The ChildSafe School

A Comprehensive Program for Positive Environmental Change Through Policy Initiatives

Created and developed by GRASSROOTS
Environmental Education
A Note From the Executive Director

Thank you for your interest in our ChildSafe School Program.

The increasing incidence of environmentally mediated disease in children has triggered a heightened concern about toxins in the environments where children spend time. This has led to particular scrutiny of school environments and focus on seven common exposures that can have a lasting impact on a child's health:

• Diesel exhaust from idling school buses
• Petroleum-based institutional cleaning products
• Turf pesticides on school grounds and playing fields
• Wireless radiation from classroom routers and electronic devices
• Chemical toxins and other exposures from synthetic turf fields
• LED lights and screens

Federal and state regulations on environmental exposures often lag behind emerging science, and are subject to political compromise with impacted industries. Most local school boards and administrators lack the scientific background to make informed policy decisions on these issues, even when the science is clear and compelling and the need to take precautionary measures is acute.

The ChildSafe School program provides the emerging science on these issues, Q&A documents, sample policies and cost-effective solutions. We hope you will find these materials helpful in your efforts to make your school truly ChildSafe.

Sincerely,

Patricia J. Wood

PJW:nl
The ChildSafe School Resource Guide
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Diesel Exhaust
Questions and Answers About Diesel Exhaust

Q. **What are the health problems associated with exposure to diesel exhaust?**

A. Diesel exhaust contains more than forty hazardous air pollutants, of which twenty-one have been identified by the U.S. Environmental Protection Agency (EPA) as known or suspected carcinogens, including benzene, formaldehyde, acetaldehyde and 1,3 butadiene. Exposure to diesel exhaust and its particulate matter has also been proven to exacerbate asthma symptoms and recent findings suggest that it may also be a causal agent for this disease. The EPA has stated that there is no safe level of exposure to diesel exhaust.

Q. **How are children exposed?**

A. Diesel exhaust from idling school buses enters vehicles through doors and windows when children are loading and unloading. The amount of exhaust entering buses depends on how many buses are queued up one behind the other, how long they idle and whether the proximity of buildings or overhangs helps to trap diesel fumes. The exhaust may also enter the school building through open doors and windows or through air ventilation systems.

Q. **Are children more vulnerable than adults to diesel exhaust exposure?**

A. Yes. Children are especially vulnerable to air pollution because their lungs are still developing - a process which is not complete until they reach their late teens. Respiratory development includes rapid rates of cell differentiation, cell division and airway branching. The average diameter of diesel particulate matter is tiny (0.2 micrometers), which means they can penetrate deeper into a child’s lungs where they are more likely to be retained. Children also breathe at a higher rate, taking in 50% more air per pound of body weight than adults.

Q. **Who else should be concerned?**

A. Bus drivers and staff who regularly monitor bus loading and unloading are also at increased risk. Pregnant women should be extremely careful about their exposure to diesel exhaust, as recent studies have shown that the developing fetus is highly vulnerable to airborne toxins. The federally funded Long Island (NY) Breast Cancer Study showed a positive association between exposure to PAHs (polycyclic aromatic hydrocarbons), key combustion by-products, and a higher incidence of breast cancer. Recent studies show that people with underlying heart disease should also avoid exposure.

Q. **Is there any reason that buses must idle to function properly?**

A. No. With current technology, properly maintained diesel buses should have no problem starting up, even during winter months (except in extremely cold conditions - below 0 degrees F). In situations when engine operation is necessary to operate safety equipment, buses can idle to permit battery operation. There are grants available to retrofit school bus diesel engines to reduce pollution.

(over, please)
Q. Will it cost more money to shut off bus engines?

A. No. According to the EPA, the adoption of a no-idling policy in a district with a fleet of 50 buses would save up to $2,250 per year in reduced fuel costs. Additionally, since school aid formulas are measured in part on school absenteeism, this effort to help keep our children healthy would also help the district: asthma and related respiratory illnesses are the leading cause of school absenteeism and the number one cause of hospitalization of children in the United States.

Q. Have any states enacted policies to prohibit the idling of diesel vehicles?

A. Many states have laws or regulations that address the idling of diesel vehicles, including school buses. In some cases, the law or regulation may limit idling to two, three or even five minutes, but it is important to remember that, according to the EPA, there is no safe level of exposure to diesel exhaust. A vehicle idling even less than a minute can generate dangerous levels of toxic fumes. Therefore, the best idling policy is to prohibit idling.

Time limitations on idling are difficult to enforce and would involve agencies or authorities that have no additional resources to monitor at schools. Depending on the state, the authority to enforce idling limits may belong to the Department of Transportation, the local police, the Department of Motor Vehicles or state environmental authorities.

Several states have programs to encourage the reduction of school bus idling. Maine, Massachusetts and Minnesota are among those that provide educational materials and other resources for school staff, teachers and parents to successfully limit or prohibit bus idling at schools. Other states, including New Jersey, New Hampshire and Rhode Island, also have programs to retrofit buses with better pollution control devices. The New York State Commissioner of Education enacted regulations that prohibit all idling on school grounds. Parents and school officials are working together to see that this zero idling policy is strictly enforced.

Q. If my state already has a law or regulation limiting idling, should my school still enact its own policy?

A. Yes, individual district or school policies are best at protecting children from this chronic and dangerous exposure. State idling laws that limit idling to several minutes are difficult to enforce and do not take into consideration the unique school environment and the special vulnerability of the children. A zero idling policy is easy to enforce utilizing educational materials for parents, administrators and bus drivers, as well as signage at the school and bus dashboard reminders.
Children’s Exposure to Diesel Exhaust on School Buses

Abstract:
In the United States nearly 600,000 school buses transport 24 million students to school daily. Each year buses travel 4.3 billion miles as children take nearly 10 billion school bus rides. If rides average 30 minutes in each direction, students will spend 180 hours on buses each year. Collectively, U.S. children spend 3 billion hours on school buses.

A vast majority of U.S. school buses are powered by diesel fuel. Diesel exhaust is comprised of very fine particles of carbon and a mixture of toxic gases. Federal agencies have classified diesel exhaust as a probable human carcinogen. Benzene, an important component of the fuel and exhaust, is designated to be a known human carcinogen. Components of diesel exhaust are genotoxic, mutagenic, and can produce symptoms of allergy, including inflammation and irritation of airways. There is no known safe level of exposure to diesel exhaust for children, especially those with respiratory illness.

Diesel exhaust can adversely affect children with underlying respiratory illness such as asthma, bronchitis, and infections. Diesel emissions may enhance the effects of some allergens among sensitive individuals. Children’s airways are not yet fully developed and have a smaller diameter than those of adults. If airways are inflamed or constricted by asthma, allergies or infections, diesel exhaust may make breathing more difficult.

Fine particulate concentrations (PM2.5) measured on buses in this study were often 5-10 times higher than average levels measured at the 13 fixed-site PM2.5 monitoring stations in Connecticut. Levels of fine particles were often higher under certain circumstances: when buses were idling with windows opened, when buses ran through their routes with windows closed, when buses moved through intense traffic, and especially when buses were queued to load or unload students while idling.

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Inhalation of Diesel Exhaust and Allergen Alters Human Bronchial Epithelium DNA Methylation
Clifford, et al, Journal of Allergy and Clinical Immunology, January, 2017

Abstract:
Allergic disease affects 30% to 40% of the world's population, and its development is determined by the interplay between environmental and inherited factors. Air pollution, primarily consisting of diesel exhaust emissions, has increased at a similar rate to allergic disease. Exposure to diesel exhaust may play a role in the development and progression of allergic disease, in particular allergic respiratory disease. One potential mechanism underlying the connection between air pollution and increased allergic disease incidence is DNA methylation, an epigenetic process with the capacity to integrate gene-environment interactions. We sought to investigate the effect of allergen and diesel exhaust exposure on bronchial epithelial DNA methylation. We performed a randomized crossover-controlled exposure study to allergen and diesel exhaust in humans, and measured single-site (CpG) resolution global DNA methylation in bronchial epithelial cells. Exposure to allergen alone, diesel exhaust alone, or allergen and diesel exhaust together (coexposure) led to significant changes in 7 CpG sites at 48 hours. However, when the same lung was exposed to allergen and diesel exhaust but separated by approximately 4 weeks, significant changes in more than 500 sites were observed. Furthermore, sites of differential methylation differed depending on which exposure was experienced first. Functional analysis of differentially methylated CpG sites found genes involved in transcription factor activity, protein metabolism, cell adhesion, and vascular development, among others. These findings suggest that specific exposures can prime the lung for changes in DNA methylation induced by a subsequent insult.

* * *
Exposure to Allergen and Diesel Exhaust Particles Potentiates Secondary Allergen-Specific Memory Responses, Promoting Asthma Susceptibility

Brandt, et al, Journal of Allergy and Clinical Immunology August 2015

Abstract:
Exposure to traffic pollution particulate matter, predominantly diesel exhaust particles (DEPs), increases the risk of asthma and asthma exacerbation; however, the underlying mechanisms remain poorly understood. We sought to examine the effect of DEP exposure on the generation and persistence of allergen-specific memory T cells in asthmatic patients and translate these findings by determining the effect of early DEP exposure on the prevalence of allergic asthma in children. The effect of DEPs on house dust mite (HDM)—specific memory responses was determined by using an asthma model. Data from children enrolled in the Cincinnati Childhood Allergy and Air Pollution Study birth cohort were analyzed to determine the effect of DEP exposure on asthma outcomes. DEP co-exposure with HDM resulted in persistent Th2/Th17 CD127+ effector/memory cells in the lungs, spleen, and lymph nodes of adult and neonatal mice. After 7 weeks of rest, a single exposure to HDM resulted in airway hyper-responsiveness and increased Th2 cytokine levels in mice that had been previously exposed to both HDM and DEPs versus those exposed to HDM alone. On this basis, we examined whether DEP exposure was similarly associated with increased asthma prevalence in children in the presence or absence of allergen exposure/sensitization in the Cincinnati Childhood Allergy and Air Pollution Study birth cohort. Early-life exposure to high DEP levels was associated with significantly increased asthma prevalence among allergic children but not among non-allergic children. These findings suggest that DEP exposure results in accumulation of allergen-specific Th2/Th17 cells in the lungs, potentiating secondary allergen recall responses and promoting the development of allergic asthma.

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The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age


Abstract
Whether exposure to air pollution adversely affects the growth of lung function during the period of rapid lung development that occurs between the ages of 10 and 18 years is unknown. In this prospective study, we recruited 1759 children (average age, 10 years) from schools in 12 southern California communities and measured lung function annually for eight years. The rate of attrition was approximately 10 percent per year. The communities represented a wide range of ambient exposures to ozone, acid vapor, nitrogen dioxide, and particulate matter. Linear regression was used to examine the relationship of air pollution to the forced expiratory volume in one second (FEV1) and other spirometric measures.

Results: Over the eight-year period, deficits in the growth of FEV1 were associated with exposure to nitrogen dioxide (P=0.005), acid vapor (P=0.004), particulate matter with an aerodynamic diameter of less than 2.5 µm (PM2.5) (P=0.04), and elemental carbon (P=0.007), even after adjustment for several potential confounders and effect modifiers. Associations were also observed for other spirometric measures. Exposure to pollutants was associated with clinically and statistically significant deficits in the FEV1 attained at the age of 18 years. For example, the estimated proportion of 18-year-old subjects with a low FEV1 (defined as a ratio of observed to expected FEV1 of less than 80 percent) was 4.9 times as great at the highest level of exposure to PM2.5 as at the lowest level of exposure (7.9 percent vs. 1.6 percent, P=0.002).

Conclusions: The results of this study indicate that current levels of air pollution have chronic, adverse effects on lung development in children from the age of 10 to 18 years, leading to clinically significant deficits in attained FEV1 as children reach adulthood.

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Diesel Exhaust and Asthma: Hypotheses and Molecular Mechanisms of Action


Abstract:
Several components of air pollution have been linked to asthma. In addition to the well-studied criteria air pollutants, such as nitrogen dioxide, sulfur dioxide, and ozone, diesel exhaust and diesel exhaust particles (DEPs) also appear to play a role in respiratory and allergic diseases. Diesel exhaust is composed of vapors, gases, and fine particles emitted by
Diesel-fueled compression-ignition engines. DEPs can act as nonspecific airway irritants at relatively high levels. At lower levels, DEPs promote release of specific cytokines, chemokines, immunoglobulins, and oxidants in the upper and lower airway. Release of these mediators of the allergic and inflammatory response initiates a cascade that can culminate in airway inflammation, mucus secretion, serum leakage into the airways, and bronchial smooth muscle contraction. DEPs also may promote the expression of the TH2 immunologic response phenotype that has been associated with asthma and allergic disease. DEPs appear to have greater immunologic effects in the presence of environmental allergens than they do alone. This immunologic evidence may help explain the epidemiologic studies indicating that children living along major trucking thoroughfares are at increased risk for asthmatic and allergic symptoms and are more likely to have objective evidence of respiratory dysfunction.

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**Short-Term Diesel Exhaust Inhalation in a Controlled Human Crossover Study is Associated with Changes in DNA Methylation of Circulating Mononuclear Cells in Asthmatics**


**Abstract:** Changes in DNA methylation have been associated with traffic-related air pollution in observational studies, but the specific mechanisms and temporal dynamics therein have not been explored in a controlled study of asthmatics. In this study, we investigate short-term effects of diesel exhaust inhalation on DNA methylation levels at CpG sites across the genome in circulating blood in asthmatics. A double-blind crossover study of filtered air and diesel exhaust exposures was performed on sixteen non-smoking asthmatic subjects. Blood samples were collected pre-exposure, and then 6 and 30 hours post-exposure. Peripheral blood mononuclear cell DNA methylation was interrogated using the Illumina Infinium HumanMethylation450 Array. Exposure-related changes in DNA methylation were identified.

