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[About this Journal](#)

[Table of Contents](#)

[Browse TOC](#)

[Find Citing Articles](#)

[Email Jumpstart](#)

[Save Article Text](#)

[Email Article Text](#)

[Print Preview](#)

Links

[Complete Reference](#)
[Catalogo Biblioteca ISS](#)

Outline

- REFERENCES

Recent History

Asthma and Indoor Exposur...



[Previous Page](#)

Asthma and Indoor Exposure to Allergens [Editorials]

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The increase in the prevalence and severity of asthma over the past 35 years has been

observed in perennial rather than seasonal disease and in many different countries. Asthma is now the most common chronic disease of childhood. In many countries, the increase in asthma has been reported in all social classes, but particularly in higher-income groups. In the United States, for reasons that are not clear, the increase has been most marked in population groups of lower socioeconomic status.

In the 1990s, African-American children living in large urban areas in the United States have rates of hospitalization and mortality that are three times as high as those for children in the suburbs. In the 1980s, many epidemiologic studies demonstrated an association between sensitivity to dust mites and asthma. [1-4] These results, combined with provocation and avoidance experiments, provided strong evidence that exposure to dust mites indoors was an important cause of asthma. [4,5] Changes in housing that might have increased the number of dust mites included higher temperatures in damp houses, decreased ventilation after the energy crisis in the United States in the 1970s, and the use of more upholstered furniture and carpets. [4] In addition, people were spending progressively more time indoors. It was suggested that increased exposure to dust mites was a primary cause of the rising prevalence of asthma.

Recent observations indicate that the situation is more complex. In humid areas, the prevalence of asthma has continued to increase without further changes in housing. [1,6] Indeed, in a prospective study in England, our group found no change in mite-allergen concentrations from 1979 to 1990. [1] In addition, the prevalence of asthma has increased in areas of the world where, because of low humidity, mites do not flourish. [7,8] In Los Alamos, New Mexico (altitude, 2133 m [7000 ft]), and in northern Sweden, cats and dogs have been identified as the dominant source of indoor allergens. [7] The recent evidence that sensitization to cockroach allergen is related to

asthma among inner-city children establishes that yet another source of allergens in houses is associated with the high prevalence of asthma and the increased morbidity due to the disease. [\[9,10\]](#)

The terminology for purified allergen proteins is based on the species name: Der p 1 and Der p 2, from the house-dust mite *Dermatophagoides pteronyssinus*, Bla g 1 and Bla g 2, from the German cockroach *Blattella germanica*, and Fel d 1 from the cat *Felis domesticus*. Using monoclonal-antibody-based assays, each of these proteins can be measured either in house dust or in the air. [\[1,4,11\]](#) Measurement of the concentration of a representative allergen from each source is accepted as the best method of assessing the exposure of patients. The genes for many of these allergens have been cloned, and the sequences show homology with known protein families. For example, the allergen Der p 1 is a cysteine protease that is produced in the gut of the mite and is present in mite feces. [\[12,13\]](#) Similarly, Bla g 2 has homology with aspartic proteases and may also have a role in digestion. [\[14\]](#) Allergen from cockroaches is thought to derive from feces, saliva, and the bodies of these insects. By contrast, Fel d 1, which is expressed in the skin of cats, does not have sequence homology with enzymes or known enzymatic activity.

The characteristic features of these proteins are solubility in normal saline and a molecular weight between 10,000 and 50,000. People who become allergic have an immediate hypersensitivity response to the allergen, which includes increases in IgE antibodies and T cells of the TH2 phenotype. Challenge of the lungs of an allergic patient with allergen extract produces bronchospasm, followed by an eosinophil-rich inflammatory response and increased bronchial reactivity similar to that in patients with asthma.

Mite allergens in the air can be measured only during activities that disturb dust, such as vacuum cleaning. The quantities found and the size of the particles (greater/equal 10 microm in diameter) suggest that a relatively small number of particles (about 200) are inhaled per day. In keeping with this finding, most patients who are allergic to house-dust mites do not recognize the relation between exposure to house dust and acute attacks. The implication is that chronic exposure to allergens in the house may be more important as a cumulative cause of bronchial hyperreactivity than as a trigger for acute attacks. [\[4,5\]](#)

The National Cooperative Inner-City Asthma Study (NCICAS) is following a large cohort of children living in seven cities in the Northeast and Midwest. The report by Rosenstreich et al. in this issue of the Journal [\[9\]](#) establishes that immediate hypersensitivity to cockroach allergens is common among children with asthma. The results also show that the degree of exposure of children with positive skin tests to cockroach allergens, as indicated by measurements of Bla g 1 in dust from their bedrooms, is correlated with their risk of hospitalization. The combination of sensitization and exposure to either house-dust-mite or cat allergen was found in very few children. The small quantities of dust-mite allergen found were probably due to the long dry winters in the cities studied. In southern cities such as Atlanta, there are high concentrations of dust-mite and cockroach allergens in inner-city housing; sensitization to both is common among children with asthma. [\[10\]](#) The major conclusions are that children who become allergic to foreign proteins in their homes have an increased risk of asthma and that continued exposure contributes to morbidity. These results raise two important issues: the role of avoidance of allergens in the treatment of asthma and the underlying causes of the epidemic.

The revised 1997 guidelines for the treatment of asthma from the National Heart,

Lung, and Blood Institute [15] recommend that all patients with persistent asthma should be tested, with skin tests or in vitro assays, for sensitization to the chief perennial allergens (house-dust mite, cat, dog, cockroach, and the fungus alternaria) and that specific advice to reduce exposure should be a key part of treatment. Homes often have more than one source of allergens, and different measures are required to avoid exposure from each source. For patients who are sensitive to dust mites, effective avoidance measures include encasing pillows and mattresses in impermeable covers, washing bedding in hot water, removing carpets when possible, and reducing or eliminating upholstered furniture. [4,16]

Measures for decreasing levels of or exposure to cockroach allergens are not well established. Proteins derived from cockroaches become airborne only when a room is disturbed and are associated with particles more than 5 microm in diameter. Because these particles fall rapidly, air filtration has little role. Avoidance measures should focus on reducing the population of cockroaches. The current recommendations are control of sources of food and water, routine cleaning, and regular use of insecticides such as hydramethylnon or avermectin in the form of bait.

Despite the fact that asthma in children and young adults is strongly associated with sensitization to the allergens found in houses and apartments, changes in exposure to these proteins do not appear sufficient to explain either the magnitude or the consistency of the increase in the prevalence of disease. Indeed, it seems unlikely that exposure has increased equally to allergens derived from several different sources over 30 years. Although asthma is strongly influenced by genetics, the severity of this disease among African Americans living in poverty in the United States is not likely to be due to racial differences. Africans living in villages with limited transportation and no electricity, and eating a traditional diet, have very low rates of asthma (less than

0.5 percent). [17] Thus, in our view, asthma is a disease of Western society. The developments in the past three decades that could be relevant include changes in homes and diet, the increased frequency of indoor entertainment, [18] and the introduction of broad-spectrum antibiotics. The tendency for children to stay indoors, with an inevitable decrease in exercise combined with increased exposure to allergens, is greater in the inner city because of concern about safety.

The challenge is to understand how events common to U.S. cities, central Virginia, Scandinavia, and Nairobi, Kenya, have contributed to progressive increases in asthma. [2,4,8-10,16,17] We know that children who become allergic to foreign proteins that are present in their homes are at the highest risk for persistent bronchial hyperreactivity and severe symptoms. However, it seems unlikely that reducing exposure to cockroaches, dust mites, or animal dander alone will effectively control the increase in this disease.

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