Allergy test results of a rural and small-city population compared with those of an urban population

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The frequency of sensitization to environmental antigens changes in different regions. As such, the pattern of sensitivity to common allergens was studied at multiple sites across central Pennsylvania, an area composed of small cities and rural communities, to determine uniqueness of allergies in populations from this area in contrast to allergies as determined by skin testing in large urban centers. The study reported was undertaken to determine allergen variation from an urban population compared with a rural population of a Northeastern state so that environmental avoidance and immunotherapy can be more precisely prescribed. Patient charts were retrospectively reviewed to determine sensitivity to house dust mites (*Dermatophagoides pteronyssinus, Dermatophagoides farinae*), cockroach, *Penicillium, Aspergillus* spp, dog, cat, timothy grass, ragweed, oak, and *Alternaria tenuis* at five sites in Pennsylvania. All of these sites were classified as "small city" or "rural" for the study. One hundred patient records were examined at each site for the results of allergy testing by the prick puncture, radioallergosorbent test (RAST), or intradermal methods. These small-city and rural data were pooled and compared with that of the National Cooperative Inner-City Asthma Study (NCICAS), which included 1286 patients from urban environments. The prevalence of allergy to both species of dust mites, dog, timothy grass, and ragweed was significantly greater in the pooled rural group than in the NCICAS inner-city patients ($P<.05$). In contrast, sensitivity to cockroach antigens and *Alternaria* was significantly greater in the NCICAS urban population than in the pooled rural group ($P<.05$). No statistically significant difference was found between the NCICAS and the pooled rural patients in reference to *Penicillium*, cat, and oak ($P>.05$).

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Allergy is a term that indicates an immediate reaction following contact with a specific environmental antigen, the allergen.[1] One of every six persons in the United States suffers from allergic disease.[2] This disease may take many diverse forms, including rhinitis, asthma, atopic dermatitis, anaphylaxis, urticaria, and angioedema.[1,2] Allergic reactions require prior sensitization to specific antigens.[3] Different regions are associated with different common allergens, and in fact, this distribution is affected by human activities. For exam-

Table
Percentage of Patients With Positive Allergy Test Results by Location

Allergen	Patients with positive test results, %							
	Bethlehem	Carlisle	Forty Fort	Altoona	Hershey	Rural pooled data	NCICAS*	All pooled data
☐ Mites (Df)†	52	27	50	50	43	44	24	30
☐ Mites (Dp)‡	53	24	50	50	42	44	31	35
☐ Cockroach	44	7	ND§	12	16	20	36	32
☐ *Penicillium*	31	8	8	22	12	16	20	19
☐ *Aspergillus* spp	34	10	14	33	7	20	ND§	20
☐ Dog	46	15	37	38	13	30	16	20
☐ Cat	38	20	28	47	28	32	24	26
☐ Timothy	37	26	49	36	27	35	21	25
☐ Ragweed	53	23	34	33	33	35	17	22
☐ Oak	43	16	22	25	26	26	23	24
☐ *Alternaria tenuis*	36	17	17	32	17	24	38	34

* NCICAS = National Cooperative Inner-City Asthma Study.
† Df = *Dermatophagoides farinae*.
‡ Dp = *Dermatophagoides pteronyssinus*.
§ ND = not done.

ple, allergy to cockroach antigens has been shown previously to have a high prevalence in urban areas, especially in patients of lower socioeconomic status.[4,5] In contrast, it has been shown to be less common in suburban and rural areas because of less infestation of homes in rural areas, except the Southeast.[5]

The importance of studying allergic disease rests in the significant morbidity that it causes. For example, patients with severe asthma are more likely to demonstrate sensitivity to allergens than are patients with less significant disease.[6,7] Studies have shown that by preventing allergen sensitization through avoidance techniques, the prevalence of asthma can be similarly decreased; and, by reducing the levels of allergen to which a sensitized asthmatic patient is exposed, symptoms can be improved.[7,8] In addition, immunotherapy has been demonstrated to be effective.[9] Limiting immunotherapy to the specific allergens to which the patient is allergic and is known to be exposed can enhance effect and decrease cost.

Our study was carried out to review, in a retrospective fashion, the results of skin prick, radioallergosorbent test (RAST), and intradermal allergy tests at multiple sites across the commonwealth of Pennsylvania. The purpose of this undertaking was to determine if a difference exists in the frequency of sensitization to specific allergens in rural areas and small cities as compared with large urban centers.

To gain a more complete understanding of the influence of geographic location on allergic disease, we also compared the results of our study to those of a similar study performed in Kentucky by Garcia and colleagues.[9] By determining the common allergens by region, it is hoped that both diagnostic and treatment modalities can be implemented more efficiently and effectively, and the morbidity of hypersensitivity reactions can thus be reduced.

