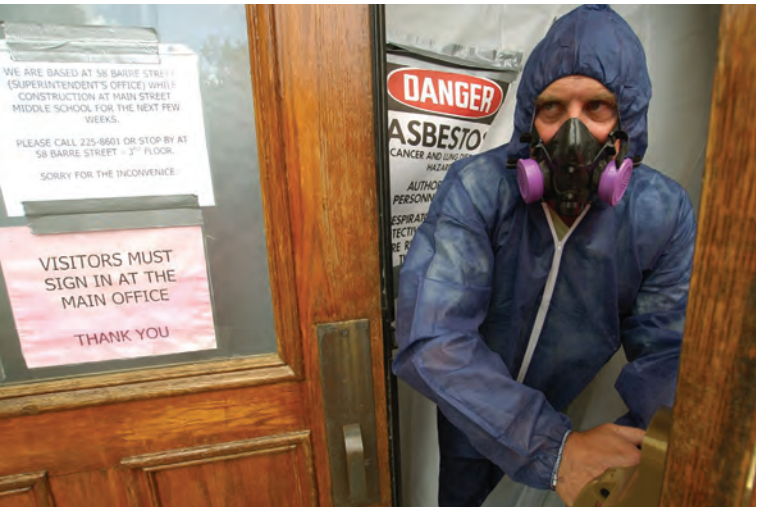
Asbestos is a fibrous mineral that occurs in nature in certain countries, notably Canada, Russia, Brazil, Australia, and South Africa. It is mined and then manufactured into a wide array of products. Asbestos is extremely resistant to fire and heat. Because of these properties, asbestos was used extensively in insulation and con-

struction materials in the years prior to recognition of the grave dangers that it poses to human health. Much asbestos was used in school construction in the United States, especially from the 1950s to the 1980s.

Asbestos is an extremely hazardous material. While it does not cause acute health effects or symptoms following exposure, asbestos is a known human carcinogen. All forms of asbestos have been shown capable of causing cancer in humans, including mesothelioma and cancers of the lungs, larynx, ovaries, and probably the gastrointestinal tract.[20]

Asbestos poses no hazard to health so long as it is in place and intact. Therefore, a child who attends a school known to have asbestos-containing materials is unlikely to be at risk for developing these health problems as long as these materials are well maintained and remain undisturbed.

When asbestos is disturbed or fractured, microscopic fibers of asbestos mineral are released into the air. Without the protective gear that asbestos remediation crews wear, these invisible air-



borne fibers can be inhaled. Because of their very small diameter, inhaled asbestos fibers can move deep into the respiratory tract and become trapped in the lungs. Once they are trapped in lung tissue, asbestos fibers can remain in the human body for years.

Chronic exposure to high levels of asbestos can lead to multiple lung diseases, including asbestosis, a chronic inflammation of the lungs that can cause shortness of breath and respiratory failure; malignant mesothelioma, a cancer of the lining of the lungs; and lung cancer. Asbestosis and asbestos-related lung cancer are seen primarily in industrial and construction workers with long histories of intense occupational exposure to asbestos. The risk of lung cancer is greatly magnified in asbestos-exposed workers who smoke cigarettes.[21] But malignant mesothelioma can result from even brief, low-dose, nonoccupational exposures to asbestos. Thus, there is no safe level of exposure to asbestos. Mesothelioma can occur in students, teachers, and other school personnel who are exposed to asbestos in their schools. Malignant mesothelioma typically arises 20 to 50 years after exposure. Asbestos is the only known cause of malignant mesothelioma.

Sources of Asbestos in the School Environment

Many buildings, including schools, constructed or renovated prior to the 1980s still contain asbestos today.[22] Specific materials in schools that may contain asbestos include boiler wraps, ceiling tiles, dry wall, floor tiles, and insulation surrounding pipes.