In addition, CpG sites overlapping with Alu or LINE1 repetitive elements and candidate microRNA loci were also analyzed. DNA methylation at 2827 CpG sites were affected by exposure to diesel exhaust but not filtered air; these sites enriched for genes involved in protein kinase and NFkB pathways. CpG sites with significant changes in response to diesel exhaust exposure primarily became less methylated, with a site residing within GSTP1 being among the significant hits. Diesel exhaust-associated change was also found for CpG sites overlapping with Alu and LINE1 elements as well as for a site within miR-21.

**Conclusion:** Short-term exposure to diesel exhaust resulted in DNA methylation changes at CpG sites residing in genes involved in inflammation and oxidative stress response, repetitive elements, and microRNA. This provides plausibility for the role of DNA methylation in pathways by which airborne particulate matter impacts gene expression and offers support for including DNA methylation analysis in future efforts to understand the interactions between environmental exposures and biological systems.

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**Diesel Exhaust Inhalation Causes Vascular Dysfunction and Impaired Endogenous Fibrinolysis**

N. Mills *et al*, for the American Heart Association; Circulation 112:25, p.930-936 (2005)

**Abstract:**

*Background:* Although the mechanisms are unknown, it has been suggested that transient exposure to traffic-derived air pollution may be a trigger for acute myocardial infarction. The study aim was to investigate the effects of diesel exhaust inhalation on vascular and endothelial function in humans.

**Methods and Results:** In a double-blind, randomized, cross-over study, 30 healthy men were exposed to diluted diesel exhaust (300 µg/m³ particulate concentration) or air for 1 hour during intermittent exercise. Bilateral forearm blood flow and inflammatory factors were measured before and during unilateral intrabrachial bradykinin (100 to 1000 pmol/min), acetylcholine (5 to 20 µg/min), sodium nitroprusside (2 to 8 µg/min), and verapamil (10 to 100 µg/min) infusions 2 and 6 hours after exposure. There were no differences in resting forearm blood flow or inflammatory markers after exposure to diesel exhaust or air. Although there was a dose-dependent increase in blood flow with each vasodilator (P<0.0001 for all), this response was attenuated with bradykinin (P<0.05), acetylcholine (P<0.05), and sodium nitroprusside (P<0.001) infusions 2 hours after exposure to diesel exhaust, which persisted at 6 hours. Bradykinin caused a dose-dependent increase in plasma tissue plasminogen activator (P<0.0001) that was suppressed 6 hours after exposure to diesel (P<0.001: area under the curve decreased by 34%).
Conclusions: At levels encountered in an urban environment, inhalation of dilute diesel exhaust impairs 2 important and complementary aspects of vascular function in humans: the regulation of vascular tone and endogenous fibrinolysis. These important findings provide a potential mechanism that links air pollution to the pathogenesis of atherothrombosis and acute myocardial infarction.

* * *

Air Pollution–Associated Changes in Lung Function among Asthmatic Children in Detroit

Abstract: In a longitudinal cohort study of primary-school–age children with asthma in Detroit, Michigan, we examined relationships between lung function and ambient levels of particulate matter ≤10µm and ≤2.5 µm in diameter (PM10 and PM2.5) and ozone at varying lag intervals using generalized estimating equations. Models considered effect modification by maintenance corticosteroid (CS) use and by the presence of an upper respiratory infection (URI) as recorded in a daily diary among 86 children who participated in six 2-week seasonal assessments from winter 2001 through spring 2002. Participants were predominantly African American from families with low income, and >75% were categorized as having persistent asthma. In both single-pollutant and two-pollutant models, many regressions demonstrated associations between higher exposure to ambient pollutants and poorer lung function (increased diurnal variability and decreased lowest daily values for forced expiratory volume in 1 sec) among children using CSs but not among those not using CSs, and among children reporting URI symptoms but not among those who did not report URIs. Our findings suggest that levels of air pollutants in Detroit, which are above the current National Ambient Air Quality Standards, adversely affect lung function of susceptible asthmatic children.

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Characterizing the Range of Children’s Pollutant Exposure During School Bus Commutes
D. Fitz, et al, for the California Air Resources Board, Contract No. 00-322 (2003)

Abstract: To determine the range of children’s exposures during their bus commutes, especially those conditions leading to high exposures, real-time and integrated measurements of pollutant concentrations were conducted inside five conventional diesel school buses, as well as a diesel bus outfitted with a particulate trap and a bus powered by natural gas. Measurements were made during 20 bus commutes on a Los Angeles Unified School District bus route from South Central Los Angeles to the west side of LA, with additional runs on a second urban route, a rural/suburban route, and to test the effect of window position. Children’s school bus commutes in Los Angeles appear to expose them to significantly higher concentrations of vehicle-related pollutants than ambient air concentrations and frequently higher concentrations than those measured on roadways. Concentrations of diesel vehicle-related pollutants such as black carbon and particle-bound PAHs were significantly higher on board conventional diesel buses when windows were closed. This was due to the intrusion of the bus’s own exhaust, as demonstrated through the use of a tracer gas added to each bus’s exhaust. When windows were open, increased ventilation rates markedly reduced this effect, although high peak concentrations were then observed when following other diesel vehicles. On-board concentrations of vehicle-related pollutants were also significantly higher on the urban routes compared to the rural/suburban route, indicating the importance of surrounding traffic density. Other related exposure scenarios such as bus loading and unloading, and time spent waiting at bus stops, were shown to make relatively insignificant contributions to children’s exposure, due to the generally lower concentrations and the short times spent at those activities compared to bus commutes. Results from this study show that minimizing commute times, using the cleanest buses for the longest routes, and reducing bus caravanning and idling time will reduce children’s exposure to bus-related pollutants.

Compiled by Grassroots Environmental Education.
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Sample School District Policy
Regarding the
Idling of School Buses and Other Vehicles on School Property

Be it resolved that the Board of Education, recognizing the importance of the safety and health of the district’s students and staff, does hereby adopt the following policy regarding the idling of school buses on school property.

Background and Intent

The health impacts of exposure to diesel exhaust and diesel particulate matter are significant and well documented. They include asthma and other respiratory illness, lung and breast cancer, and heart problems. Children are particularly vulnerable due to their narrow airways and rapidly developing bodies. The purpose of the policy is to reduce student, staff and driver exposure to harmful emissions found in diesel exhaust by eliminating the unnecessary idling of school buses on school property.

Application

This policy shall apply to all school buses operated by or for the district for the purpose of transporting the district’s students to or from school or school related activities, whether the buses are owned by the district or by an independent vendor.

Implementation

1. The driver of a diesel school bus must turn off his engine upon arrival at a school. The engine must remain off until the bus is loaded (or unloaded) and is ready to depart from school property.

2. If more than one bus is involved in the boarding process, all buses must be loaded and doors closed before engines are started.

3. The district shall communicate this policy to all parents, administrators, teachers and other staff or district employees involved with transportation. Appropriate signage shall be posted at each school and inside buses to remind drivers and school staff of the policy. The provisions of this policy shall be incorporated by reference in all transportation contracts and agreements.

4. School bus drivers, whether employed by the district or by an independent vendor, will be informed of the district’s policy and advised of the requirements of the drivers.
Exemptions

The provisions of this policy shall be suspended under the following conditions:

1. If the outside temperature at the school is less than 20 degrees Fahrenheit, buses shall be permitted to idle for up to five minutes, or as much time as local regulations permit, whichever is shorter.

2. When bus engines are required to operate special equipment for disabled students.

3. When the use of defrosters, heaters or other equipment is required for safety or health considerations, as determined by the district’s Director of Transportation.

4. When use of the bus headlights or four-way flasher warning lights is required for visibility purposes; or for other traffic, safety or emergency situations.

Additional Applications

This no-idling policy shall also apply to all cars and any other vehicles operating on school properties during school hours (except when engines are required for operation of equipment). The district shall inform parents, staff and district vendors of the policy, and the policy should be referenced in all new contracts and service agreements.

* * *

This sample policy was developed by Grassroots Environmental Education, a science-based non-profit organization. The policy is part of the EPA award-winning ChildSafe School program. More information is available at www.TheChildSafeSchool.org.
School District has a no idling policy. Turn off engine upon arriving at school.

dashboard sign
The ChildSafe School

Turf Pesticides
**Questions and Answers About Turf Pesticides**

**Q. Isn’t it necessary to use chemical pesticides to keep playing fields in top condition?**

A. No. Playing fields maintained naturally can perform just as well as those maintained with chemicals, but with even greater resiliency, softer playing surface, less water consumption and greater drought tolerance. A naturally maintained field typically requires aeration, regular over-seeding and periodic applications of natural soil amendments (compost or compost teases) and fertilizers. Chemical pesticides can destroy essential beneficial organisms and create unhealthy soil conditions.

**Q. What health effects have been associated with chemical pesticides?**

A. Exposure to pesticide products has been associated with an increased risk of serious acute and chronic health problems, including asthma, certain types of cancer, nervous and immune system damage, liver or kidney damage, reproductive impairment, birth defects and damage to the endocrine system. The development of health problems related to chemical pesticide exposures can take years, with many genetic and environmental factors playing a role.

**Q. How are children exposed to turf pesticides?**

A. Children come into close contact with turf pesticides that have been applied to playgrounds and athletic fields. Their hands, arms, legs and faces can all become contaminated as they roll, slip, slide and fall. Typical routes of exposure include inhalation, skin absorption and accidental ingestion. The normal hand-to-mouth behavior patterns of younger children further amplify their exposure. Additionally, sports gear and water bottles are often thrown down on the turf where they can be contaminated with pesticides and then transferred to athletes when they drink or use the equipment. Pesticide residues on the soles of sneakers and athletic shoes are tracked inside schools and homes where they can continue to create exposure risks for long periods of time.

**Q. Are children more vulnerable to pesticides than adults?**

A. Yes. Their bodies are undergoing rapid development, which put them at increased risk for exposure to chemicals that may interfere with normal growth processes. They also have higher rates of respiration and more skin surface area per unit of body weight. There are certain times during childhood, so-called “windows of vulnerability,” when development of organs or body systems can be disrupted from even low-level exposures to certain toxins. Additionally, most major classes of pesticides have been shown to adversely affect the developing nervous system, which begins at about two weeks of gestation and continues through adolescence. Lastly, children have more years of life ahead of them compared to adults, so they have a longer time to manifest the health effects associated with pesticide exposures.

**Q. Is artificial turf a good solution?**

A. Artificial or “synthetic” turf is promoted as an environmentally preferable, low maintenance, durable surface that can be played on 24/7. These claims are being challenged, however, as we are learning more about problems associated with toxic infill materials, surface contamination and considerable maintenance costs related to heavy usage. More importantly, there are a growing number of questions concerning significant health risks to young athletes which urgently need to be addressed.
Q. Is "Integrated Pest Management" or "IPM" an appropriate choice for managing school playing fields?

A. IPM is an outdated concept, originally developed by the chemical pesticide industry to address the public’s growing concern over health issues related to pesticides. The concept is that non-toxic pest control methods should be tried first, and if that doesn’t produce the desired effect, chemical pesticides may then be employed as a last resort. However, IPM programs, which require no special training and have no recognized standards, permit the use of any pesticide product, including the most toxic products on the market.

Sadly, since the introduction and promotion of IPM programs back in the 1970s, the use of pesticides in the United States has increased significantly.

With recent advances in soil science and product development, there is no longer any reason, other than legitimate public health emergencies (which are very rare), to use pesticides on school fields. The evidence linking exposure to pesticides with serious human health problems, especially for children, make IPM programs completely inappropriate for school grounds and playing fields.

Q. Have any state governments acted on the issue of turf pesticides?

A. Yes. New York was the first state in the nation to pass a comprehensive ban on the use of chemical pesticides on school grounds and playing fields for students in grades K-12. The law also applies to most day care centers. Connecticut prohibits the use of pesticides on school grounds for grades K-8.

Many states have notification laws, under which parents must be notified if their child’s school grounds or fields are to be treated with pesticides. Such laws vary by state and could differ as to the time frame or method of notification. It is important to find out if your state has such mandates, and if the school is properly notifying parents and staff.
Science Abstracts on Turf Pesticides

Risks from Lawn-Care Pesticides

Five of the most popular pesticides in the U.S. home and garden sales market (2,4-D, glyphosate, MCPP, dicamba, and diazion) have been associated with non-Hodgkin’s lymphoma (NHL) in epidemiological studies...Non-Hodgkin’s lymphoma is the sixth most common malignancy in America, with nearly 54,000 cases estimated to have occurred in 2002. Between 1973 and 1997, the incidence increased by 80 percent. According to scientists at the National Cancer Institute, "Since the use of pesticides, particularly phenoxy herbicides, has increased dramatically preceding and during the time period in which the incidence of HNL has increased, they could have contributed to the rising incidence of NHL."

Children are often more susceptible to the toxic effects of pesticides than adults; they take in more pesticides relative to body weight than adults, and have developing organ systems that are more vulnerable and less able to detoxify toxic chemicals. In addition, the likelihood of developing cancer is greater if exposure occurs early in life, since cancer develops over time.

Children can be exposed to lawn-care pesticides by playing near an area where pesticides are being applied or by playing outside following a pesticide application, drinking or bathing in water contaminated with lawn-care pesticides, or from parental exposure to lawn-care chemicals during the child’s gestation or prior to conception. Exposure to lawn-care pesticides can even occur inside a child’s home. Studies have found that 2,4-D can be tracked from lawns into homes, leaving residues of the herbicide in carpets, on surfaces, and in indoor air. Estimated post-application indoor exposure levels for young children from non-dietary ingestion may be as high as 30 micrograms/day from contact with table tops. By comparison, dietary ingestion of 2,4-D is approximately 1.3 micrograms/day.

Childhood malignancies linked to pesticides in studies include leukemia, neuroblastoma, Wilms’ tumor, soft-tissue sarcoma, Ewing’s sarcoma, NHL, and cancers of the brain, colorectum, and testes. Many of the reported increased risks are greater than those noted in studies of pesticide-exposed adults, indicating that children may be particularly sensitive to the carcinogenic effects of pesticides.