Methods

Test sites

Five regions in Pennsylvania were chosen from which to acquire rural/small-city data for the study: Altoona, Carlisle, Hershey, Forty Fort, and Bethlehem. The National Cooperative Inner-City Asthma Study (NCICAS),[7] published in 1997, was referenced to provide a source of inner-city and urban data.

Data acquisition

At each site, 100 patient records were reviewed for allergy test results. Of concern were sensitivities to the following specific allergens: house dust mites (*Dermatophagoides pteronyssinus, Dermatophagoides farinae*), cockroach, *Penicillium* spp, *Aspergillus* spp, dog, cat, timothy grass, ragweed, oak, and *Alternaria tenuis*.

Prick puncture, intradermal, and rarely in vitro tests for specific IgE were included.

Data analysis

The five rural/small-city sites were pooled into one data set for all 11 allergens tested. This pooled data set was then compared with that of the NCICAS by use of 2×2 χ^2 tests for each allergen.

Results

Patients

A total of 500 patients were included in the study to represent the rural/small-city group. The NCICAS, which was used for urban data, included 1286 subjects. The *Table* compares the frequencies of positive test results at each site, between urban and rural sites (pooled rural data), and all data pooled, which represents sensitization in the general population of the Northeast.

Pooled data

We compared the NCICAS urban data with data of a group consisting of all the rural/small-city sites pooled (*Table*). The following results were found. The prevalence of allergy to both species of dust mites, dog, timothy grass, and ragweed was significantly greater in the pooled rural group than in the NCICAS inner-city patients ($P<.05$). In contrast, sensitivity to cockroach antigens and *Alternaria* was significantly greater in the NCICAS urban population than in the pooled rural group ($P<.05$). No statistically significant difference was found between the NCICAS and the pooled rural patients in reference to *Penicillium*, cat, and oak ($P>.05$).

Discussion

Our study was performed to determine if a difference in the frequency of allergen sensitization exists between rural regions/small cities and large metropolitan areas. Past research has shown that cockroach allergy is more common in urban settings.[4,5] In designing this study, we hoped to clarify similar patterns for other allergens.

Based on the comparison between the pooled rural data and the NCICAS data, our study found that allergy to dust mites, dog, timothy grass, and ragweed is more common in rural areas/small cites than in large metropolitan centers. In contrast, cockroach and *Alternaria* hypersensitivity was shown to be more prevalent in large cities. These findings suggest that a regional difference does exist in reference to common allergens to which patients are sensitized, even within a similar climatic condition.

This conclusion is further supported by the results of a study by Garcia and associates.[9] They looked at the prevalence of cockroach allergy in inner-city, suburban, and rural/small-town Kentucky. In their study, they reported that overall, 41% of inner-city patients, 30.1% of suburban patients, and 43.6% of rural/small-town patients demonstrated sensitivity to cockroach antigens. A statistically significant difference was found between the inner-city and suburban populations and between the rural/small-town and suburban groups. However, no significant difference in the prevalence of cockroach allergy was found when inner-city patients were compared with rural/small-town patients. These results differ from those of our study in which cockroach hypersensitivity was found to be significantly more common in large cities than in rural areas. As mentioned previously, cockroach allergy has been previously found to be more common in cities than in less urban regions.[4,5] Our study confirms that this is the case in a northern state. Despite this confirmation, we were impressed with the frequency of cockroach allergy in small cities and rural areas of the Northeast. Cockroaches are thought to be an infrequent inhabitant of single-family houses in the North. The frequency of positive reactions may reflect cross-reactivity to other insect exposures. Relocation from areas where cockroaches are more common may account for a portion of the positive tests in central Pennsylvania; however, the population of central Pennsylvania is very stable.

In previous studies, up to 50% to 60% of patients have demonstrated an allergy to house dust mites.[10] Similar numbers were found in this study, with the exception of the Carlisle test site and the NCICAS (*Table*). Of importance, allergy to both species of mites in the NCICAS inner-city patients was found to be significantly lower than in the pooled rural group. This would seem to indicate that in contrast to cockroach allergy, hypersensitivity to house dust mites is not as prevalent in cities as in less urban areas. The almost identical sensitivities between the two house dust mites in the population we studied again confirms cross-reactivity of the dust mites *D farinae* and *D pteronyssinus* (*Table*). This cross-reactivity suggests that including only one of the two species in the RAST and skin test panels and treatment sets is adequate. We were unable to explain the difference between sensitivities to *D farinae* and *D pteronyssinus* in the NCICAS.

Penicillium, an indoor mold, would be expected to have a uniform prevalence. Our study found this expectation to be broadly true in that there was not a statistically significant difference in the frequency of sensitization in rural regions as compared with the NCICAS data.