The Educator's Role in Preventing Exposure to Asbestos

Due to its potentially fatal effects, the use of asbestos has been largely phased out in developed countries. Since asbestos still remains in many buildings, however, exposure may still occur. Exposure is likely to occur during renovation or demolition projects. Through the Asbestos Hazard Emergency Response Act of 1986, the federal government requires that all schools in the United States periodically inspect for asbestos-containing materials, create a plan to manage these materials, and regularly evaluate these locations to check for any degradation. School authorities are mandated to make the results of these inspections available to the public. Asbestos that remains intact in a building typically does not represent a threat; actions that may disturb asbestos-containing materials and release the fibers into the air should be avoided.[23] For this reason, authorities usually recommend that schools do not remove asbestos unless the material is severely damaged or is a component of a renovation project. Any such projects should be performed by trained, certified individuals. If there is concern about asbestos due to, for instance, a fallen ceiling tile or damaged insulation in a boiler room, then the school's custodial staff and administration should be notified. The EPA maintains a website dedicated to the topic of asbestos in schools, including a description of the health effects and ways to minimize exposure to asbestos; for further information, see **www.epa.gov/asbestos/pubs/asbestos_in_schools.html**.

Radon

Radon is an odorless, tasteless, invisible gas produced through the decay of uranium in soil and water. It is a type of ionizing radiation that can cause lung cancer, the only known effect of radon on human health. There is no evidence that children are at a higher risk of lung cancer than adults.

Sources of Radon in the School Environment

Radon is found in both outdoor and indoor air. A nationwide survey of radon levels in schools estimates that nearly one in five has at least one classroom with a short-term radon level above the action level of 4 pCi/L (picocuries per liter), the EPA level at which schools are required to take action to reduce the level. More than 70,000 schoolrooms in use today are estimated by the EPA to have high short-term radon levels.

The Educator's Role in Preventing Exposure to Radon

The EPA recommends that all schools be tested for radon, but according to a recent estimate, only 20 percent of schools nationwide have performed some testing. Some states, however, have tested all their public schools.[24] It's important to test all frequently used rooms on and below the ground level and to conduct tests in the cooler months of the year. If the average of the initial and short-term follow-up tests is 4 pCi/L or greater, or the result of the long-term test is 4 pCi/L or greater, then a qualified radon service professional must evaluate and remediate the problem (see **www.epa.gov/radon/radontest.html**).

Left, this playground had unsafe levels of lead and arsenic in the soil, so the ground was covered in fabric and capped with clean soil to prevent children from being exposed to the toxins. Below, one of the most important things teachers can do to minimize exposure is to have students wash their hands frequently—especially before eating.

Bisphenol A (BPA)/Phthalates

During the past two decades, there has been an increasing focus on the potential health effects of various groups of chemicals used in plastic materials. Many of these chemicals are endocrine disruptors, meaning they can interfere with our hormone system. Bisphenol A (BPA) and phthalates are examples of endocrine disruptors that have come under scrutiny. Much of the information we have regarding potential health effects for both of these chemicals comes from animal studies. Studies have found that individuals with higher levels of BPA in their urine have changes in some of their hormone levels, increased levels of abnormal liver enzymes, and higher rates of diabetes mellitus ("type 2 diabetes") and cardiovascular disease.[25]

Exposure to phthalates while in the womb has been associated with abnormalities in the genitals of newborn males and with poorer scores on behavior tests (specifically aggression, conduct, and attention) in school-age children.[26] Similar to the BPA studies, these findings do not prove that phthalates cause these changes or diagnoses directly, but that there is an association and further research is needed to clarify the potential relationship between these chemicals and human health.

Sources of BPA/Phthalates in the School Environment

BPA, which was initially considered to have potential medical applications due to its ability to mimic the female hormone estrogen, has been used in plastics for decades. It is commonly found in items made of #7 plastics, such as drinking water bottles; in the linings of food cans; in dental sealants; and in the ink used to print receipts.[27] Diet is thought to be the greatest source of exposure for most individuals, as BPA leaches into food and drinks from packaging. Exposure to BPA is common, with more than 90 percent of people in the United States having BPA in their urine.[28]

Phthalates, which are often found in polyvinyl chloride (PVC) or #3 plastics, are in a wide variety of materials, including medical bags, tubing, and catheters; children's toys; household items such as shower curtains and floor tiling; and personal care products (often an ingredient in the "fragrance" listing).

