

School Environmental Intervention Programs



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Overall Purpose/Goal: To provide excellent reviews on key aspects of allergic disease to those who research, treat, or manage allergic disease.

Target Audience: Physicians and researchers within the field of allergic disease.

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List of Design Committee Members: Perdita Permaul, MD, and Wanda Phipatanakul, MD, MS (authors); Michael Schatz, MD, MS (editor)

Learning objectives:

1. To describe significant allergen and pollutant exposures in the school environment.
2. To review the role the school environment plays in asthma and how effectively changing the environment might reduce morbidity.
3. To discuss the challenges and benefits of comprehensive environmental assessment and intervention programs in schools.

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Exposure to indoor allergens and pollutants plays a significant part in the development of asthma and its associated morbidity. Inner-city children with asthma are disproportionately affected by these exposures with increased asthma morbidity. Although years of previous research have linked exposures in the urban home environment with significant childhood asthma disease,

many of these allergens are also present in inner-city school environments. Therefore, evaluation of the school environment of patients with asthma is also essential. School-based environmental interventions may offer benefit for this problem and has the potential to help many children with asthma at once in a cost-effective manner. It is important that environmental health researchers continue to assess which interventions are most practical and result in the greatest measurable improvements. © 2017 American Academy of Allergy, Asthma & Immunology (*J Allergy Clin Immunol Pract* 2018;6:22-9)

Key words: Asthma; Environment; Allergen; Pollutant; Inner-city; Home; School; Intervention; Integrated pest management

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role in causing allergic inflammation, such as the involvement of allergen proteases¹ and the stimulation of pattern-recognition receptors on epithelial cells,² to name a few. Studies indicate that more than 80% of school-age children with asthma are sensitized to at least 1 indoor allergen and that allergic sensitization is a strong predictor of disease persistence in later life.^{3,4} The timing of sensitization is also an important factor; Rubner et al⁵ demonstrated that aeroallergen sensitization at younger ages was associated with an increased risk of asthma in later childhood.⁵ In addition, children are likely to become sensitized to the allergen that predominates in their local environment. Therefore, the effects of these individual allergens will vary depending on the socioeconomic status, weather, and geographical location, among the many factors.

Although years of previous research have demonstrated the association between environmental exposures in the inner-city home environment and significant childhood asthma morbidity,⁶⁻⁸ many of these allergens and pollutants are also present in urban school environments.⁹⁻¹¹ This is noteworthy because children spend 7 to 12 hours per day in school and daycare settings, representing an occupational model for children. The common indoor allergens include house dust mites, cockroaches, rodents, furry pets such as cat and dog, and molds. Previous studies have identified unique inner-city allergen exposures in homes and schools as important risk factors for asthma morbidity,^{8,12,13} namely, mouse and cockroach allergens, and demonstrated that interventions to reduce home exposure improve asthma outcomes.¹⁴ As such, several studies have investigated the effects of multifaceted intervention regimens in homes, which include education, thorough cleaning, use of high-efficiency particulate arrestance (HEPA) filters, integrated pest management (IPM), and maintenance of these practices.^{14,15} The environment outside of the home, especially in the United States, is less well understood though. Literature reviews have discussed the limited school-based environmental intervention studies to date in the United States and highlight the need for them.¹⁶⁻¹⁸ As a consequence, successful home-based strategies currently serve as the prototype for school-based environmental interventions.

In this article, we discuss common exposures encountered in schools, especially in urban areas where asthma morbidity and mortality is highest among children.¹⁹ We review the association between school environmental exposures and pediatric asthma morbidity. In addition, we review school-based asthma management programs and environmental control and intervention strategies intended to improve asthma morbidity in the pediatric population.

THE IMPORTANCE OF INDOOR ENVIRONMENTAL EXPOSURE CONTROL

The indoor environment is a significant reservoir of various exposures (allergens, pollutants, bacteria, and viruses) with the ability to affect the development of asthma and its associated morbidity. This is supported by observational epidemiologic studies that identified early-life allergen exposures as risk factors for early allergic sensitization and the subsequent development of asthma.^{20,21} It is difficult to know, however, whether environmental control methods have a role in the primary prevention of asthma; the results of several primary prevention trials have been mixed.^{3,22,23} Despite these findings, a Cochrane meta-analysis

estimated that environmental control practices reduced the risk of current asthma by approximately 30% to 50% in children.²⁴ Therefore, although primary prevention is a goal we hope to attain, controlling environmental asthma triggers is beneficial for those with current asthma.

It is important that patients with asthma take all the essential actions recommended to reduce their exposure to indoor environmental asthma triggers.^{25,26} A priority message from the National Asthma Education and Prevention Program Expert Panel Report 3 guidelines for the management of asthma is that for any patient with persistent asthma, the clinician should (1) identify allergen exposures, (2) use skin testing or *in vitro* testing to assess specific sensitivities to indoor allergens, and (3) implement environmental controls to reduce exposure to relevant allergens.²⁷ Health care providers have a responsibility to ask about environmental exposures and to ensure that patients have the knowledge and resources to implement environmental control measures. Low-cost environmental interventions are a reasonable first start, with costly interventions reserved for after an allergy consultation is completed. Strategies for allergen avoidance should include a comprehensive targeted environmental control strategy that takes into account the patient's sensitizations and exposures. It should be considered the first line of therapy for patients with indoor allergen sensitivities.

Although the home environment is important, consideration should be given to other places where the child spends time such as schools and daycares. It has been shown that schools can be a source of allergen exposure connected to asthma morbidity.¹² School-based environmental interventions may offer benefit for this problem and has the potential to help many children with asthma at once. A US school-based environmental intervention study is currently underway to help answer this question, using pest management techniques and HEPA air filters.²⁸

THE SCHOOL ENVIRONMENT

Indoor allergens

Historically, the prevalent allergens discovered in inner-city home environments have been cockroach and mouse allergen,^{8,29-33} both of which are also linked to higher asthma morbidity.^{8,13,34} These findings have translated to the urban school environment in the United States where the majority of school studies examining cockroach and mouse allergen levels have been conducted.^{9,10,35,36} The School Inner-City Asthma Study (SICAS) is a National Institute of Health and National Institute of Allergy and Infectious Disease-funded, comprehensive, prospective study of inner-city school and classroom-specific exposures and asthma morbidity among students in the Northeastern United States, adjusting for home exposures.³⁷ The SICAS results demonstrated substantial levels of mouse allergen in school classrooms compared with the same students' homes,¹⁰ with exposure to mouse allergen in schools associated with increased asthma symptoms and decreased lung function.¹² Interestingly, cat and dog allergen levels were lower in these SICAS inner-city schools when compared with European school-based studies showing higher levels, likely due to passive transfer from students who owned pets in their homes.^{38,39} Levels of cockroach and dust mite allergens were undetectable to very low in SICAS dust samples from both schools and homes. In contrast, school-based studies performed in southeast Texas,

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