Pesticides and Childhood Cancer: An Update of Zahm and Ward’s 1998 Review

Abstract:
Children are exposed to pesticides through a number of sources, including residential and agricultural applications. Parental occupational exposure to pesticides is also a concern because exposures occurring during pregnancy and carry-home residues also contribute to children’s cumulative burden. A number of epidemiological studies consistently reported increased risks between pesticide exposures and childhood leukemia, brain cancer, neuroblastoma, non-Hodgkin’s lymphoma, Wilms’ tumor, and Ewing’s sarcoma. An extensive review of these studies was published in 1998 (Zahm & Ward, 1998).

Fifteen case-control studies, 4 cohort studies, and 2 ecological studies have been published since this review, and 15 of these 21 studies reported statistically significant increased risks between either childhood pesticide exposure or parental occupational exposure and childhood cancer. Therefore, one can confidently state that there is at least some association between pesticide exposure and childhood cancer. However, an unambiguous mechanistic cause-and-effect relationship between pesticide exposure and childhood cancer was not demonstrated in these studies, and modifying factors such as genetic predisposition, rarely considered in the reviewed studies, likely play an important role. While the time window of exposure may be a crucial determinant for biological effects associated with pesticide exposure on children, studies have not
contributed definitive information on the most vulnerable period. Accurate exposure assessment remains a challenge; future epidemiological studies need to assess gene-environment interactions and use improved exposure measures, including separate parental interviews, specific pesticide exposure questions, and semiquantitative exposure measures that can be used to confirm information obtained through questionnaires.

* * *

**Cancer health effects of pesticides: A Systematic review**

**OBJECTIVE:** To review literature documenting associations between pesticide use and cancer.

**DATA SOURCES:** We searched MEDLINE, PreMedline, CancerLit, and LILACS to find studies published between 1992 and 2003 on non-Hodgkin lymphoma, leukemia, and 8 solid-tumour cancers: brain, breast, kidney, lung, ovarian, pancreatic, prostate, and stomach cancer.

**STUDY SELECTION:** Each title and abstract was assessed for relevance; disagreements among reviewers were resolved by consensus. Studies were assessed by a team of 2 trained reviewers and rated based on methodologic quality according to a 5-page assessment tool and a global assessment scale. Studies rated below a global score of 4 out of 7 were excluded.

**SYNTHESIS:** Most studies on non-Hodgkin lymphoma and leukemia showed positive associations with pesticide exposure. Some showed dose-response relationships, and a few were able to identify specific pesticides. Children’s and pregnant women’s exposure to pesticides was positively associated with the cancers studied in some studies, as was parents’ exposure to pesticides at work. Many studies showed positive associations between pesticide exposure and solid tumours. The most consistent associations were found for brain and prostate cancer. An association was also found between kidney cancer in children and their parents’ exposure to pesticides at work. These associations were most consistent for high and prolonged exposures. Specific weaknesses and inherent limitations in epidemiologic studies were noted, particularly around ascertaining whether and how much exposure had taken place.

**CONCLUSION:** Our findings support attempts to reduce exposure to pesticides. Reductions are likely best achieved through decreasing pesticide use for cosmetic (non-commercial) purposes (where children might be exposed) and on the job.

* * *

**Residential Exposure to Polychlorinated Biphenyls and Organochlorine Pesticides and Risk of Childhood Leukemia**

**BACKGROUND:** Incidence of childhood leukemia in industrialized countries rose significantly during 1975-2004, and the reasons for the increase are not understood.

**OBJECTIVES:** We used carpet dust as an exposure indicator to examine the risk of childhood leukemia in relation to residential exposure to persistent organochlorine chemicals: six polychlorinated biphenyl (PCB) congeners and the pesticides alpha- and gamma-chlordane, p,p'-DDT (dichlorodiphenyltrichloroethane), p,p'-DDE (dichlorodiphenyldichloroethylene), methoxychlor, and pentachlorophenol.

**METHODS:** We conducted a population-based case-control study in 35 counties in northern and central California in 2001-2006. The study included 184 acute lymphocytic leukemia (ALL) cases 0-7 years of age and 212 birth certificate controls matched to cases by birth date, sex, race, and Hispanic ethnicity. We collected carpet dust samples from the room where the child spent the most time before diagnosis (similar date for controls) using a specialized vacuum.

**RESULTS:** Detection of any PCB congener in the dust conferred a 2-fold increased risk of ALL (odds ratio
(OR) = 1.97; 95% confidence interval (CI), 1.22-3.17]. Compared with those in the lowest quartile of total PCBs, the highest quartile was associated with about a 3-fold risk (OR = 2.78; 95% CI, 1.41-5.48), and the positive trend was significant (p = 0.017). Significant positive trends in ALL risk were apparent with increasing concentrations of PCB congeners 118, 138, and 153. We observed no significant positive associations for chlordane, DDT, DDE, methoxychlor, or pentachlorophenol. The associations with PCBs were stronger among non-Hispanic whites than among Hispanics despite similar distributions of PCB levels among controls in each racial/ethnic group.

CONCLUSIONS: Our findings suggest that PCBs, which are considered probable human carcinogens and cause perturbations of the immune system, may represent a previously unrecognized risk factor for childhood leukemia.

* * *

Childhood Brain Tumors, Residential Insecticide Exposure, and Pesticide Metabolism Genes

BACKGROUND: Insecticides that target the nervous system may play a role in the development of childhood brain tumors (CBTs). Constitutive genetic variation affects metabolism of these chemicals.

METHODS: We analyzed population-based case-control data to examine whether CBT is associated with the functional genetic polymorphisms PON1C108T, PON1Q192R, PON1L55M, BCHEA539T, FMO1C9536A, FMO3E158K, ALDH3A1S134A, and GSTT1 (null). DNA was obtained from newborn screening archives for 201 cases and 285 controls, <or= 10 years of age, and born in California or Washington State between 1978 and 1990. Conception-to-diagnosis home insecticide treatment history was ascertained by interview.

RESULTS: We observed no biologically plausible main effects for any of the metabolic polymorphisms with CBT risk. However, we observed strong interactions between genotype and insecticide exposure during childhood. Among exposed children, CBT risk increased per PON1-108T allele [odds ratio (OR) = 1.8; 95% confidence interval (CI), 1.1-3.0] and FMO1-9536A (*/6) allele (OR = 2.7; 95% CI, 1.2-5.9), whereas among children never exposed, CBT risk was not increased (PON1: OR = 0.7; 95% CI, 0.5-1.0, interaction p = 0.005; FMO1: OR = 1.0; 95% CI, 0.6-1.6, interaction p = 0.009). We observed a similar but statistically nonsignificant interaction between childhood exposure and BCHEA539T (interaction p = 0.08). These interactions were present among both Hispanic and non-Hispanic white children.

CONCLUSION: Based on known effects of these variants, these results suggest that exposure in childhood to organophosphorus and perhaps to carbamate insecticides in combination with a reduced ability to detoxify them may be associated with CBT. Confirmation in other studies is required.

* * *

Pesticides Literature Review

Abstract:
In recent years, few environmental issues have aroused the concern of the public as much as pesticides, especially in relation to the health of children. In spite of the many published studies on the subject of pesticides and human health, there remains deep controversy surrounding this issue.

During the 1960s and 1970s, epidemiologists in the USA noted a rise in the incidence of non-Hodgkin’s lymphoma (NHL). When plotted on a map of the USA these cases were clearly clustered in agricultural areas. This increase in NHL incidence paralleled the rise in pesticide use, prompting some epidemiologists to theorize that there was a causal link.
Several studies found associations between pesticide exposures and solid tumours in children. An elevated rate of kidney cancer was associated with paternal pesticide exposure through agriculture. Four studies found associations with brain cancer: two found associations with indoor household use of pesticides one with parental farming occupation, and one with parental occupational exposure to pesticides.

**Conclusions:**
Several studies in this review implicate pesticides as a cause of hematologic tumours in children. One study found an association with childhood non-Hodgkin’s lymphoma, and several studies found elevated childhood leukemia rates with pesticide exposure. An excellent study by [Xiaomei Ma (University of California, Berkeley)] showed an association between maternal pesticide exposure and childhood leukemia.

In the genotoxicity or immunotoxicity area there were two studies relevant to children. In the first, children with poor metabolizer polymorphisms, genotyped at birth and representing just over 40% of the Montreal study group, had overall increased risk of acute lymphocytic leukemia if exposed to pesticides in utero or during childhood, especially for exposure to repellents and sprays for outdoor insects during pregnancy, and exposure to mite and spider killers during pregnancy or between birth and leukemia diagnosis. Herbicide use (mainly 2,4-D) both during pregnancy and in childhood, showed a consistent interaction with poor metabolizer genes and was associated with a 2-fold increase in leukemia incidence. [Terry M.] Phillips found that children exposed to chlordane and/or heptachlor had more cytokine panel abnormalities than matched controls.

Neurodevelopmental effects were found in pre-school children in pervasive pesticide exposure situations in Mexican valley agriculture, and likely resulted from maternal, in-utero, and early childhood exposures. The only other study of effects on children found substantially higher proportions of residents — including adolescents — exposed to pesticides from aerial spraying drift to have mental and emotional symptoms compared to those not exposed by aerial spraying, consistent with other studies of broader nervous system function.

* * *

**Adverse Health Effects of Children’s Exposure to Pesticides: What Do We Really Know and What Can Be Done About It?**

**Abstract:**
Children may be exposed to pesticides in several ways, such as by transplacental transfer during fetal life, by intake of contaminated breast milk and other nutrients, or by contact with contaminated subjects and areas in the environment such as pets treated with insecticides, house dust, carpets and chemically treated lawns and gardens. Exposure early in life, and particularly during periods of rapid development, such as during foetal life and infancy, may have severe effects on child health and development by elevating the risk of congenital malformations, cancer, malabsorption, immunological dysfunction, endocrine disease, and neurobehavioural deficiencies. As pesticides can also interfere with parental reproductive health, exposure of parents may have consequences for the offspring leading to reduced chance of male birth and increased risk of childhood cancer.

**Conclusions:** Current knowledge about tolerable levels and consequences of toxic exposure to pesticides during human development is rather scarce. Owing to the high risk of exposure to pesticides, particularly in less developed countries, further elucidation by well-controlled epidemiological studies in this field it is urgently needed. The Policy Interpretation Network on Children's Health and Environment (PINCHE), which is financed by the EU DG research has suggested actions against pesticide exposure.
Sample School District Policy  
Regarding the Use of  
Pesticides on School Grounds

Be it resolved that the Board of Education, recognizing the importance of the safety and health of the district’s students, teachers and staff, does hereby adopt the following policy regarding the use of pesticides on school grounds within the district.

Background and Intent

Exposure to chemical pesticides commonly used in lawn care products has been associated with an increased risk of asthma, certain types of cancer, neurological disorders and endocrine disruption. Fetal exposures to pesticides have been associated with an increased risk of birth defects. Pesticides can move through the environment, contaminating ground and surface waters, as well as air and soil.

The Board believes it is not necessary to jeopardize the health and safety of our students, teachers and staff, or to pollute our environment with the use of chemical pesticides when a natural turf management program is a viable alternative.

Therefore the intent of this policy is to reduce exposure to these chemicals and reduce environmental pollution by stipulating the procurement of non-toxic lawn care products and the adoption and implementation of natural turf management, which will ensure the highest levels of safety, efficacy and economy.

Implementation

1. The Director of Facilities, in cooperation with the Superintendent of Schools and the Director of Athletics (if applicable), and such other independent turf experts as may be required, shall conduct an evaluation of all playing fields in the district, and develop a comprehensive plan for maintaining school properties without the use of chemical pesticides.

2. The plan shall be based on the Principles of Natural Turf Maintenance, attached hereto as Exhibit A.

3. Once the plan is developed, the District shall undertake to communicate the contents of the policy and the reasons for its adoption to all teachers, coaches, grounds personnel, parents and others within the community.

Exceptions

This policy shall prohibit the use of pesticides on school grounds except in the case of a public health emergency as determined by the Superintendent of
Schools, the Board of Education or the local Department of Health.

**Effective Date and Notice**

This policy shall take effect on __________. The district shall undertake to inform all parents, teachers and staff of the contents of this policy and the reasons for its adoption.

This policy shall be communicated to all vendors and suppliers, and it shall be referenced in all new contracts and service agreements.

Existing stocks of non-complying products shall be disposed of appropriately as directed by the Director of Facilities.

* * *

_This sample policy was developed by Grassroots Environmental Education, a science-based non-profit organization. The policy is part of the EPA award-winning ChildSafe School program. More information is available at www.TheChildSafeSchool.org._
**EXHIBIT A**

*Principles of Natural Turf Maintenance*

**Soil Testing:** Soil tests reveal the condition of the soil and determine what kinds of amendments might be required. Using a clean sampling tube, take samples from various locations on the field (more samples for larger properties) at a 4 to 5 inch depth. Remove debris (roots, thatch) from the top of the sample, air-dry overnight, mix the samples thoroughly and send one cup of the mixture to the lab. Request a standard test that usually includes soil pH, calcium, magnesium and potassium levels, phosphorus levels and cation exchange capacity. You should also request percent of organic matter.

**Adjusting Soil pH Balance:** The soil test will reveal the pH of the soil, and in many cases, give you the recommended amount and type of lime to apply to the field. The ideal pH for turf grass is between 6.5 and 7.0. Keep in mind that you should never apply more than fifty pounds of lime per 1,000 sq ft (if you need more lime, it should be made in two applications). Also remember that lime can take up to three months to become fully integrated into the soil. Use calcitic lime if calcium levels are low; dolomitic lime if magnesium levels are low.

**Fertilization:** The soil test will also come with recommendations for fertilization. The choice and application of the proper fertilizer is one of the most important aspects of natural turf maintenance. Unlike synthetic fertilizers that are water soluble, natural organic fertilizers are water insoluble; they break down by the action of microbes which exist in the soil. In effect, you are feeding those microbes, which in turn make nutrients available to the plants. As the level of organic matter is raised through leaving grass clippings on the ground and the application of compost (see below), the need for fertilizer is reduced.

