New Asthma Study Links VOCs and Allergens to an Increase in Childhood Asthma

The number of cases of asthma in school-aged children has increased dramatically over the past 30 years. Nearly one in 13 school-aged children suffers from asthma, the leading cause of school absenteeism accounting for over 10 million missed school days each year[1]. Asthma is a chronic obstructive lung disease caused by inflammation and increased reaction of the airways to various triggers. Symptoms can include wheezing, coughing, chest tightness and shortness of breath. Asthma can be a life-threatening disease if not managed properly. Indoor environments and poor indoor air quality (IAQ) appear to play a key role in the development and/or exacerbation of this disease.

U. S. Environmental Protection Agency studies of human exposure to air pollutants indicate that indoor levels of pollutants may be between 2 and 100 times higher than outdoor levels. This is of particular concern when we consider that most people spend more than 90 percent of their time indoors[2]. Children face even greater environmental health risks than adults. Their immune systems are still developing, and because of their lower body weight, they breathe a relatively greater volume of air as compared with adults. This results in a higher body burden of air pollutants than that obtained by adults for the same exposure concentration of pollutants[3]. This is magnified to a larger degree for those children who suffer from asthma and are spending a significant amount of time indoors.

A recent study published in *Thorax*, an international peer reviewed journal for health professionals in all aspects of respiratory medicine, investigated the association between exposure to volatile organic compounds (VOCs) and asthma in young children[4]. The study entitled “Association of domestic exposure to volatile organic compounds with asthma in young children” assessed levels of volatile organic compounds (VOCs) such as those found in cigarette smoke, cleaning products, room fresheners, polishes, fitted carpets, solvents, paints, and floor adhesives. The study found that most individual VOCs appeared to be significant risk factors for asthma with the highest odds ratios being associated with benzene, ethylbenzene and toluene respectively. The results of the study also showed that the most common allergy among both asthmatics and non-asthmatics was to house dust mite *Dermatophagoides farinae* and *Dermatophagoides pteronyssinus*, two species which together account for 90% of dust mite allergens.

Volatile Organic Compounds (VOCs)

VOCs are chemicals used to manufacture and prepare many building materials, interior furnishings, textiles, office equipment, cleaners, personal care supplies, and pesticides. "Volatile" is a term meaning that these chemicals evaporate, or get into the air easily at room temperature. That is why they are an indoor air concern. "Organic" is another chemical term meaning that these types of chemicals contain carbon. Since carbon burns, many of these chemicals, including organic solvents, are flammable.

Studies by the EPA and other researchers have found that VOCs are common in the indoor environment and that their levels may be from ten to thousands of times higher indoors than in the outdoor air. There may be anywhere from 50 up to hundreds of individual VOCs in an indoor air sample. The majority of these VOCs are found to emit from indoor materials and processes. Some may produce odors that are considered objectionable, even at very low levels. Many VOCs are irritants and can result in headaches and eye, nose and throat irritation, and dizziness. At high concentrations, some VOCs are toxic. Common VOCs in schools include formaldehyde, decane, butoxyethanol, isopentane, limonene, styrene, xylenes, perchloroethylene, methylene chloride, toluene, and vinyl chloride.

Total Volatile Organic Compounds (TVOCs)

The sum of all volatile organic compounds measured in an air sample is referred to as TVOC. The TVOC concentration is expressed as micrograms per cubic meter of air (µg/m^3). The TVOC level in a building is a good indicator of whether or not there are elevated levels of chemicals in the indoor air. Most buildings will have TVOC levels ranging from 100 to 500 µg/m^3. Newly constructed or renovated buildings may temporarily have higher levels that decrease over time. Most standards and guidelines consider 200-500 µg/m^3 TVOC an acceptable level in buildings. Levels higher than this may result in irritation to some occupants. However, lower levels can also be an issue if an individual chemical that may be particularly toxic or an odorant is present. Common sources of VOCs in schools include cleaning chemicals, deodorizers, art and graphic supplies, new building materials, science and shop supplies, personal care items, pesticides and food.

Although there are no regulated levels of TVOC, there are available guidelines or recommendations of acceptable levels from numerous health researchers and/or governmental programs. Results are usually compared against the following guide:[5]

Less than 0.20 mg/m^3	No irritation or discomfort expected
0.20-3.0 mg/m^3	Irritation and discomfort may be possible
3.0-25.0 mg/m^3	Discomfort expected and headache possible
Greater than 25 mg/m^3	Toxic range where other neurotoxic effects may occur

Dust Mite Allergens

Allergens are biological or chemical substances that can cause the human body to develop a specific immune response with each exposure, even when exposure levels are low. Dust mites are living, spider-like microscopic insects that can travel through the air. They feed off dead skin cells from humans and are a major component of indoor dust. Dust mites, like other biological contaminants, contribute to poor indoor air quality (IAQ) and may be a major cause of days lost from school because they can trigger allergic reactions, cause rashes, watery eyes, coughing, dizziness, lethargy, breathing difficulties, and digestive problems. Exposure to allergens such as dust mites, animal dander**,** cat saliva and mold causes about 200,000 emergency-room visits a year for people with asthma.

