

Animal allergens: Looking beyond the tip of the iceberg

Over the past 10 years it has become clear that cat and dog allergens are commonly present in homes without pets, as well as in a variety of public buildings. In our early reports of this occurrence, we found that cat and dog allergens were present in 100% of dust samples from pet-free homes and suggested that these allergens were most likely carried from one home to another on the clothing of pet owners.^{1,2} Not surprisingly, these results were met with some skepticism, and even we were reluctant to attach any clinical significance to these findings, except possibly for the few homes in which allergen levels were as high as those found in homes with cats and dogs. Subsequently, the widespread distribution of animal allergens in both homes and public buildings was verified by using a variety of sampling and assay methods and is now generally accepted,³⁻¹⁹ although its clinical significance has remained largely a matter of speculation. A number of these studies have focused on animal allergens in schools, and two further reports on this topic appear in this issue of *The Journal*. Both confirm the universal presence of animal allergens in elementary school classrooms and provide new and important information on their origins and potential significance.

Almqvist et al²⁰ measured cat allergen levels in homes, schools, and the clothing of schoolchildren and used this information to study both allergen exposure and the transfer of allergen between homes and schools. Earlier studies had shown that cat allergen is indeed carried on clothing and that allergen levels in settled dust samples from classrooms are proportional to the number of cat owners in that room.^{5,16,21} The study by Almqvist et al improves on those done previously by using a more sensitive assay to measure airborne cat allergen, a more accurate measure of personal allergen exposure, and by elegantly demonstrating the movement of allergen between homes and schools. They showed that airborne allergen levels, like settled dust levels, are higher in classrooms with more cat owners and that the levels in classrooms with many cat owners were significantly higher than those found in homes without cats. More importantly, they found that cat allergen levels on non-cat owner's clothing increased while at school and that non-cat owners in classrooms with many cat owners had higher cat allergen levels in their mattress dust samples. It is therefore likely that we were incorrect in our original hypothesis that most of the cat allergen found in environments not containing cats is directly caused by dispersal from the clothing of cat owners. Although cat owners are

still certainly an integral piece of the puzzle, this study demonstrates that non-cat owners can easily collect cat allergen on their clothing, most likely by both airborne and direct contact, and then disperse it in their own travels, especially if they attend school or have other close contact with cat owners.

The study by Perzanowski et al²² also adds considerably to our understanding of this topic. They investigated the relationships between asthma, allergic sensitization, and allergen exposure in Northern Sweden, with particular attention to the role of allergens in schools. Northern Sweden was chosen for study because there is a high prevalence of asthma in children in spite of the relative absence of dust mite exposure or sensitization. Of the 110 asthmatic children studied, 30% were cat sensitive and 15% were dog sensitive compared with 3% to 5% of the control subjects, respectively. However, only 17% of the children with cat sensitivity had a cat at home compared with 36% of those without cat sensitivity. Although this may simply mean that families with a child with cat sensitivity tended to remove cats from their homes, they looked further into the relationship between cat exposure and sensitization by also measuring cat-specific IgG levels. They found that the presence of a cat in the home was associated with IgG antibodies to cat and that among those children with IgE to cat, there was a strong correlation between IgE and IgG levels. However, of the 28 children with cat-specific IgG but not IgE, 71% had a history of having a cat in the home. The possibility that high-dose cat exposure may induce tolerance to cat allergen in some individuals might therefore be considered, although the authors do not discuss this notion in their article.

In this study settled dust samples from homes and schools were collected to assess exposure to cat, dog, dust mite, and cockroach allergens. Both cat and dog allergens were detected in almost all of the samples, often at moderate to high levels. As in previous studies, levels in schools were highest in samples from desks and chairs, in which 97% and 82% of samples had at least moderate ($>1 \mu\text{g/g}$) levels of dog and cat allergen, respectively. These levels were considerably lower than those from homes with pets but higher than those from homes without pets. The authors conclude that cat and dog allergens are the primary allergens associated with asthma in this region and that "schools appear to be a major site of exposure."

Both these studies confirm that animal allergens are routinely present in schools at levels that are at least as high as those found in homes without pets. The Perzanowski study suggests that this exposure is relevant to the high rate of sensitization in children with asthma but does not contain persuasive data to prove that point.

In the absence of a prospective study to answer this question, there is no reason to assume that the exposure that occurs during the school day is any more important than the exposure that occurs while sleeping on a contaminated mattress or pillow, even if levels are somewhat higher in school. It is likely that the exposure that occurs at home, even if no animal is present, will be sufficient to induce sensitization in susceptible children, especially if the rate of pet ownership in a given region is high. However, if the two studies are viewed together, it is clear that schools are an important, although probably not essential, piece of this puzzle in that they serve both as a source of direct allergen exposure and as a reservoir of allergen that contributes to the contamination of homes.

The final and more important question still remains, however: What is the relationship of low-level animal allergen exposure, whether it takes place in the home, the school, or elsewhere, to disease activity? Although a definitive answer to this question is currently not possible, there are several lines of evidence to suggest that a relationship is indeed likely. The first comes from another study by Almquist et al,²³ thus far only reported in abstract form, demonstrating that cat-sensitive asthmatic children may experience a worsening of their asthma after returning to school and that those children in classrooms with more cat owners tended to have the highest symptom scores and medication requirements. The second comes from challenge studies in which we demonstrated acute upper and lower airway responses to relatively low airborne cat allergen levels, which were consistent with the levels found in many classrooms and homes without cats. Third, in addition to the potential for acute allergic responses, 2 recent studies^{24,25} have also shown that repeated low-level allergen exposure may induce chronic airway changes, specifically increases in airway hyperresponsiveness. Although these studies used aerosolized allergen challenges and not natural exposure, they did clearly demonstrate increases in bronchial responsiveness after repeated exposure to very low allergen doses, which are almost certainly consistent with those found in schools and cat-free homes. Finally, in the only controlled study to date on the use of environmental control measures for cat allergen in the homes of subjects allergic to cats,²⁶ there was no attenuation of disease activity, even though significant reductions in airborne allergen levels were achieved. Although the allergen levels after environmental control were still slightly higher than those found in most classrooms, the complete absence of clinical benefit further suggests that relatively low levels of exposure can drive disease activity.

Several recommendations can be made on the basis of the available information. First, it is critical that additional studies be performed to further clarify the role of these allergens with regard to both sensitization and disease. Second, interventions that will help to reduce exposure should be pursued, especially if the association with disease is clearly demonstrated. Third, and most important, it is essential that all those caring for allergic patients be educated about this issue. The notion that we

can adequately assess animal allergen exposure by simply asking whether or not a patient owns a pet is clearly incorrect. Most patients are being exposed on a daily basis and many may be adversely affected, especially if they have a high level of sensitivity and/or more contact with cat owners. Furthermore, although approaches that would reduce exposure would be ideal, they will be difficult or impossible to accomplish without a major public health initiative. This exposure must therefore be considered in the development of plans for allergy testing, pharmacotherapy, and immunotherapy for all patients with allergic disease.

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