Natural organic fertilizers will generally not produce the sudden, dramatic greening effect common to many commercial synthetic fertilizers containing high nitrogen levels. Look for lower nitrogen numbers (natural products always have N numbers of 10 or less). Fifty pounds will cover approximately 2,000 sq ft.

**Compost Top-Dress:** If the soil test reveals an organic matter level of less than 5%, aerate and top-dress with a good quality compost. If the property has been chemically maintained, a 1/4 inch to 1/2 inch layer of compost should be spread directly on top of the entire field. Compost can be spread with a compost spreader, an air blower, or on small areas by broadcasting with shovels. It will take about a yard of compost to cover 1000 sq ft with 1/2 inch of compost; one acre of turf will require approximately 40 yards.

**Soil Detoxification and Inoculation Using Other Amendments:** Marine products such as kelp and seaweed contain minerals and add organic matter to the soil. They promote deep root growth which helps keep fields green even during times of moderate drought. The minerals and nutrients found in rock dust are particularly useful in re-energizing soil that has been compromised by chemical use. It is also a natural source of potassium (K).

**Compost Tea:** The application of high quality compost tea can be an effective way to build soil quality, increase resistance to diseases and help during droughts. Compost tea is made by steeping top quality compost and other nutrients in circulating water. Commercial tea brewers in sizes from 5 to 500 gallons are available from many manufacturers. You can spray tea from a
backpack sprayer or a traditional spray rig. Remember that you are spraying live organisms, so allow the spray to fall gently on surfaces.

**Basic Compost Tea Recipe:**

- 20 gallons of chlorine-free water
- 1 lb highest quality compost
- 4 oz. molasses
- 1 oz. humic acid

Tea should be mixed with water in sufficient dilution to achieve a rate of 15-20 gallons per acre. A typical mix is 20 gallons to tea to 100 gallons of water. Problem areas can be treated with a higher concentration of tea.

**Irrigation:** Automatic sprinkler systems can be a great time saver, but they can also be the source of trouble. Over-watering is a primary cause of turf fungal problems, and can undo much of the work you are doing. The system should be calibrated to deliver no more than 1.5 inches of water per week, and less if a rain event occurs. (To calibrate the system for this optimal irrigation target number, place an empty tuna can on the field and see how long it takes to fill the can.)

**Blade Height:** School and municipal turf managers must balance the need for grass plants to grow with the demands of competitive athletic play. Grass plants develop deep root systems when the blades are allowed to grow high, so turf managers try to find at least some time during the growing season when grass can be allowed to grow to 3.5 to 4 inches, usually in summer when fields are used for non-competitive sports. Grass clippings should always be left on the field (they provide free nitrogen). If necessary, rake up clumps and re-broadcast. Remember never to cut more than the top 1/3 of the grass blade at any one time.

**Aeration:** Compaction is the number one enemy of turf grass, and is the most common problem faced by turf managers, particularly on playing fields with heavy traffic. Compacted soil prevents turf roots from penetrating deep into the soil profile (turf roots grow in the air spaces between soil particles). If the soil is compacted (to the point where a penetrometer reads more than 200 pounds per square inch in the top 3 inches of soil, aeration is required, using either a core or slice aerator. Aeration is stressful for turf and should only be undertaken when the grass is actively growing, but can be performed as often as every two to four weeks when necessary. Aerate in a crisscross pattern until 15-20% of the soil surface has been exposed.

**Over-Seeding:** The best defense against weeds is a strong and healthy turf. Given the opportunity, grass plants will out-compete most weeds. Over-seeding, which is simply adding new grass plants to an existing lawn or field, rejuvenates the field with new life, fills in bare spots and keeps weeds from growing. Use a high quality seed or seed mix, appropriate for your climate, and with a minimum of noxious weeds (check the label for weed content).

**Natural Pest and Disease Control:** A healthy, well maintained natural field will be resistant to most pests and disease. However, lack of organic matter, poor cultural practices, too much water and other stresses can reduce turf’s ability to fend off pests and disease. When pests present themselves, here are some natural solutions:

**Beneficial nematodes** have proven to be very effective at dealing with grubs. These are microscopic worms that feed on grub larvae. Nematodes are aquatic animals, and need moisture to survive. Apply with water and keep the soil moist for a few days after
application (see package for details.) You can purchase nematodes from an insectary or nursery that carries beneficial insects.

**Milky Spore** is actually a disease that can be an effective biological control for Japanese beetle grubs. The best time to apply is mid-to late summer when the new brood have hatched and are beginning to feed. The protective effects can last for many years.

Here are some other typical turf problems and recommended solutions:

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dandelions</td>
<td>Lack of calcium, low pH</td>
<td>Apply calcium, keep pH balanced.</td>
</tr>
<tr>
<td>Moss</td>
<td>Low pH, too much moisture</td>
<td>Add lime, improve drainage.</td>
</tr>
<tr>
<td>Red Thread</td>
<td>Lack of nitrogen</td>
<td>Fertilize with organic fertilizer; check potassium and raise if necessary.</td>
</tr>
<tr>
<td>Dollar Spot</td>
<td>Lack of nitrogen, excess thatch, drought stress</td>
<td>Fertilize with organic fertilizer, apply compost top-dress, irrigate.</td>
</tr>
<tr>
<td>Crabgrass</td>
<td>Turf cut too close, excess nitrogen, low pH</td>
<td>Raise cutting height, over-seed, use organic (low N) fertilizer, apply lime to raise pH.</td>
</tr>
<tr>
<td>Thatch</td>
<td>Excess irrigation, improper mowing, too much fertilizer</td>
<td>Apply compost top-dress, raise mower blades, leave clippings on the field, adjust irrigation.</td>
</tr>
<tr>
<td>Patches of dead grass</td>
<td>Grubs</td>
<td>Apply beneficial nematodes.</td>
</tr>
<tr>
<td>Compaction</td>
<td>Sports, high traffic, machinery</td>
<td>Apply compost top-dress, over-seed, apply organic fertilizer, mechanical aeration if necessary.</td>
</tr>
</tbody>
</table>

**Landscaping Equipment:** Excessive noise and dangerous air contaminants from 2-cycle gas-powered leaf blowers and trimmers make them unsuitable for use around schools. Their highly inefficient polluting engines spew fine particulate matter and up to 30% raw gasoline directly into the air. The raw gas combines with nitrous oxide and UV to create ground level ozone, while the fine particulates are hazardous to developing lungs and individuals with asthma. We highly recommend manual equipment or electric and battery-powered leaf blowers and trimmers for use in and around school buildings.
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Chip Osborne is a professional turf consultant for municipalities and school districts across the country, helping them develop effective natural turf management programs. A veteran with thirty years experience, Mr. Osborne is the Chairman of the Town of Marblehead Recreation, Parks, and Forestry Commission where he oversees the management of the Town’s school and municipal fields.

Produced and distributed by Grassroots Environmental Education, a non-profit organization.

52 Main Street • Port Washington • NY • 11050 • www.grassrootsinfo.org
The ChildSafe School

Cleaning Products
Questions and Answers About Green Cleaning

Q. What exactly is green cleaning?
A. There is no legal definition of “green,” and no restriction on the use of that term or others such as “natural,” “environmentally friendly,” eco-friendly,” or “sustainable,” by manufacturers. A true “green cleaning” program refers to the use of products that use bio-based ingredients that have minimal impact on human health and the environment.

Q. Do traditional petrochemical based cleaning products pose health risks for children?
A. Yes. There is widespread consensus among pediatric environmental health experts that chronic, low level exposures to some of the chemicals commonly found in traditional petrochemical cleaning products pose a significant health risk to children. Exposure to these substances has been associated with an increased incidence of both acute and long term health problems, such as allergies, asthma, neurological problems, certain types of cancer, endocrine disruption, chemical sensitivity, and kidney or liver damage. See our science abstracts for more detailed information.

Q. Are children more vulnerable than adults to these toxins?
A. Yes. Children are at greater risk because of their rapidly developing physiology and their natural patterns of behavior. Children play on floors, sprawl on desk and table surfaces, and frequently engage in hand-to-mouth behavior. Pound for pound, children take in more contaminants than adults.

Additionally, most schools are cleaned daily, leaving behind fresh residues of cleaning chemicals on surfaces with which children come into direct contact. Some chemicals found in cleaning products (particularly solvents and fragrances) become airborne when used, and can trigger asthma attacks or other acute health problems in sensitive individuals.

Q. Are there any standards for green cleaning products?
A. There are several independent certifying organizations that have developed standards for green cleaning products including EcoLogo and GreenSeal. However, none of them are specifically designed to compensate for the unique vulnerability of children.

Using criteria originally developed by the U. S. Department of Agriculture (USDA), the Environmental Protection Agency (EPA) and the U.S. Department of the Interior, and in consultation with manufacturers, Grassroots has developed the ChildSafe Guidelines which provide the most stringent standards for green cleaning products in the nation.

The ChildSafe Guidelines take into account the myriad different situations and uses of products in schools, and strive to ensure that even when misused (or in case of a major spill) they will not present any risks to employees, staff or students.

We have also developed a list of products that meet or exceed these specifications. Please see our website (www.TheChildSafeSchool.org) for additional information.
Q. Are green cleaning products more expensive than traditional petrochemical products?

A. No. There are usually some initial costs for employee training and the installation of dispensing systems, and there may be costs associated with the disposal of toxic cleaning products currently in use, but the products themselves are not generally more expensive. Most districts find that the improved health (and attendance) of students, teachers and staff that can result from an effective green cleaning program makes such a program a good financial investment.

Q. Should our school district adopt a green cleaning policy even if our state has mandated green cleaning in schools?

A. Yes. States may be considering green cleaning legislation, but market protection laws in some states may prevent lawmakers from prohibiting the use of certain types of products. Thus, the most effective way to ensure an effective green cleaning program in schools is to adopt an official school policy mandating the exclusive use of bio-based cleaning products which are safe for children and the environment.
Cleaning Products and Air Fresheners: Emissions and Resulting Concentrations of Glycol Ethers and Terpenoids


Abstract:
Experiments were conducted to quantify emissions and concentrations of glycol ethers and terpenoids from cleaning product and air freshener use in a 50-m³ room ventilated at approximately 0.5/h. Five cleaning products were applied full-strength (FS); three were additionally used in dilute solution. During FS application including rinsing with sponge and wiping with towels, fractional emissions (mass volatilized/dispensed) of 2-butoxyethanol and d-limonene were 50–100% with towels retained, and approximately 25–50% when towels were removed after cleaning. Fractional emissions of terpenes from FS use of POC were approximately 35–70% with towels retained, and 20–50% with towels removed. During floor cleaning with dilute solution of POC, 7–12% of dispensed terpenes were emitted. Terpene alcohols were emitted at lower fractions: 7–30% (FS, towels retained), 2–9% (FS, towels removed), and 2–5% (dilute). During air-fresher use, d-limonene, dihydromyrcenol, linalool, linalyl acetate, and citronelol) were emitted at 35–180 mg/day over 3 days while air concentrations averaged 30–160 g/m³.

While effective cleaning can improve the healthfulness of indoor environments, this work shows that use of some consumer cleaning agents can yield high levels of volatile organic compounds, including glycol ethers – which are regulated toxic air contaminants – and terpenes that can react with ozone to form a variety of secondary pollutants including formaldehyde and ultrafine particles. Persons involved in cleaning, especially those who clean occupationally or often, might encounter excessive exposures to these pollutants owing to cleaning product emissions. Mitigation options include screening of product ingredients and increased ventilation during and after cleaning. Certain practices, such as the use of some products in dilute solution vs. full-strength and the prompt removal of cleaning supplies from occupied spaces, can reduce emissions and exposures to 2-butoxyethanol and other volatile constituents. Also, it may be prudent to limit use of products containing ozone-reactive constituents when indoor ozone concentrations are elevated either because of high ambient ozone levels or because of the indoor use of ozone-generating equipment.

Indoor Air Quality, Ventilation and Health Symptoms in Schools: An Analysis of Existing Information


Abstract:
We reviewed the literature on Indoor Air Quality (IAQ), ventilation, and building-related health problems in schools and identified commonly reported building-related health symptoms involving schools until 1999. We collected existing data on ventilation rates, carbon dioxide (CO2) concentrations and symptom-relevant indoor air contaminants, and evaluated information on causal relationships between pollutant exposures and health symptoms. Reported ventilation and CO2 data strongly indicate that ventilation is inadequate in many classrooms, possibly leading to health symptoms. Adequate ventilation should be a major focus of design or remediation efforts. Total volatile organic compounds, formaldehyde (HCHO) and microbiological contaminants are reported. Low HCHO concentrations were unlikely to cause acute irritant symptoms (<0.05 ppm), but possibly increased risks for allergen sensitivities, chronic irritation, and cancer. Reported microbiological contaminants included allergens in deposited d fungi, and bacteria. Levels of specific allergens were sufficient to cause symptoms in allergic occupants. Measurements of airborne bacteria and airborne and surface fungal spores were reported in schoolrooms. Asthma and ’sick building syndrome’ symptoms are commonly reported. The few studies investigating causal relationships between health symptoms and exposures to specific pollutants suggest that such symptoms in schools are related to exposures to volatile organic compounds (VOCs), molds and microbial VOCs, and allergens.
Practical Implications:
Although peer-reviewed literature on this subject is sparse, there is a clear indication that classroom ventilation is typically inadequate. Researchers observed specific allergens in classrooms at levels sufficient to affect sensitive occupants. Studies of health symptom associations with IAQ conditions in the classroom are very rare, but taken with more general knowledge of IAQ, suggest that improved ventilation and targeted indoor pollutant source reductions could reduce certain occupant symptoms and improve the standard of health of the occupants.

