

School Classrooms as Targets to Reduce Allergens and Improve Asthma

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Aeroallergens are important components in the pathogenesis and pathophysiology of asthma, with allergic sensitization a phenotypic component and risk factor for disease severity.¹ Aeroallergens provoke airway inflammation, cause airflow obstruction,



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and create risks for exacerbations of asthma.² Guideline-directed treatments for asthma

target airway inflammation by prescribing anti-inflammatory medications, such as inhaled corticosteroids, to gain disease control.³ Guidelines also recommend more holistic approaches to asthma control, including allergen avoidance.

In contrast to a near-universal use of anti-inflammatory medications for patients with asthma, allergen avoidance is a far less frequent undertaking because it is often difficult to select the susceptible patient, identify the most causative environment and relevant allergen, and use effective methods of intervention, which are often costly and difficult to maintain.⁴ However, allergen avoidance can be effective when exposure contributes to asthma severity. For example, home exposure to cockroach allergen is a major contributing factor to asthma severity in children who live in urban areas.⁵ When Morgan et al⁶ intervened to diminish home cockroach allergen exposure, there was improvement in day-to-day symptoms and a reduction in unscheduled visits to the emergency department or clinic for asthma. The latter beneficial effects are particularly important because acute care visits usually result in systemic corticosteroid use, which, although effective, has risks for significant adverse effects.⁷ Similar increased adverse effects can follow increases in inhaled corticosteroid use in attempts to gain asthma control.⁸ In children, safe and effective methods to achieve asthma control by reducing allergen exposure may reduce the need for corticosteroids.

In 2000, as part of the National Cooperative Inner-City Asthma Study, Phipatanakul et al⁹ established a relationship between mouse allergen exposure and asthma disease activity in a study population of 499 children aged 4 to 13 years with asthma who attended inner-city schools in the northeastern US. Mouse allergen emerged as the dominant allergen detected in schools, with higher concentrations in school dust than in home dust (0.90 µg/g vs 0.14 µg/g; $P < .01$). Independent of the children's sensitization status, mouse allergen exposure was significantly associated with an increase in the number of days with asthma symptoms. These data established the school environment as a meaningful reservoir for mouse allergen, linked mouse allergen exposure to measures of asthma control, and substantiated that children attending inner-city schools were a suitable and vulnerable population for study. These key background findings identified the most meaningful environmental allergen to modify and the envi-

ronmental locale to consider. Targeting the classroom coincided with a growing interest in leveraging the school in childhood asthma management programs.¹⁰⁻¹² The next step was to identify an intervention model.

An integrated pest management (IPM) intervention includes extermination and sealing holes to prevent mouse entry into the building. To evaluate the efficacy of these methods, Matsui et al¹³ conducted a home-based study involving 361 children who were randomized to an IPM plus education group or education alone for 1 year. Both treatment approaches significantly reduced bedroom floor mouse allergen, but no significant changes were detected between the reduced bedroom floor mouse allergen content and measures of asthma control, including hospitalization, need for a short course of oral corticosteroids, or improved lung function. An accompanying editorial by Bacharier¹⁴ raised the question whether a reduction in mouse allergen exposure was enough to improve asthma control. A potential limitation of the study by Matsui et al¹³ was their focus on the home rather than in the classroom because there can be more mouse allergen at school where school-aged children have daily exposures throughout the school year.

With this information as a framework, the study by Phipatanakul et al¹⁵ in this issue of *JAMA* reports on the use of a school-wide IPM strategy or high-efficiency particulate air (HEPA) filter purifiers in the classrooms to reduce allergen and particle exposure and, as a consequence, improve asthma symptom control in school-aged children. The study has a number of positive aspects. First, the authors used validated classroom interventions to diminish allergen environment content, IPM (reapplied every 3 months as needed) and HEPA filter purifiers. Second, they identified and recruited 236 children with asthma from 41 schools and living in inner-city neighborhoods. Third, quantitation of allergen content and exposure (dust and airborne) was performed in classroom samples collected at baseline and postintervention, along with similar assessments of dust collections from the enrollees' homes. Nearly all (98%) of the classrooms had detectable levels of mouse allergen but at variable concentrations, and 26% of children were sensitized to mouse allergen. From an identification of classroom allergens, the analysis focused on mouse, cat, and dog allergens.