The Educator's Role in Preventing Exposure to BPA/Phthalates

Due to concerns about potential health effects, especially in children, some government bodies have banned BPA in certain products, such as baby bottles. In the school setting, measures to reduce children's exposure to BPA include avoiding #7 plastics, using BPA-free plastics, not microwaving food in plastic containers, and seeking alternatives to canned food, such as fresh or frozen vegetables.

In daycare and preschool settings, infants and toddlers may be at the highest risk for exposure to phthalates given their developmentally appropriate hand-to-mouth behavior. Schools with youth of all ages should seek to purchase phthalate-free plastics, use fragrance-free products, and ensure that dust is minimized, as this also can be a source of phthalate exposure. For further information, see **www.aoec.org/pehsu/facts.html**.

Polychlorinated Biphenyls

Polychlorinated biphenyls (PCBs) are man-made chemicals that were frequently used in building materials and electrical products. The EPA banned manufacturing of PCBs in 1978, but buildings constructed or renovated between 1950 and 1978 may still have materials and electrical products with PCBs. Products containing PCBs include caulk, paint, glues, plastics, fluorescent lighting ballasts, transformers, and capacitors.

Acute exposure to high levels of PCBs can lead to rashes, decreased liver function, headaches, dizziness, nausea, vomiting, and abdominal pain. These symptoms are seen only among people with exposure to very large amounts of PCBs (for example, workers who handle PCBs or people who ingest PCBs).[29] Long-term exposure to lower levels of PCBs also can cause health effects. Results from animal studies have shown that exposure may affect the immune, reproductive, nervous, and endocrine systems, and may cause cancer. Studies with humans have shown inconsistent findings for these health outcomes. Studies also show that high levels of PCBs in pregnant women (through regular ingestion of PCB-contaminated fish, for example) can affect their children's birth weight, behavior, and development.[30]

Sources of PCBs in the School Environment

PCBs remain in the environment for a long time because they

break down very slowly; they can be found in soil, air, water, and food. Because they are ubiquitous in the environment, almost everyone has been exposed to PCBs, and most people have some level of PCBs in their bodies. Since their ban, however, PCB levels in people have been decreasing.

The major source of PCB exposure is through food. Meat, dairy products, and fish contain small amounts of PCBs. In schools, exposure to PCBs can occur through the use of building materials and electrical products such as fluorescent light ballasts that release PCB-containing vapor and dust when they break down or are disturbed. Teachers and students can be exposed by inhaling these vapors and dust, through hand-to-mouth contact, and by dermal contact with PCB-containing materials.

The Educator's Role in Preventing Exposure to PCBs

There are steps educators can take to minimize exposure to PCBs. By consulting the EPA's IAQ Tools for Schools Action Kit (**www.epa.gov/iaq/schools/actionkit.html**), schools can assess their risk for having PCBs and find resources for testing and remediation. Some steps teachers can routinely take in their classrooms to minimize children's exposure to PCBs are cleaning surfaces and toys regularly, having children wash their hands with soap and water before eating, and improving ventilation in the classroom. Also, schools should not wait for fluorescent light ballasts containing PCBs to break; all PCB-containing ballasts need to be removed expeditiously from schools. If caulk containing PCBs is found, then it is important to follow safe work practices when renovating and to avoid direct contact with it. For more information on PCBs, see **www.nyc.gov/html/doh/html/epi/pcb.shtml** and **www.epa.gov/pcbsincaulk/caulkschoolkit.pdf**.