* * *

Cleaning Products and Air Fresheners: Exposure to Primary and Secondary Air pollutants

Abstract:
Building occupants, including cleaning personnel, are exposed to a wide variety of airborne chemicals when cleaning agents and air fresheners are used in buildings. Certain of these chemicals are listed by the state of California as toxic air contaminants (TACs) and a subset of these are regulated by the US federal government as hazardous air pollutants (HAPs). In addition, many cleaning agents and air fresheners contain chemicals that can react with other air contaminants to yield potentially harmful secondary products. For example, terpenes can react rapidly with ozone in indoor air generating many secondary pollutants, including TACs such as formaldehyde. Furthermore, ozone-terpene reactions produce the hydroxyl radical, which reacts rapidly with organics, leading to the formation of other potentially toxic air pollutants. Indoor reactive chemistry involving the nitrate radical and cleaning-product constituents is also of concern, since it produces organic nitrates as well as some of the same oxidation products generated by ozone and hydroxyl radicals.

Few studies have directly addressed the indoor concentrations of TACs that might result from primary emissions or secondary pollutant formation following the use of cleaning agents and air fresheners. In this paper, we combine direct empirical evidence with the basic principles of indoor pollutant behavior and with information from relevant studies, to analyze and critically assess air pollutant exposures resulting from the use of cleaning products and air fresheners, toxicants and compounds that can readily react to generate secondary pollutants. The toxicity of many of these secondary pollutants has yet to be evaluated. The inhalation intake of airborne organic compounds from cleaning product use is estimated to be of the order of 10 mg d-1 per person-1 in California. More than two dozen research articles present evidence of adverse health effects from inhalation exposure associated with cleaning or cleaning products. Exposure to primary and secondary pollutants depends on the complex interplay of many sets of factors and processes, ventilation, absorptive interactions with building surfaces, and reactive chemistry. Current understanding is sufficient to describe the influence of these variables qualitatively in most cases and quantitatively in a few.

* * *

Update on Asthma and Cleaners

Abstract:
The present study summarizes the recent literature on the relation between cleaning exposures and respiratory health, in particular asthma, including reviews, epidemiological surveys, surveillance programs and exposure studies.

A large international general population study showed an increased risk of new-onset asthma associated with cleaning work, with professional use of cleaning products and with domestic use of cleaning sprays. Three surveillance studies confirm the recognition of occupational asthma cases among cleaners and among others who use cleaning products at work. Six workforce-based studies show that respiratory symptoms are partly work-related, and are associated with certain specific exposures including sprays, chlorine bleach and other disinfectants.

Recent studies have strengthened the evidence of asthma and other adverse respiratory effects in cleaning workers. Similar effects are seen in other settings in which cleaning products are used such as healthcare
professionals and homemakers. Both new-onset asthma and work-exacerbated asthma due to cleaning exposures may play a role. Exposure to cleaning sprays, chlorine bleach and other disinfectants may be particularly relevant. The predominant effect mechanisms remain largely unclear and may include both specific sensitization and irritant-related features.

* * *

**Halogenated Volatile Organic Compounds from the Use of Chlorine-Bleach-Containing Household Products**  

**Abstract:**  
Sodium hypochlorite (NaOCl) and many organic chemicals contained in household cleaning products may react to generate halogenated volatile organic compounds (VOCs). Halogenated VOC emissions from eight different chlorine bleach containing household products (pure and diluted) were investigated by headspace experiments. Chloroform and carbon tetrachloride were the leading compounds along with several halogenated compounds in the headspace of chlorine bleach products.

One of the most surprising results was the presence of carbon tetrachloride (a probable human carcinogen and a powerful greenhouse gas that was banned for household use by the U.S. Food and Drug Administration) in very high concentrations (up to 101 mg m\(^{-3}\)). By mixing surfactants or soap with NaOCl, it was shown that the formation of carbon tetrachloride and several other halogenated VOCs is possible. In addition to quantitatively determined halogenated VOCs (n = 15), several nitrogen-containing (n = 4), chlorinated (n = 10), oxygenated compounds (n = 22), and hydrocarbons (n = 14) were identified in the headspace of bleach products. Among these, 1,1-dichlorobutane and 2-chloro-2-nitropropane were the most abundant chlorinated VOCs, whereas trichloronitromethane and hexachloroethane were the most frequently detected ones.

Indoor air halogenated VOC concentrations resulting from the use of four selected household products were also measured before, during, and 30 min after bathroom, kitchen, and floor cleaning applications. Chloroform (2.9-24.6 microg m\(^{-3}\)) and carbon tetrachloride (0.25-459 microg m\(^{-3}\)) concentrations significantly increased during the use of bleach containing products. During/ before concentration ratios ranged between 8 and 52 (25 +/- 14, average +/- SD) for chloroform and 1-1170 (146 +/- 367, average +/- SD) for carbon tetrachloride, respectively. These results indicated that the bleach use can be important in terms of inhalation exposure to carbon tetrachloride, chloroform and several other halogenated VOCs.

* * *

**Children's vulnerability to toxic chemicals: a challenge and opportunity to strengthen health and environmental policy.**  
Landrigan, Philip, Environmental Health Perspectives 30:5, p.842-50 (2011)

**Abstract:**  
A key policy breakthrough occurred nearly twenty years ago with the discovery that children are far more sensitive than adults to toxic chemicals in the environment. This finding led to the recognition that chemical exposures early in life are significant and preventable causes of disease in children and adults. We review this knowledge and recommend a new policy to regulate industrial and consumer chemicals that will protect the health of children and all Americans, prevent disease, and reduce health care costs. The linchpins of a new US chemical policy will be: first, a legally mandated requirement to test the toxicity of chemicals already in commerce, prioritizing chemicals in the widest use, and incorporating new assessment technologies; second, a tiered approach to premarket evaluation of new chemicals; and third, epidemiologic monitoring and focused health studies of exposed populations.

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Sample School District Policy
Regarding the Specification and Use of
Environmentally Preferable Bio-Based Cleaning Products

Be it resolved that the Board of Education, recognizing the importance of the safety and health of the district’s students, teachers and staff, does hereby adopt the following policy regarding products used to clean and maintain school facilities within the district.

Background and Intent

Many chemicals commonly found in institutional cleaning and maintenance products pose significant and unnecessary health risks for children, as well as teachers and staff. Exposure to some of these chemicals has been associated with an increased incidence of asthma, allergies, certain types of cancer, neurological disorders, endocrine disruption, chemical sensitivity and kidney or liver damage. When released into the environment, cleaning chemicals can contaminate water sources or be acutely toxic to marine life. The Board believes it is not necessary to jeopardize the health and safety of our students, teachers and staff, or to pollute our environment, when many less toxic or non-toxic alternatives are available.

Therefore the intent of this policy is to reduce student, teacher and staff exposure to these chemicals and reduce environmental pollution by stipulating the exclusive procurement and use of bio-based cleaning products that ensure the highest levels of safety, efficacy and economy.

Procurement

Only products that meet or exceed the ChildSafe Guidelines for Green Cleaning Products, attached hereto, shall be purchased for use in school facilities. This shall include general purpose cleaners, sanitizers and disinfectants, and floor care products. When there is no product available to complete a cleaning or maintenance task that meets the guidelines in this policy, the least toxic alternative with the lowest VOC level should be purchased.

Implementation Guidelines

1. All facilities cleaning and maintenance staff shall be instructed in the proper use of these products to maximize their efficacy. Special training for cleaning when there is a disease outbreak shall be a part of the training program.

2. All classroom teachers shall be provided with approved cleaning products for
use when necessary, and shall be given instruction in their proper use.

3. No parent, teacher or staff member may bring into a school facility any consumer product which is intended to clean, deodorize, sanitize or disinfect.

4. Disinfectant products shall be used only for body fluid spills or in areas where there is a high potential for direct contact with body fluids or when a public health concern requires their use. These products contain registered pesticides and should never be used for general cleaning purposes or when children are present.

5. Floor stripping and finishing products shall only be used when facilities are not in use (vacation breaks) or over long weekends, when buildings can be properly ventilated before children, teachers and staff return. Even environmentally friendly, bio-based products designed for this use typically contain higher levels of volatile ingredients.

**Effective Date and Notice**

This policy shall take effect on ________________

The district shall undertake to inform all parents, teachers and staff of the contents of this policy and the reasons for its adoption. All custodial staff shall be informed of the policy and trained in the use of “green” cleaning products. The district shall inform all vendors of this policy in writing and it shall be referenced in all new contracts and service agreements. Existing stocks of non-complying products shall be used up in areas of the district that are not utilized by children or disposed of as directed by the Director of Facilities.

* * *

*This sample policy was developed by Grassroots Environmental Education, a science-based non-profit organization. The policy is part of the EPA award-winning ChildSafe School program. More information is available at www.TheChildSafeSchool.org.*
Introduction

Environmentally-mediated illness is a growing, yet preventable public health threat. Emerging science links many of these illnesses with exposures to chemical toxins, which has precipitated an increased interest in “green” cleaning products for use in schools and other facilities where children spend time.

Why Children Are Uniquely Vulnerable

Children are at greater risk from toxic exposures because of their immature and rapidly developing physiology and their natural behavioral patterns. They live in their environments in ways adults do not; they play on floors, sprawl on desk and table surfaces, and engage in hand-to-mouth behavior. Pound for pound, children take in more contaminants than adults, increasing their risk.

Researchers have found that early exposures to environmental toxins appear more likely to produce chronic disease than similar exposures encountered later in life. (Studies also show that a developing fetus is particularly at risk from maternal exposures to certain chemicals – a special concern for pregnant women working in schools.)

Furthermore, most schools and child care facilities are cleaned every day, leaving behind fresh residues of cleaning chemicals on surfaces with which children come into direct contact. Some chemicals found in cleaning products become airborne when used and can trigger asthma attacks in affected individuals and possibly contribute to the onset of the disease.

How Exposure Impacts Health

Routes of children’s exposure to cleaning chemicals include inhalation, skin absorption and accidental ingestion. Health impacts from cleaning products used in schools can result from either acute or chronic exposures. Acute exposures (significant one-time exposures) may burn the eyes or skin, cause blindness, poisoning, headaches and respiratory and gastrointestinal ailments. Chronic exposures (frequent low-dose exposures over a longer period of time) can lead to
asthma, allergies, certain types of cancer, learning and behavioral disorders, endocrine disruption, chemical sensitivity and kidney or liver damage.

Moreover, a significant percentage of a student and school staff population may have a specific or general chemical hypersensitivity; that is, they react adversely to extremely low levels of one or more types of chemical exposures. For example, many cleaning products contain fragrances which are common triggers for asthma attacks. Sensitive populations include those with allergies or asthma, individuals with upper respiratory infections (colds, sore throats, etc.) and those on medication for chronic illnesses.

Conclusion

A growing body of evidence suggests that children are more vulnerable to toxins in their environments than previously known, and that the effects of exposure may not be manifested for years. While scientists continue to probe for more answers to these complex issues, parents and school administrators should be aware that their decisions in this area may have profound impacts on the health and well-being of students, long after those students have left the classroom.
The ChildSafe Guidelines for Green Cleaning Products

Type I Products – General Purpose Cleaners

General Purpose Cleaners must pose no or minimal health risks to children from inhalation, skin absorption, accidental ingestion or eye and skin contact. ChildSafe products must meet or exceed the following specifications:

• Product must be bio-based and biodegradable or based on naturally occurring ingredients.
• Product in concentrate form must have a health rating of 0 as designated by the Hazardous Materials Information System (HMIS) and/or National Fire Protection Association (NFPA).
• Product in concentrate form must have a VOC content of less than .5%.
• Product in concentrate form must not contain known or suspected endocrine disruptors or ingredients that are toxic to the liver or kidneys.
• Product must not contain added fragrances (non-functional fragrances).
• Product must not be packaged as aerosol spray using propellant.
• Products must be certified by Green Seal® (using the GS-37 Standard for Cleaning Products for Industrial and Institutional Use, Edition 7.2) or by EcoLogo® under the EcoLogo certification program of Underwriters Laboratories, or meet the specifications and criteria set forth by those organizations as verified by an independent third party certifying entity.
• For products not certified by Green Seal® or EcoLogo®, all ingredients must be disclosed to purchaser.

Note: We encourage the use of products with ingredients that do not contribute to the development of antibiotic-resistant bacteria.

Type II Products – Sanitizers & Disinfectants

Disinfectants are registered pesticides and should never be used for sanitizing or general cleaning purposes because of their significant toxicity and corresponding high risk to humans and the environment. ChildSafe products must meet the following specifications:

• Product must be bio-based and biodegradable or based on naturally occurring ingredients.
• Product must not contain chlorine-based ingredients (e.g., sodium hypochlorite).
• Product must not contain quaternary ammonium compounds (“quats”) (e.g., ammonium chloride).
• Product must not contain phenolics.
• Product must not be packaged as aerosol spray using propellant.
• Product labels must include instructions that the product should be used only after surfaces have been pre-cleaned.
• Product must be certified by GreenSeal® using the GS-53 standard or meet the specifications and criteria contained in that standard as verified by an independent third party certifying entity.

As with Type I products, we encourage the use of products with ingredients that do not add to the development of antibiotic-resistant bacteria.

Type III Products – Floor Care

Floor care products should only be used when facilities are vacant, preferably during summer vacation or over extended holiday breaks when buildings can be properly ventilated before children and staff return to school. ChildSafe products must meet the following specifications:

• Product does not contain styrene or polystyrene.
• Product does not contain urethane or polyurethane.
• Product does not contain petroleum solvents or 2-butoxyethanol.
• Product does not contain ammonia.
• Products must be certified by GreenSeal® using the GS-37 or GS-40 standard (as applicable) or meet the specifications and criteria contained in that standard as verified by an independent third party certifying entity.

Notes About Floor Products:

Bio-based and biodegradable products are preferred and should be used once petroleum-based finishes have been removed.

Floor stripping products typically contain highly toxic, caustic and corrosive chemicals. Their high VOC and pH levels require them to be used with extreme caution, even when following the guidelines above.

Type I products in combination with hot-water extraction usually perform well for basic floor cleaning.