The children were randomized using a factorial design into 4 treatment groups: IPM and HEPA filter ($n = 59$), IPM and sham HEPA filter ($n = 59$), no IPM and HEPA filter ($n = 59$), and no IPM and sham HEPA filter ($n = 59$). Approximately 75% of the children used only short-acting β -agonists alone, low-dose inhaled corticosteroids, or a leukotriene modifier. At randomization, the mean ranged from a 2-week maximum of 1.5 symptom-days with asthma to 3.0 symptom-days and 88% to 98%

had 0 missed school days due to asthma. As a group, this reflects mild, well-controlled asthma, but approximately 25% of the children had at least 1 short course of oral corticosteroids during the previous year.

There were no significant effects of any intervention on the primary outcome, the number of symptom-days with asthma during the 2-week period, which was assessed every 2 months for 10 months. Other prespecified secondary outcomes, including missed school days due to asthma or health care use due to asthma, also did not differ significantly between the intervention groups. The HEPA filter purifiers significantly reduced mouse and dog allergens and other particles but the IPM program did not significantly reduce concentrations of any of the measured allergens or particles.

However, a post hoc exploratory analysis is of interest. This analysis found an association between IPM compared with no IPM and improved outcomes earlier but not later in the school year. The number of symptom-days with asthma that occurred during a 2-week period was significantly reduced at 2 weeks' postintervention (1.1 symptom-days with asthma in the IPM group vs 2.5 symptom-days in the no IPM group; incidence rate ratio, 0.37 [95% CI, 0.15-0.91]; $P = .03$) and at 8 weeks' postintervention. However, there were no significant effects later in the school year. These exploratory analyses suggest that the effects of IPM were not sustained. The reasons for the apparent loss of benefit over time is unknown, but possibly related to variations in occurrences of viral infections or inadequate sustained effects of the interventions during the study.

What are the lessons from this large-scale school and classroom-directed approach to modify environmental allergen exposure to improve asthma control? The study endorses the fea-

sibility of using an allergen-rich school environment as a therapeutic target for asthma control, but perhaps benefit would occur if home allergen avoidance was also used to more fully eliminate the environmental allergen exposure. In addition, insights emerged for next steps to answer whether allergen avoidance is effective. Future efforts should more fully phenotype both the environment and study participants, and select environments with consistently higher concentrations of allergen exposure and children with greater levels of allergen sensitization and more symptomatic disease to allow for a greater likelihood of detecting a treatment effect. The environmental abatement should also be frequently monitored and reapplied if needed to ensure that the initial beneficial effects on asthma control are sustained.

Allergen sensitization is related to the pathogenesis and pathophysiology of childhood asthma.¹ Potent sensitizing allergens, like mouse, are ubiquitous in high-risk environments, including the classroom, and may influence asthma severity. Although the study by Phipatanakul et al¹⁵ did not affect patient-related outcomes of asthma, the scientific rationale to regulate allergen exposure to high-risk children with asthma is sound. Observations from exploratory analyses suggest that further considerations for implementing allergen avoidance with targeted environments and in selected patients may improve the likelihood of success. Childhood asthma often is a lifelong disease with ongoing symptoms, risks for exacerbations, and an accelerated loss of lung function; early life efforts to improve asthma control that are safe and effective may diminish these consequences of disease and an associated need for systemic corticosteroids, thus, improving long-term safety for children. Allergen avoidance for asthma is safe, rational, and remains worthy of continued consideration and study.

ARTICLE INFORMATION

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