Dust mites are able to extract moisture from the air and can obtain enough moisture in this manner as long as the relative humidity stays above 60 percent for at least a few hours a day. Dust mites accumulate mainly in upholstered furniture, floor dust and other fleecy or porous materials. Control measures such as regular dusting with a slightly damp cloth and vacuuming of both flooring and upholstered surfaces using a vacuum cleaner equipped with a high efficiency particulate air (HEPA) filter, has been shown to be beneficial in reducing the amount of allergens present[6]. Dust mite allergy is as high as 25 percent in the humid southeastern U.S. and as low as five percent in the drier mountain states. Exposure to dust mite allergens may be a major reason why asthma and other allergic diseases are experienced at increasing rates worldwide.

Maintaining Good IAQ in Schools

There are several proactive steps that can be taken to improve and maintain good IAQ in schools. A strong IAQ management plan is essential. Key components include good communication channels, auditing of air pollutant levels and facility planning.

I. *Facility planning* includes establishing procedures and guidelines for building operation and maintenance designed to maintain good IAQ. The facility plan should incorporate cleaning and maintenance procedures, including appropriate scheduling of these activities and use of low emitting cleaning products. Also important are procurement specifications for the selection and use of low emitting furnishings and construction materials, office equipment, etc., as well as use and storage of classroom items such as art supplies and laboratory chemicals.

II. *Baseline monitoring of pollutants* (for example, prior to the opening of the school year) and periodic monitoring audits throughout the school year during occupancy periods are useful for tracking pollutant levels. Pollutants of interest include carbon dioxide, volatile organic compounds, formaldehyde, respirable particles and allergens including dust mite. Periodic testing should be performed to ensure that dust mite allergen levels fall below the level of concern, 2 micrograms per gram of dust (µg/g) [7]. Simple survey tools such as the AQS School Test Kit are available for this monitoring.

III. A *good communications plan* is important for allowing prompt and accurate IAQ information exchange among school officials, school populations, the community and the media. The plan should address dissemination of proactive and educational information, as well as including a predetermined approach for releasing and discussing information on IAQ events when they occur.

Other proactive measures for existing school buildings include:

I. Providing an adequate amount of clean, controlled outdoor air throughout the building
II. Cleaning classrooms regularly to help reduce the amount of dust and dirt in the school, including molds and pollens. These substances can cause allergic reactions.
III. Making sure that the school is dusted and vacuumed thoroughly and regularly and ensuring effectiveness of cleaning efforts through visual inspection
IV. Using high-efficiency vacuum bags that can retain dust and particles (3 micron or smaller)
V. Vacuuming dust from heating, cooling, and ventilation air return grilles, air supply vents, and ceiling and wall surfaces regularly
VI. Only fumigating (if necessary) when school is not in session
VII. Only using cleaning solvents when school is not in session
VIII. Ensuring proper design and operation of the HVAC system
IX. Controlling relative humidity to less than 60-65 percent and minimizing damp conditions
X. Repairing all water leaks immediately
XI. Establishing a school policy to control the presence of pets and animals in the classroom

School facility managers, superintendents and maintenance staff have a variety of resources available to them to aid in the formulation of a solid IAQ plan.

Washington State Department of Health

The School Indoor Air Quality Best Management Practices Manual[8] prepared by the Washington State Department of Health in response to state legislature requirements, was updated in 2003. It is a comprehensive guide to practices that are recommended to promote good indoor air quality in schools. Users are encouraged to evaluate the discretionary recommendations and adopt or promote those that are relevant and feasible to implement within their school building or district.

Environmental Protection Agency

The Indoor Air Quality (IAQ) Tools for Schools Kit[9] shows schools how to carry out a practical plan of action to improve indoor air problems at little or no cost using straightforward activities and in-house staff. The voluntary guidance in Indoor Air Quality Tools for Schools can save schools time and money so that attention can be directed to educating children. EPA's IAQ Tools for Schools kit includes checklists for all school employees, a flexible step-by-step guide for coordinating the checklists, an Indoor Air Quality Problem Solving Wheel, a fact sheet on indoor air pollution issues, and sample policies and memos.

Indoor Air Quality Specialists

Indoor air quality specialists such as Air Quality Sciences can help a school manage their IAQ. They can develop a functional and cost-effective operations and maintenance program that takes a practical approach to managing IAQ on a day-to-day basis. Test kits are available to establish baseline data for VOCs and dust mite allergens, allowing a school to monitor pollutants throughout the year and take action if they rise above the level of concern. Early detection of problems is often key to finding a quick and cost effective solution.

In large buildings such as schools, managing IAQ can be challenging. By taking proactive steps to manage IAQ and consistently following best practices, school facility managers can often avoid major problems in their buildings. The ultimate goal is to provide healthful indoor environments for all students and staff, so that the focus can be on learning.

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