The use of carpeting in schools is not recommended because of the typically high VOC content of chemicals found in carpet, padding and adhesives. Carpet fibers retain many types of allergens and chemicals, increasing the inappropriateness of this floor covering option.

Notes about Sanitizers and Disinfectants:

Sanitizers should be used in areas where there is a desire to reduce microbes to a safe level and where the use of a stronger disinfectant product is not indicated. Promising new technologies for sanitizing include ionized water.
**Disinfectants** should be used only for body fluid spills, in areas where there is a high potential for direct contact with body fluids, or when a public health concern or regulation of the Department of Health or Centers for Disease Control requires their use. Sanitizers or disinfectants have no value if they are applied to soiled surfaces. In fact, this practice promotes the development of even more antibiotic resistant pathogens (so-called “Super Bugs”). Disinfectant products should be allowed to remain on the cleaned surface for the required dwell time (usually about 10 minutes).

**Notes About Hand Soaps**

Pediatricians agree that the use of regular soap and water is just as effective as an antibacterial product in preventing the spread of disease. Regular use of antibacterial hand soaps containing chemicals such as triclosan contributes to the growing problem of antibiotic-resistant strains of bacteria. Alcohol-based sanitizing gels leave a toxic residue on hands, which is of special concern for young children. When there is concern about an illness spreading in a classroom or if parents are anxious, the use of a bio-based (e.g., thyme oil) antibacterial soap can be used.

**Notes About Air Fresheners**

Synthetic fragrances and other petroleum-based components of air fresheners contain volatile organic compounds (VOCs) and other hazardous substances that are released into indoor air. Phthalates, known endocrine disruptors, are also used in artificial fragrance formulations to make scents last longer. In a school environment with many children all in different development stages, and with a significant percentage of them suffering from asthma and allergies, synthetic air fresheners should not be used. Instead of air fresheners, identify the source of the odor, clean it up and use ventilation.

* * *

**Definitions**

“**Bio-based”** means a commercial or industrial product in which more than 60% of the ingredients (other than water) are biological or renewable domestic agricultural (plant, animal or marine) or forestry materials as defined by the U. S. Department of Agriculture (USDA) Bio-Preferred program.

“**Biodegradable”** means a product in which a minimum of 70% of the ingredients are capable of undergoing biological anaerobic or aerobic degradation leading to the production of CO2, H2O, methane, biomass, and mineral salts, depending on the environmental conditions of the process.

“**Disinfectant”** is any product designed to kill microbes and is required to be registered under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

“**Carcinogen”** is an agent that has been determined to be possibly, probably or known to be carcinogenic in humans by the International Agency for Research on Cancer
(IARC), the National Toxicology Program (NTP) or the Environmental Protection Agency (EPA).

“Floor Care Product” includes any product designed for floor stripping, polishing, waxing or heavy-duty cleaning but does not include regular cleaning or dust mop treatments.

“General Purpose Cleaner” is a product designed for routine cleaning of classrooms, hallways, offices, cafeterias, lobbies, auditoriums, libraries and other areas inside school facilities. The category includes all-purpose surface and floor cleaners, cleaning pastes, window and mirror cleaners, and dust mop treatments, but does not include air fresheners.

“Mutagen” is any agent, such as ultraviolet light, radioactive elements or chemical ingredients which can induce or increase the frequency of mutation in a living organism as determined by the Globally Harmonized System for Classification and Labeling of Chemicals (GHS).

“Sanitizer” is any product designed to reduce the number of microbes and is required to be registered under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

“Teratogen” is any agent such as a virus, a drug or radiation that adversely affects and causes malformations of a developing fetus or embryo as determined by an ASTM E1439 FETAX analysis of equivalent.

“Volatile Organic Compounds (VOCs)” are organic chemicals that have a high vapor pressure and easily form vapors at normal temperature and pressure, such as aerosol spray propellants, petroleum distillates and solvents as defined by the California Code of Regulations (CCR).

* * *

The ChildSafe Guidelines are based on recommendations originally developed by the U. S. Department of Agriculture (USDA), the Environmental Protection Agency (EPA) and the U.S. Department of the Interior. A more recent certification standard for bio-based cleaning and maintenance products has been developed by the U.S. Department of Agriculture (USDA) called the BioPreferred Voluntary Labeling Program. We look forward to being able to adopt this new standard as more products are formulated to meet the requirements.

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## The ChildSafe Cleaning Product List

The following products have been warranted by their manufacturers and/or distributors as complying with the ChildSafe Guidelines. The inclusion of products on this list does not constitute endorsement by Grassroots Environmental Education nor constitute any express or implied warranty of safety, efficacy or performance standard. See the websites of third-party certification organizations for testing standards. Grassroots does not accept financial contributions from manufacturers and charges no fee for inclusion on this list. For more information please visit www.grassrootsinfo.org or call (516) 883-0887.

### GENERAL PURPOSE CLEANERS

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*Many of these products have multiple applications based on dilution rates. See product specifications for more information.*
# BATHROOM CLEANERS

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**DISINFECTANTS**

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**OTHER/MISCELLANEOUS**

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The ChildSafe School

Wireless in Schools
Questions and Answers About Wireless (RF) Radiation

Q. What is wireless radiation?

A. Non-ionizing radio-frequency (RF) radiation, also known as microwave or wireless radiation, is one form of man-made electromagnetic radiation. Current technologies use RF radiation to send and receive data wirelessly. Common RF radiation sources are radio and television transmissions, cell towers and antennas, cell phones, cordless phones, baby monitors, wireless computer networks (WLAN), smart utility meters and all other wireless devices.

Q. Are there health impacts associated with wireless, or RF radiation?

A. Until recently, it was generally accepted that a device using RF radiation only posed a health risk if it generated enough heat to raise the temperature of body tissue – referred to as a thermal effect. In 2016, the results of a multi-year, $25M study from the National Toxicology Program revealed that RF radiation can cause biological harm at levels far below the actual heating of tissue. This study confirmed the findings of the World Health Organization which classified RF radiation as a possible human carcinogen. Thousands of other peer-reviewed academic studies from around the world have corroborated these findings.

Besides cancer, other health impacts associated with exposure to RF radiation include interference with normal brain development in fetuses, damage to reproductive systems, genetic damage, neurological problems and learning deficits, behavioral issues, sleep disruption and electromagnetic hypersensitivity.

Given our incomplete knowledge of the health effects associated with chronic, low level exposure to RF radiation, the employment of the Precautionary Principle* seems entirely appropriate and necessary for schools, where children spend about half of their waking hours each day.

* The Precautionary Principle states that “when there is an indication of harm to health or the environment, precautionary measures should be taken, even if some cause and effect relationships are not yet fully established scientifically.” This principle guides governments around the world when considering regulation of chemicals, products and technologies.

Q. Are children more vulnerable to RF radiation?

A. Children are always more vulnerable to threats in their environment due to their immature and rapidly developing bodies and their typical behaviors. A growing body of scientific research confirms this vulnerability. Some key findings include:

- Children have more stem cells which are shown to be especially sensitive to RF radiation, and because they are still growing, their cells are dividing more rapidly.

- A child’s head shows absorption (or penetration) rates of RF radiation at approximately twice that of an adult.

- Children today will have a longer lifetime exposure and have most of their lives in front of them. A time lag of 10-20 years to develop cancer will impact them more significantly in the prime years of their lives.

- RF radiation has become ubiquitous in young children’s lives, as companies design and manufacture wireless devices that are intended for use by children, even before birth and as newborns.

Q. Does the use of wireless devices in schools create high levels of RF radiation?

A. Schools may employ commercial routers to accommodate the large number of users in a classroom. These routers can be more powerful than home models and close proximity to the router can greatly increase exposure.

Typical WLAN or WiFi installations in schools generate constant, pulsed RF radiation even when no wireless devices are being used. Teachers and students add to (or amplify) this when they are downloading and uploading information.
The level of RF radiation at tables of 6 or 8 children when they are all using the internet can easily exceed levels deemed safe by experts.

Radiation can be blocked or reflected by metal objects and then absorbed or reflected by people in the room. This causes “hot” and “cold” spots in the classroom, making it impossible to get an accurate exposure reading in a classroom with multiple users.

Q. What are other countries doing to protect children from wireless radiation in schools?

A. 2007 - The Bavarian Parliament (Germany) recommends the use of wired networks in all Bavarian schools due to health concerns and had each single school informed about this recommendation by the state secretary.

2011 - The Council of Europe recommends WiFi be banned from schools. The Council of Europe has 47 member states and is highly influential in policymaking. Its scientific panel concludes that standards for WiFi and other wireless devices are “entirely inadequate” and “strongly recommends that schools do not install wireless internet connections that create pervasive and prolonged EMF exposures for children.”

2015 - The Israeli government bans WiFi in kindergartens and restricts hours of use in schools. "Israel is a world leader in research on the health effects of non-ionizing radiation," said Linda Birnbaum, Director of the US National Institute of Environmental Health Sciences. “If some of the studies turn out to be harbingers of things to come, we may have major health consequences from the nearly ubiquitous presence of wireless equipment.”

Q. Are there other reasons or cost effective options for providing wired internet access to school children?

A. Wired connections are more protective of children’s privacy and more secure than wireless because they are more difficult to “hack.” Wired connections are faster than wireless if high-speed gigabit Ethernet connections are used.

Newer technologies already exist and more are in development for hardwiring classrooms at a comparable or even reduced cost compared to wireless installations.
The following scientific studies on wireless (microwave) radiation are the property of their respective Copyright owners

I. Effects On Fetal And Newborn Development

II. Effects On Young Children

III. Brain Tumors

IV. Parotid Gland Tumors

V. Other Malignancies

VI. Effects On DNA

VII. Neurological/Cognitive Effects

VIII. Effects On Male Fertility

IX. Electromagnetic Sensitivity

X. Effects On Implanted Medical Devices

XI. Miscellaneous Articles

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“Current FCC standards do not account for the unique vulnerability and use patterns specific to pregnant women and children. It is essential that any new standards for cell phones and other wireless devices be based on protecting the youngest and most vulnerable population to ensure they are safeguarded throughout their lifetimes.”

- American Academy of Pediatrics

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- Newer technologies already exist and more are in development for hardwiring classrooms at a comparable or even reduced cost compared to wireless installations.

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We fully support and promote access to the internet in all schools. We join with medical doctors, medical researchers, toxicologists, United States and International Public Health Agencies who advise caution and risk reduction around wireless radiation in places where pregnant women and children live, learn and play and strongly suggest hardwired internet connectivity.
Guidelines for Use of Wired and Wireless Technology in Classrooms

All wireless devices emit radio-frequency (RF) microwave radiation. Recent scientific studies have shown that this type of non-ionizing radiation, previously thought to be relatively safe, has measurable and harmful biological effects on humans. Developing fetuses and young children are among the most vulnerable to this type of radiation.

The safest solution is to provide wired connections. Wired connections are faster, more secure, more economical and safer than wireless networks. Most wireless routers have Ethernet connections, and allow the wireless function to be disabled. Using state-of-the-art technology, your IT department can install wired Ethernet connections in classrooms.

For situations where wired installations are not yet possible, we offer the guidelines below. The guidelines are based on the Precautionary Principle, which dictates that when an activity raises threats of harm to human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.

This is a living document that will be regularly updated as additional science on wireless radiation emerges.

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>Proximity to wireless devices is the most important factor in determining the amount of your radiation exposure. The amount of radiation decreases significantly as you move away from the source.</td>
</tr>
<tr>
<td>2.</td>
<td>Avoid prolonged, close contact with wireless routers, laptop computers, tablets, cell phones and cordless phones. Don’t allow children to hold devices on their laps.</td>
</tr>
<tr>
<td>3.</td>
<td>Concentrated groups of wireless devices (such as clusters of children using their tablets or laptops while connected to the internet) emit the highest levels of radiation in the classroom.</td>
</tr>
<tr>
<td>4.</td>
<td>Placing wireless devices in “airplane” mode will eliminate virtually all radiation emissions. If students are not using the internet, make sure they de-activate the WiFi connection using this setting or ask them to turn off their devices.</td>
</tr>
<tr>
<td>5.</td>
<td>The router is a constant source of radiation in a classroom. The strongest radiation from a router typically extends out from the router 5 to 10 feet in every direction. Find out if the router has an easily accessible power switch that can be turned off when you don’t need access to the internet.</td>
</tr>
<tr>
<td>6.</td>
<td>Ask your staff IT person if they can reduce the power of the router. Commercial routers are more powerful than those for home use and are often overpowered for classroom needs.</td>
</tr>
</tbody>
</table>

This information is provided by Grassroots Environmental Education, Inc., a science-based non-profit organization, in cooperation with New York State United Teachers (NYSUT). To learn more about wireless radiation and the peer-reviewed science supporting these Guidelines, please visit [www.Grassrootsinfo.org/cellphonesandwireless.php](http://www.Grassrootsinfo.org/cellphonesandwireless.php) © 2019 Grassroots Environmental Education. All Rights Reserved.
The ChildSafe School

Synthetic Turf
Questions and Answers About Synthetic Turf

Q. What’s wrong with using crumb rubber to cushion synthetic turf fields?

A. The crumb rubber from used vehicle tires contains a myriad of toxic, restricted-use chemicals, including heavy metals, benzene, carbon black and volatile organic compounds (VOCs). Many of the chemicals are known carcinogens, neurotoxins and endocrine disruptors. Student athletes can be exposed to these highly toxic substances through inhalation, skin absorption and accidental ingestion, all of which can easily occur during normal sports activities. A single synthetic turf field can use up to 40,000 used vehicle tires.

Q. What other chemicals may be found on synthetic turf fields?

A. Many synthetic turf fields have been found to contain lead. The green pigment used in the synthetic “grass” carpets and blades can contain lead. As the fields age and the elements fade and break down the plastic, it begins to powder, making the lead more accessible. The crumb rubber may also contain lead from tire balancing weights and lead paint residue picked up from road surfaces. Lead is a potent neurotoxin and even tiny amounts can affect the brain, especially in young children. There is no safe lead exposure level for children.