Because the NCICAS did not study *Aspergillus*, it cannot be determined from our study if any differences exist between its prevalence in urban and rural/small-city environments. Because *Aspergillus* is an indoor mold, we would expect similar prevalence of positive sensitivities. In our population, skin test positivity to *Aspergillus* and *Penicillium* is similar, as expected, as both are indoor molds.

Sensitivity to pets—dogs and cats—varies from site to site. Pooled data for small-city/rural areas demonstrated that dogs were responsible for greater rates of sensitivity in these areas as compared with large urban regions. However, rates of sensitivity to cat was not significantly different in rural/small-city areas as compared with that in large urban centers.

Allergy to timothy grass is distinct between urban and rural/small-city sites. There was a statistically significant difference between the NCICAS inner-city group and the pooled rural group. However, it is difficult to interpret this data set because the NCICAS tested mixed grass, not specifically timothy. Nevertheless, most northern grasses cross-react, and thus, a comparison of timothy grass with a mixed grass is prob-

ably a legitimate one and suggests decreased exposure to grasses in an urban setting, a not unexpected difference.

Similar to grasses, a difference in the prevalence of ragweed allergy exists between urban and rural/small-city groups. The NCICAS inner-city patients demonstrated a significantly lower level of ragweed sensitization than the pooled rural group. Again, this finding probably reflects increased exposure in rural regions, because ragweed grows in areas of tilled soil.

For oak, unlike the other plants, our study does not show convincing evidence that the prevalence of oak allergy varies from rural to urban regions. The lack of difference in oak allergy, as compared with grasses and ragweed allergy, probably is secondary to the planting of oak trees in metropolitan centers along streets and in parks. Oak trees are frequently used, even though they are not the preferred trees for city planting. Other explanations for the uniform sensitivity to oak are the prolific production of pollen from trees, the large distribution of oak tree species throughout the United States, and the large distance that tree pollen can be distributed by the wind.

As expected, the prevalence of *Alternaria* allergy does vary between regions. The presence of *Alternaria* and thus allergy to it are expected to be highest in agricultural regions; however, in our study, the NCICAS inner-city patients demonstrated a significantly greater frequency of *Alternaria* sensitivity than the pooled rural group. This prevalence of *Alternaria* sensitivity in cities over that in smaller communities and rural areas is surprising and contrary to the belief that *Alternaria* is most prevalent in areas of farms and grasslands.

From the analysis of the study data pooled, the most common allergens to which patients are sensitized in the Northeast region of the country as a whole can be determined and used as a standard for this broad area. In our study, dust mites, *Alternaria,* and cockroach showed the greatest prevalence in the pooled patient population (*Table*). Pollen and cat sensitivity were common, but less so (*Table*). Indoor molds and dog allergy demonstrated the lowest prevalence in our study (*Table*). A similar study was performed by Whitcomb in 1971.[11] In his research, he found that mixed-grass pollen and house dust allergy were most prevalent. Although he did not study dust mites specifically, they are a significant allergic component of house dust. *Alternaria* and cat hypersensitivity were among the next most common. Similar to the pooled patient population in our study, dog allergy was less prevalent than cat allergy. Whitcomb did not study cockroach, or any of the other molds included in our study. Several factors may account for the difference between his and our work, but the most significant is that his study was performed in California. In addition, it is possible that allergen prevalence changes over time as buildings vary in design and urbanization continues to spread. This possibility reaffirms the need to determine the common allergens in a region for the implementation of efficacious treatment of allergic disease.

Certain limitations are associated with the data presented in our study. The first is that migration of patients to their specific region from other areas could not be controlled. For example, subjects from the Hershey rural test site could actually be from Harrisburg, an urban area. Their allergen sensitivities would thus not be representative of Hershey, producing some inaccurate results. Testing between sites varies. Sites may have a different criterion to determine positive and negative test results. In addition, techniques, allergens, and frequency of intradermal test use may vary. Despite these limitations, however, our study reflects a real-life situation in which populations shift regularly and techniques used by allergists vary significantly.

Comment

Based on the results of our study, we conclude that allergies to cockroach and *Alternaria* are more common in large cities than in rural areas and small cities. We also reaffirm that sensitivity to dust mites, ragweed, and timothy grass is more prevalent in rural areas and small cities than in inner-city areas. Our findings confirm the data presented by the NCICAS for cockroach, but it is contrary to that expected for *Alternaria*. This information is useful for determining the makeup of standard allergy panels based on geographic location. Patients in urban and rural areas should be tested for cockroach allergy. *Alternaria* is expected in farming communities, but it also is important to incorporate it into panels used in metropolitan areas. Whereas the most common allergen to cause a positive skin test is house dust mite in small cities and rural areas, *Alternaria* and cockroach are the most common allergens in inner cities.

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