Due to public health measures instituted over the past several decades, children's exposure to some environmental toxins, such as lead and mercury, has decreased substantially. In the case of lead, this decrease has had enormous benefits not only on an individual level, but also from a societal and economic standpoint.[31] However, as exposure to these well-known toxins is decreasing, the emergence of other potential environmental threats to children's health, such as phthalates and BPA, must be investigated. As institutions integral to the health and development of children, schools should take steps to minimize exposure to the threats discussed in this article. By addressing these issues, we can ensure that schools are safe for students and staff. Our children are 30 percent of our population, but they are 100 percent of our future. They deserve our protection. □

Endnotes

1. Leonardo Trasande and Yinghua Liu, "Reducing the Staggering Costs of Environmental Disease in Children, Estimated at $76.6 Billion in 2008," *Health Affairs* 30, no. 5 (May 2011): 863–870.

2. American Academy of Pediatrics Committee on Environmental Health, *Pediatric Environmental Health*, 2nd ed. (Elk Grove Village, IL: American Academy of Pediatrics, 2003), 459.

3. Latha Chandran and Rosa Cataldo, "Lead Poisoning: Basics and New Developments," *Pediatrics in Review* 31, no. 10 (October 2010): 399–406.

4. Bruce P. Lanphear, Richard Hornung, Jane Khoury, et al., "Low-Level Environmental Lead Exposure and Children's Intellectual Function: An International Pooled Analysis," *Environmental Health Perspectives* 113, no. 7 (2005): 894–899.

5. American Academy of Pediatrics, *Pediatric Environmental Health*, 249–266, 469–470.

6. Sheela Sathyanarayana, Nancy Beaudet, Katie Omri, and Catherine Karr, "Predicting Children's Blood Lead Levels from Exposure to School Drinking Water in Seattle, Washington, USA," *Ambulatory Pediatrics* 6, no. 5 (2006): 288–292.

7. Marc Cohen, "Environmental Toxins and Health—the Health Impact of Pesticides," *Australian Family Physician* 36, no. 12 (2007): 1002–1004.

8. Christine L. Johnson, "Mercury in the Environment: Sources, Toxicities, and Prevention of Exposure," *Pediatric Annals* 33, no. 7 (2004): 437–442.

9. Stephan Bose-O'Reilly, Kathleen M. McCarty, Nadine Steckling, and Beate Lettmeier, "Mercury Exposure and Children's Health," *Current Problems in Pediatric and Adolescent Health Care* 40, no. 8 (2010): 185–216.

10. American Academy of Pediatrics, *Pediatric Environmental Health*, 267–282.

11. Jennifer A. Davis and Kenny D. Runkle, "Reducing the Risk of Chemical Exposures in Schools," *Journal of Environmental Health* 67, no. 5 (2004): 9–13.

12. American Academy of Pediatrics, *Pediatric Environmental Health*, 87–98.

13. Elena Kwon, Hongquan Zhang, Zhongwen Wang, et al., "Arsenic on the Hands of Children after Playing in Playgrounds," *Environmental Health Perspectives* 112, no. 14 (2004): 1375–1380.

14. Kristi Lew, Jason P. Acker, Stephan Gabos, and X. Chris Le, "Biomonitoring of Arsenic in Urine and Saliva of Children Playing on Playgrounds Constructed from Chromated Copper Arsenate–Treated Wood," *Environmental Science and Technology* 44, no. 10 (2010): 3986–3991.

15. Rob McConnell, Talat Islam, Ketan Shankardass, et al., "Childhood Incident Asthma and Traffic-Related Air Pollution at Home and School," *Environmental Health Perspectives* 118, no. 7 (2010): 1021–1026.

16. American Academy of Pediatrics, *Pediatric Environmental Health*, 69–86.

17. American Academy of Pediatrics, *Pediatric Environmental Health*, 51–57, 465–466.

18. Institute of Medicine of the National Academies, *Damp Indoor Spaces and Health* (Washington, DC: National Academies Press, 2004), www.nap.edu/books/0309091934/html.

19. United States Environmental Protection Agency, "Mold Resources," www.epa.gov/mold/moldresources.html.

20. National Cancer Institute, "Asbestos Exposure and Cancer Risk," www.cancer.gov/cancertopics/factsheet/risk/asbestos.

21. National Cancer Institute, "Asbestos Exposure and Cancer Risk."

22. United States Environmental Protection Agency, "Asbestos in Schools," www.epa.gov/asbestos/pubs/asbestos_in_schools.html.