Q. Are high temperatures on these fields a problem?

A. Yes. The surface temperature of synthetic turf fields on hot, sunny days can reach 180F or higher. High-powered water cannons can be used to cool down unsafe surface temperatures, but this is only temporary, as it takes only about 20 minutes for the temperature to rebound to the unsafe level.

On hot, sunny days, water cannons must be used repeatedly to keep field surface temperatures down and reduce the risk of serious heat-related illnesses as well as burns to the soles of the feet of the athletes.

Q. Why do synthetic turf fields require disinfecting chemicals (pesticides)?

A. A synthetic turf field must be disinfected regularly to remove disease-causing pathogens from body fluid spills such as blood, vomit, sweat and saliva. The use of these chemical pesticides can present their own health risks, whereas natural grass fields have the advantage of soil microbial activity, which helps to break down contaminants through natural processes. Additionally, skin abrasions (turf burns) are more common on synthetic turf fields and are typically larger in size, providing more opportunity for antibiotic-resistant infections, including MRSA. Medical experts have found that staphylococci and other bacteria can survive for more than 3 months on polyethylene plastic, the material used in the manufacture of synthetic turf carpets and grass blades.

Q. Aren’t synthetic turf fields safer for young athletes?

A. Although there is not enough research yet comparing injuries incurred on synthetic turf with those occurring on natural grass fields, there is compelling data indicating that joint injuries (especially ankles and knees) are more common and more severe among athletes playing on synthetic turf. A painful and debilitating condition called “turf toe” is unique to athletes playing on synthetic turf surfaces, and many professional athletes report increased fatigue and greater muscle soreness when playing on these surfaces.
Q. Don’t synthetic turf fields reduce the use of chemical pesticides that can be harmful to children?

A. No! Synthetic turf is not a solution for the problem of chemical pesticides. The often-used argument that synthetic turf decreases the use of chemical pesticides wrongly assumes that these chemicals are required for natural grass. They are not. In fact, organically maintained natural grass uses no chemical pesticides, and new technologies and equipment make maintaining natural grass playing surfaces easier than ever before. Properly maintained grass fields can stand up to heavy use and are completely safe for users, from young soccer players to high school football teams.

Q. Aren’t synthetic turf fields better for the environment?

A. Absolutely not. Synthetic turf fields appear dark when photographed from the air because of the black crumb rubber infill, and like tar roofs, contribute to a “heat island” effect. In addition, these fields, made from petroleum, are unable to convert carbon dioxide into oxygen or store carbon in their biomass as grass fields do.

Q. Are these fields considered safe by the government?

A. Actually, no. Both the Consumer Product Safety Commission and the United States Environmental Protection Agency have withdrawn safety assurances for recycled rubber tire products, including synthetic turf. The EPA has posted new cautions concerning unexplored chemical exposure to more than 30 compounds found in synthetic shredded tire infill and encouraged future studies to enable more comprehensive conclusions.

Q. Isn’t there a federal study being conducted to determine the safety of these fields?

A. A study was started, then suddenly defunded. Nevertheless, emerging health impacts of synthetic turf are causing concern among parents, coaches and school administrators. There are confirmed reports of a growing incidence of lymphoma and leukemia as well as other diagnoses among student athletes using synthetic turf fields filled with crumb rubber, particularly among soccer goalies. While no peer-reviewed studies have been conducted to confirm or disprove a link, there is a call for independent, scientific research and the establishment of a health agency registry to track athletes who’ve been diagnosed.
Independent Science on Public Health Concerns Regarding Synthetic Turf

I. Crumb Rubber Chemicals
   A. 1,3 Butadiene
   B. Arsenic
   C. Arylamines
   D. Benzene
   E. Benzothiazoles
   F. Butylated Hydroxyanisole (BHA)
   G. Cadmium
   H. Carbon Black
   I. Lead
   J. Manganese
   K. Mercury
   L. Phenols
   M. Phthalates
   N. Polycyclic Aromatic Hydrocarbons (PAHs)
   O. Styrene
   P. Toluidine
   Q. Trichloroethylene (TCE)

II. Bioaccessibility

III. Heat Effects

IV. Injuries

V. Flame Retardants

VI. Disinfectants and Sanitizers

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Synthetic Turf Fields
Fact Sheet

Background Information

• Used or “scrap” rubber tires present significant problems in solid waste management as their sheer numbers, flammability and indestructible nature makes them persist in the environment. When disposed of in landfills, they take up massive amounts of space, leach toxic chemicals and collect water that creates a fertile breeding ground for disease-transmitting mosquitoes.

• There is a considerable effort to find uses for recycled rubber tires. Historically they have been used as fuel in the paper and cement industries, as road construction materials and in construction of drainage fields for septic systems, among other industrial applications. But with the growing number of used tires and prohibitions for their disposal in landfills, new markets for this hazardous waste product are actively being sought.

• A relatively recent use of ground up used rubber tires, also known as “crumb rubber,” is to cushion or infill synthetic turf fields or create playground surfaces. Approximately 40,000 tires can be recycled into crumb rubber pellets to use as infill material for a single field.

• The Resource Conservation and Recovery Act (RCRA) of 1976, our nation’s primary law governing disposal of solid and hazardous waste, gives the EPA the authority to control hazardous waste from “cradle-to-grave,” including used rubber tires. But it also states that the recycling of a hazardous waste product into a useable consumer product automatically exempts it from RCRA requirements, even if the end product it creates is more toxic than other similar products on the market. This loophole means that no monitoring follows the new products that have been manufactured from recycled hazardous waste, such as synthetic turf crumb rubber infill or recycled rubber playground surfaces.

Chemical Composition of Crumb Rubber

• The exact chemical composition of tires is largely determined by the intended use for the tire and the manufacturing location. Typical tire rubber contains 40-60% rubber polymer, 20-35% reinforcing agents, up to 28% aromatic extender oil, vulcanization
additives, antioxidants, antiozonants, and processing aids (plasticizers and softeners).

- Examples of chemicals of concern in the above categories and their potential health effects:

  1,3 Butadiene – human carcinogen
  4-(t-octyl) phenol – corrosive to mucous membranes
  Arsenic – human carcinogen
  Benzene – human carcinogen, developmental and reproductive toxicant
  Benzothiazole – acutely toxic, respiratory and eye irritant, dermal sensitizer
  Butylated Hydroxyanisole – human carcinogen, suspected endocrine and immune system toxicant
  Cadmium – human carcinogen
  Carbon Black – human carcinogen (makes up to 40% of rubber tires)
  Flouranthene – human carcinogen
  Latex – allergic reactions in susceptible individuals
  Lead – neurotoxin
  Manganese – neurotoxin
  Mercury – neurotoxin
  N-hexadecane – eye, skin and respiratory system irritant
  Octylphenol – endocrine disruptor
  Phthalates – endocrine disruptors, developmental and reproductive toxicants
  Polycyclic Aromatic Hydrocarbons (PAHs) – reproductive and respiratory toxicants, liver toxicants, suspected blood or cardiovascular toxicants
  Styrene – human carcinogen and mutagen
  Toluidine – human carcinogen
  Trichloroethylene – human carcinogen

Crumb Rubber Health Concerns

- Crumb rubber pieces can become lodged in mouths, ears and noses, and crumb rubber dust can be easily inhaled as it becomes disturbed during play. Also, many of the above listed chemicals are volatiles (chemicals which outgas), which means that they will create inhalation exposures, especially in warmer temperatures. Given the number of different sources for ground up rubber tires and the unique chemical components of each individual field, an absolute determination of safety is impossible. And since many of these chemicals are toxic at any level of exposure, the presence of even one of these chemicals on fields where children play should trigger a public health concern.

There have been reports of higher than usual cases of lymphoma and leukemia among athletes using synthetic turf fields, especially soccer goalies. While no studies to date have confirmed a link, common sense tells us that chemicals in tires that are known to cause cancer should be avoided wherever possible.
Other Health Concerns

• High temperatures on synthetic turf - A comprehensive study on the temperature of synthetic turf fields was conducted by Brigham Young University. The researchers found that the amount of light (electromagnetic radiation) had the greater impact on heating of the fields than air temperature. The hottest surface temperature recorded was 200°F on a 98°F day. Even on cooler days, field temperatures of 120°F to 174°F were recorded. In general, the surface temperature of the synthetic turf was 37°F higher than asphalt and 86.5°F hotter than natural grass.

Water canons or other irrigation systems can cool down a field for only about 20 minutes, interrupting the game numerous times on particularly hot days.

Serious heat-related health problems are associated with playing on synthetic turf fields, including dehydration, heat stroke and heat exhaustion. More frequent water breaks are a necessity and many players concur that the heat issue impacts their ability to perform their best. There are also many reports of serious burns on the soles of the feet of players (through socks and shoes) when the temperatures on the turf are dangerously high.

• Body fluid contamination – there is always potential for body fluid contamination on a playing field during normal sports activities, including blood, saliva, sweat and vomit. Natural grass fields have the advantage of soil microbes to help break down pathogens, but plastic surfaces on synthetic turf need to be disinfected after games to ensure safety. However, in practice, this is rarely done, if ever, and the use of chemical disinfectants (pesticides) adds an additional concern for the health and safety of players.

• Injuries – Although there is not enough research comparing injuries incurred on synthetic turf versus natural grass fields, there is compelling data indicating that joint injuries (especially ankles and knees) are more common on synthetic turf surfaces. The Hospital for Special Surgery in New York notes that despite progress by synthetic turf manufacturers in making their fields feel more “natural,” players still suffer from debilitating turf toe (sprain of the main joint of the big toe) which is unique to artificial playing surfaces. Almost 75% of NFL players feel that playing on synthetic turf increases soreness and fatigue.

• Turf burns or abrasions and infections – Skin abrasions (turf burns) are more common on plastic synthetic turf fields than natural grass fields and are typically larger in size, providing more opportunity for infection. Research on the causes of MRSA (Methicillin-resistant Staphylococcus aureus) outbreaks in sports teams is ongoing, but there appears to be an association with traumatized skin, as seen in turf burns, and this serious antibiotic-resistant staph infection. Medical experts have found that staphylococci and other bacteria can survive for more than 3 months on polyethylene plastic, the material used in the manufacture of synthetic turf carpets and grass blades.
• **Chemical flame retardants** – One of the more recent developments in the controversy over synthetic turf has been the vandalizing of fields by setting them on fire. Rubber tires (and tire crumbs) burn for long periods of time, releasing highly toxic smoke, which could be hazardous for those living in close proximity to a school or park where a field is located. Because of this, manufacturers of synthetic turf are now treating the fields with chemical flame retardants. Polyclanorinated diphenyl ethers, or PBDEs, are commonly used flame retardant chemicals that belong to a broader class of chemicals called polyhalogenated aromatic hydrocarbons, or PHAHs. PBDEs are intrinsically hazardous because they are persistent in the environment, accumulating in the fatty tissue and especially breast milk of humans through bio-magnification and bio-accumulation. They are linked to endocrine disruption (especially thyroid function) and neurological impacts. They are considered possible human carcinogens.

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*Grassroots Environmental Education is a 501 (c) (3) non-profit organization with a mission to inform the public about the health risks of common environmental exposures and to empower individuals to act as catalysts for change in their own communities. We strive to accomplish this using science-driven arguments for clean air, clean water and a safe food supply, and for stricter regulation of chemical toxins. More information at www.Grassrootsinfo.org.*
1. Toxic tire scraps don't belong on playing fields. Most synthetic turf fields use shredded or "crumb" rubber from recycled tires as an infill or cushioning material. Up to 40,000 used tires can be utilized for a single field. The crumb rubber contains a myriad of toxic, restricted use chemicals, including heavy metals, benzene, carbon black and volatile organic compounds (VOCs). Many of the chemicals are known carcinogens, neurotoxins and endocrine disruptors. Student athletes can be exposed to these highly toxic substances through inhalation, skin absorption and accidental ingestion, all of which can easily occur during normal sports activities.

2. Temperatures on synthetic turf fields can rise to unsafe levels. The surface temperature of synthetic turf fields on hot, sunny days can reach 180°F or higher. High-powered water cannons can be used to cool down unsafe surface temperatures, but this is only temporary, as it takes only about 20 minutes for the temperature to rebound to the unsafe level. On hot, sunny days, water cannons must be used repeatedly to keep field surface temperatures down and reduce the risk of serious heat related illnesses as well as burns to the soles of the feet of the athletes.

3. Synthetic turf requires the use of disinfecting chemicals (pesticides). A synthetic turf field must be disinfected regularly to remove disease-causing pathogens from body fluid spills such as blood, vomit, sweat and saliva. The use of these chemical pesticides can present their own health risks, whereas natural grass fields have the advantage of soil microbial activity, which helps to break down contaminants through natural processes. Additionally, skin abrasions (turf burns) are more common on synthetic turf fields and are typically larger in size, providing more opportunity for antibiotic resistant infections, including MRSA. Medical experts have found that staphylococci and other bacteria can survive for more than 3 months on polyethylene plastic, the material used in the manufacture of synthetic turf carpets and grass blades.

4. Synthetic turf fields produce unusual and more severe injuries. Although there is not enough research yet comparing injuries incurred on synthetic turf with those occurring on natural grass fields, there is compelling data indicating that joint injuries (especially ankles and knees) are more common and more severe among athletes playing on synthetic turf. A painful and debilitating condition called "turf toe" is unique to athletes playing on synthetic turf surfaces, and many professional athletes report increased fatigue and greater muscle soreness when playing on these surfaces.
5. Initial cost, maintenance and replacement costs are higher for synthetic turf fields. The cost of a synthetic turf field can range from $750,000 to well over one million dollars, depending on size and multiple factors involving base construction and choice of materials. Maintenance of a synthetic turf field includes cleaning and disinfecting, anti-static and flame retardant chemical applications, painting, brushing, replacement of crumb rubber infill, seam repair, water cooling and weeding. Conservative estimates for proper maintenance are around $100,000 annually. This cost is more than three times the cost of proper maintenance of natural grass fields. Synthetic turf fields have a set life of 8 to 12 years (sometimes less, depending on usage) and must be replaced due to compaction and worn fibers. Assuming the base is still good, the cost to remove and dispose of the old field and replace the carpet and infill is approximately $500,000.