23. American Academy of Pediatrics, *Pediatric Environmental Health*, 51–57, 465–466.

24. United States Environmental Protection Agency, "IAQ Tools for Schools Program," www.epa.gov/iaq/schools/index.html.

25. T. Hanaoka, N. Kawamura, K. Hara, and S. Tsugane, "Urinary Bisphenol A and Plasma Hormone Concentrations in Male Workers Exposed to Bisphenol A Diglycidyl Ether and Mixed Organic Solvents," *Occupational and Environmental Medicine* 59, no. 9 (2002): 625–628; and Iain A. Lang, Tamara S. Galloway, Alan Scarlett, et al., "Association of Urinary Bisphenol A Concentration with Medical Disorders and Laboratory Abnormalities in Adults," *JAMA* 300, no. 11 (2008): 1303–1310.

26. Shanna H. Swan, Katharina M. Main, Fan Liu, et al., "Decrease in Anogenital Distance among Male Infants with Prenatal Phthalate Exposure," *Environmental Health Perspectives* 113, no. 8 (2005): 1056–1061; and Stephanie M. Engel, Amir Miodovnik, Richard L. Canfield, et al., "Prenatal Phthalate Exposure Is Associated with Childhood Behavior and Executive Functioning," *Environmental Health Perspectives* 118, no. 4 (2010): 565–571.

27. Jeong-Hun Kang, Fusao Kondo, and Yoshiki Katayama, "Human Exposure to Bisphenol A," *Toxicology* 226, nos. 2–3 (2006): 78–89; and Abby F. Fleisch, Perry E. Sheffield, Courtney Chinn, Burton L. Edelstein, and Philip J. Landrigan, "Bisphenol A and Related Compounds in Dental Materials," *Pediatrics* 126, no. 4 (2010): 760–768.

28. Antonia M. Calafat, Xiaoyun Ye, Lee-Yang Wong, John A. Reidy, and Larry L. Needham, "Exposure of the U.S. Population to Bisphenol A and 4-*tertiary*-Octylphenol: 2003–2004," *Environmental Health Perspectives* 116, no. 1 (2008): 39–44.

29. New York City Department of Health and Mental Hygiene, "In the News: NYC Pilot Study on PCBs in Schools," February 2011, www.nyc.gov/html/doh/html/epi/pcb.shtml.

30. Calafat et al., "Exposure of the U.S. Population"; and American Academy of Pediatrics, *Pediatric Environmental Health*, 363–365.

31. Philip J. Landrigan, Clyde B. Schechter, Jeffrey M. Lipton, Marianne C. Fahs, and Joel Schwartz, "Environmental Pollutants and Disease in American Children: Estimates of Morbidity, Mortality, and Costs for Lead Poisoning, Asthma, Cancer, and Developmental Disabilities," *Environmental Health Perspectives* 110, no. 7 (2002): 721–728.

Photo credits

Page 22, vehicle emissions, AP Photo/Mark J. Terrill.

Page 22, lead, © iStockphoto.com/Matthew Valentine.

Page 22, pesticide application, courtesy of Linda Falkenstein.

Page 23, deteriorating classroom, © J A Giordano/CORBIS SABA.

Page 25, chemical plant, courtesy of Bill Wolfe.

Page 25, arsenic-treated wood, Susan Milton/Cape Cod Times.

Page 26, diesel particulate pollution, AP Photo/Bob Child.

Page 27, broken HVAC, courtesy of the American Federation of Teachers.

Page 28, water damage, AP Photo/Journal Times, Gregory Shaver.

Page 29, asbestos, AP Photo/Stefan Hard/Times Argus.

Page 30, toxic soil, AP Photo/The Wentachee World, Don Seabrook.

Page 30, washing hands, AP Photo/Jack Dempsey.