6. Synthetic turf is not a solution for the problem of chemical pesticides. The often-used argument that synthetic turf decreases the use of chemical pesticides wrongly assumes that these chemicals are required for natural grass. They are not. In fact, organically maintained natural grass uses no chemical pesticides, and new technologies and equipment make maintaining natural grass playing surfaces easier than ever before. These fields can stand up to heavy use and are completely safe for users, from young soccer players to high school football teams.

7. Synthetic turf fields have been found to contain lead. The green pigment used in the synthetic “grass” carpets and blades can contain lead. As the fields age and the elements fade and break down the plastic, it begins to powder, making the lead more accessible. The crumb rubber may also contain lead from tire balancing weights and lead paint residue picked up from road surfaces. Lead is a potent neurotoxin and even tiny amounts can affect the brain, especially in young children. There is no safe lead exposure level for children.

8. Federal agencies have withdrawn their assurances of safety for synthetic turf fields. Both the Consumer Product Safety Commission and the United States Environmental Protection Agency have withdrawn safety assurances for recycled rubber tire products, including synthetic turf. The EPA has posted new cautions concerning unexplored chemical exposure to more than 30 compounds found in synthetic shredded tire turf and encouraged future studies to enable more comprehensive conclusions.

9. Synthetic turf fields contribute to a warming planet. Synthetic turf fields appear dark when photographed from the air because of the black crumb rubber infill, and like tar roofs, contribute to a “heat island” effect. In addition, these fields, made from petroleum, are unable to convert carbon dioxide into oxygen and store carbon in their biomass as grass fields do.

10. Emerging health impacts of synthetic turf are causing concern among parents, coaches and school administrators. There are confirmed reports of a growing incidence of lymphoma and leukemia diagnoses among athletes using synthetic turf fields filled with crumb rubber, particularly among soccer goalies. While no peer-reviewed studies have been conducted to confirm a link, there is a call for independent, scientific research and the establishment of a health agency registry to track athletes who’ve been diagnosed.

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The ChildSafe School

LED Lighting
Q. Why should I be concerned about LED lighting in schools?

A. LED lighting can have many advantages for schools, including significant energy and maintenance savings. However, not all LED lighting is the same. LED bulbs that emit a bright, almost-daylight color contain a large portion of the blue light portion of the light spectrum, which can be harmful to the eyes of young children.

Over time, LED lighting with high levels of blue light can negatively affect the lens and, especially, the retina of the eye. Studies in both animals and humans have shown a relationship between long-term exposure to blue light and age-related macular degeneration.

Q. What is blue light?

A. Blue light is part of the visible light spectrum, which also includes green, yellow, orange and red. Blue light has a very short wavelength, and produces a higher amount of energy than other parts of the spectrum. The higher the color temperature (see below), the higher the proportion of blue light being emitted.

Q. Are children more vulnerable to the blue light part of the spectrum?

A. Yes. The absorption spectrum of the human eye changes with age. In young children, more than 65% of blue light is transmitted to the retina through the lens. At around 25 years old, only about 20% of blue light is transmitted to the retina. For this reason, many health experts recommend avoiding the use of light sources emitting light with a high blue component (above 5000 degrees on the Kelvin scale) in schools and other places frequented by children.

Q. What’s the Kelvin scale?

A. The Kelvin scale, named for a 19th century Irish engineer, is the measurement tool we use to gauge the color temperature of lighting sources. Daylight is approximately 5600 K on the Kelvin scale; a typical indoor incandescent bulb is about 2700 K.

Q. So are LED lights available with lower temperature bulbs?

A. Yes, manufacturers make bulbs in a variety of different color temperatures. Some manufacturers of industrial and school lighting even allow users to "tune" the temperature of the light, in a range from 2700 K to 5000 K, depending on the tasks being performed.

Q. So what should schools do about LED lighting?

A. If your classrooms and hallways look as if they're constantly bathed in daylight, chances are good you're using very high temperature bulbs. Talk with your school administrator about changing the color temperature of the bulbs, especially in elementary school classrooms where younger children are more vulnerable, and where they are usually in the same classroom all day long.
Retinal Damage Induced by Commercial Light Emitting Diodes (LEDs)

Abstract:
Spectra of “white LEDs” are characterized by an intense emission in the blue region of the visible spectrum, absent in daylight spectra. This blue component and the high intensity of emission are the main sources of concern about the health risks of LEDs with respect to their toxicity to the eye and the retina. The aim of our study was to elucidate the role of blue light from LEDs in retinal damage. Commercially available white LEDs and four different blue LEDs (507, 473, 467, and 449 nm) were used for exposure experiments on Wistar rats. Immunohistochemical stain, transmission electron microscopy, and Western blot were used to exam the retinas. We evaluated LED-induced retinal cell damage by studying oxidative stress, stress response pathways, and the identification of cell death pathways. LED light caused a state of suffering of the retina with oxidative damage and retinal injury. We observed a loss of photoreceptors and the activation of caspase-independent apoptosis, necroptosis, and necrosis. A wavelength dependence of the effects was observed. Phototoxicity of LEDs on the retina is characterized by a strong damage of photoreceptors and by the induction of necrosis.

Potential Danger of Light Emitting Diode Illumination to the Eye, in Children and Teenagers

Abstract:
Modern white light emitting diodes (LED) have an expressed emission band in a blue and dark-blue interval of 440-460 nm, which completely coincides with the spectrum causing photochemical damage of eye retina and its pigmented epithelium. This radiation represents an increased level of risk danger for the eyes in children and teenagers, because their crystalline lenses are twice as transparent in the blue and dark-blue interval than adult eyes. Photochemical damage of the retina progresses over a long period of time and causes gradual irreversible degradation of sight. The use of luminaires with LEDs in childcare facilities of the Russian Federation can have unpredictable negative and irreversible consequences for children’s sight and demand a serious professional ophthalmology and physiological substantiation.

Effects of White Light-Emitting Diode (LED) Light Exposure with Different Correlated Color Temperatures (CCTs) on Human Lens Epithelial Cells in Culture

Abstract:
Cataract is the major cause for legal blindness in the world. Oxidative stress on the lens epithelial cells (hLECs) is the most important factor in cataract formation. Cumulative light-exposure from widely used light-emitting diodes (LEDs) may pose a potential oxidative threat to the lens epithelium, due to the high-energy blue light component in the white-light emission from diodes. In the interest of perfecting biosafety standards for LED domestic lighting, this study analyzed the photobiological effect of white LED light with different correlated color temperatures (CCTs) on cultured hLECs. The hLECs were cultured and cumulatively exposed to multichromatic white LED light with CCTs of 2954,
Cell viability of hLECs was measured by Cell Counting Kit-8 (CCK-8) assay. DNA damage was determined by alkaline comet assay. Intracellular reactive oxygen species (ROS) generation, cell cycle, and apoptosis were quantified by flow cytometry. Compared with 2954 and 5624 K LED light, LED light having a CCT of 7378 K caused overproduction of intracellular ROS and severe DNA damage, which triggered G2/M arrest and apoptosis. These results indicate that white LEDs with a high CCT could cause significant photobiological damage to hLECs.

* * *

**Light-Emitting Diodes (LED) for Domestic Lighting: Any Risks for The Eye?**


**Abstract:**
Light-emitting diodes (LEDs) are taking an increasing place in the market of domestic lighting because they produce light with low energy consumption. In the EU, by 2016, no traditional incandescent light sources will be available, and LEDs may become the major domestic light sources. Due to specific spectral and energetic characteristics of white LEDs as compared to other domestic light sources, some concerns have been raised regarding their safety for human health and particularly potential harmful risks for the eye.

To conduct a health risk assessment on systems using LEDs, the French Agency for Food, Environmental and Occupational Health & Safety (ANSES), a public body reporting to the French Ministers for ecology, for health and for employment, has organized a task group. This group consisted physicists, lighting and metrology specialists, retinal biologist and ophthalmologist who have worked together for a year. Part of this work has comprised the evaluation of group risks of different white LEDs commercialized on the French market, according to the standards and found that some of these lights belonged to the group risk 1 or 2. This paper gives a comprehensive analysis of the potential risks of white LEDs, taking into account pre-clinical knowledge as well as epidemiologic studies and reports the French Agency's recommendations to avoid potential retinal hazards.

* * *

**White Light–Emitting Diodes (LEDs) at Domestic Lighting Levels and Retinal Injury in a Rat Model**


**BACKGROUND:** Light-emitting diodes (LEDs) deliver higher levels of blue light to the retina than do conventional domestic light sources. Chronic exposure to high-intensity light (2,000–10,000 lux) has previously been found to result in light-induced retinal injury, but chronic exposure to relatively low-intensity (750 lux) light has not been previously assessed with LEDs in a rodent model.

**OBJECTIVE:** We examined LED-induced retinal neuronal cell damage in the Sprague-Dawley rat using functional, histological, and biochemical measurements.

**METHODS:** We used blue LEDs (460 nm) and full-spectrum white LEDs, coupled with matching compact fluorescent lights, for exposures. Pathological examinations included electroretinogram, hematoxylin and eosin (H&E) staining, immunohistochemistry (IHC), and transmission electron microscopy (TEM). We also measured free radical production in the retina to determine the oxidative stress level.

**RESULTS:** H&E staining and TEM revealed apoptosis and necrosis of photoreceptors, which indicated blue-light induced photochemical injury of the retina. Free radical production in the retina was increased in LED-exposed groups. IHC staining demonstrated that oxidative stress was associated with retinal injury. Although we found serious retinal light injury in LED groups, the compact fluorescent lamp (CFL) groups showed moderate to mild injury.

**CONCLUSIONS:** Our results raise questions about adverse effects on the retina from chronic exposure to LED light compared with other light sources that have less blue light. Thus, we suggest a precautionary approach with regard to the use of blue-rich "white" LEDs for general lighting.
Exposure to LED lighting can cause both short and long-term effects on our health.

**LED Lighting Fact Sheet**

There has been a vigorous effort over the past several decades to replace inefficient lighting with more energy efficient options, including LEDs. Light-emitting diodes (LEDs) are now used in a large number of applications, including digital device screens, television screens, electronic billboards, automobile headlights, street lighting and light bulbs for residential, commercial and institutional lighting.

Here are the basics:
- LEDs are a type of solid-state lighting that use a semiconductor to convert electricity into light.
- Instead of watts, the light output or brightness of LEDs is measured in lumens.
- LED light bulbs use very little power and about 90% of the energy used is converted into visible light. Traditional incandescent bulbs actually convert 95% of energy to heat and only 5% into light!
- LEDs have a long life span (up to 50,000 hours).

But there is also a dark side to this new lighting technology.

**LEDs produce significant amounts of blue light**, which can cause harm to our eyes and disrupt our circadian rhythm. Blue light encompasses shorter wavelengths and is a higher energy emitter, similar to ultraviolet light, except that ultraviolet (UV) light is invisible and blue light appears white to the naked eye. Until relatively recently, our only exposure to blue light was the sun, which is considered a short term exposure. LEDs contain about 35% of harmful blue light and we are exposed to it more and more in our homes, workplaces and schools and in our daily use of devices with screens.

**LED bulbs contain lead, arsenic, nickel and copper**, in different amounts depending on the bulb. However, any of these toxic metals can create a health hazard if they break in the home or at a traffic accident site. Clean up crews are often not warned of the potential hazard and the public has not been instructed to clean up broken LED bulbs with extreme care. According to the experts, LED makers could easily reduce the concentrations of heavy metals in their products or even redesign them with truly safer materials if state or federal regulators required them to do so.

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**The Color Spectrum**

Light color, or color temperature, is measured using the Kelvin scale, which has a typical range of 1,000K to 10,000K. LEDs are available in warm colors (below 3500K) to match the yellowish light of incandescent bulbs, but they also come in white-blue cool colors (5500K to 6500K) which most closely resemble daylight. In layman’s terms, color temperature is used as a method of describing the warm or cool color characteristics of a light source.
LEDs and our eyes

Cumulative exposure to LED bulbs and the myriad of devices with screens we gaze at every day can cause both short and long term effects on eye health. Short term effects include eye strain, headaches, and dry and burning eyes. More serious long term effects include retinal cell damage, cataracts and age related macular degeneration (AMD), which are typically related to aging, but are now being diagnosed at younger ages.

LEDs and circadian rhythm

Exposure to LEDs in the form of lighting or digital device screens can interrupt our natural circadian rhythm or sleep/wake cycle, leading to poorer quality or insufficient sleep. Darkness at night is also critical for the production of melatonin in the brain’s pineal gland. Melatonin regulates hormones as well as performing various other protective and vital functions in our bodies. Regular suppression of the production of melatonin is known to disrupt our biological clock and be a factor in serious health problems. Low levels of melatonin have been associated with cardiovascular disease, high blood pressure, obesity and diabetes.

Blue-light and cancer

A study published in 2017 on outdoor light at night and breast cancer was conducted by the Harvard School of Public Health and four other medical schools. Its findings suggest that exposure to residential outdoor light at night may contribute to invasive breast cancer risk.

*The American Medical Association (AMA) has also weighed in, recommending intensity thresholds that minimize blue-rich lighting to protect public health.*

What can you do?

- Replace LED and compact fluorescent bulbs (CFLs) with long-life incandescent bulbs wherever possible. If you must use LEDs, choose bulbs with a lower color temperature of 2700K.

- Avoid looking at bright screens beginning two to three hours before bedtime.

- Expose yourself to natural light during the day, which will boost your ability to sleep at night, as well as lift your mood and alertness during the day.

- Reduce the amount of blue light that screens emit by either changing the settings on your device (if there is a built-in function), or by using a free downloadable app, such as *f.lux* or *Iris*, which reduces harsh blue light and turns your screen to a yellow/orange hue.

- Consider wearing specially tinted glasses that block much of the blue light when working on computers or even driving at night.