Pulmonary Responses to Allergens and Pollutants*

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Indoor allergen exposures are ubiquitous and can lead to significant allergic diseases (including asthma), in significant proportions of the population. Immunologic sensitization and resulting inflammatory conditions on reexposure are responsible for greater susceptibility to other triggers of airway responses. Air pollutants may act as adjuvants, as predisposing exposures producing airway inflammation, and/or as primary agents for airway responses. Different measures of bronchial responsiveness (BR) (including bronchodilator responsiveness and peak expiratory flow [PEF] lability, as well as responses to specific agents or nonspecific bronchoconstrictor drugs) have shown a relationship between these indexes and symptoms, diagnoses, and function, especially asthma. Finding markers of exposure, and markers of biological responses, are a major feature of the new environmental epidemiology. Immunomarkers are a category of biological markers. The immunologic system (host characteristics) may "cause," mediate, and modulate the respiratory responses to the allergen exposures/doses and likely irritants. Thus, we seek to measure these host characteristics, especially the immunologic factors that modulate the responses to inhaled allergens and irritants, and to find the best markers to measure the exposure dose to allergens.

**Materials and Methods**

The Tucson Health and Environment study, a representative multistage stratified cluster sample, has monitored aeroallergens and irritants indoors and out, with use of time-activity diaries, in over 400 families with children to characterize these exposures.5,7 We monitored regional (macro) pollen and mold outdoors using a Burkard 7-day trap sampler (Rickmansworth; Hertfordshire, England) and indoors with a combination of the 7-day Burkard industrial trap and personal monitor. Skin tests for multiple allergens were used to measure specific responses to these allergens; a wheal from the skin test at least 1 mm greater than that resulting from the negative control (diluent) was regarded as positive. Self-reports (American Thoracic Society standard questions) of physician-diagnosed asthma, responses to five screening allergens, and diurnal variation of PEF (our indicator of bronchial lability) were obtained and used to stratify subjects.5,8 These were utilized initially as indicators of prevalent pulmonary conditions as well. Individual respiratory responses were monitored with daily symptom diaries and peak flow measurements.

**Results**

Exposure assessment in Tucson indicated that the proportion of exposure occurring indoors accounts for 50% or more for pollen and 60 to 80% for mold; we assume it is 100% for mites and animal allergens. The distributions of the immunomarkers are related to the distributions of the monitored aeroallergens in Tucson; an example, mesquite, is shown in Figure 1. Among subjects with even minimum (1 mm) skin test responses (ie, minimum immunomarkers), symptoms increase by over 30% with elevated pollen concentrations.

Prevalence rates of asthma, allergy, and BR were related to specific allergen and air pollutant exposures. Using a set of 11 allergens, 56% of subjects had positive immunomarkers of exposure (skin test reactivity). Positive immunmarkers were compared with BR: house dust to which 5.5% re-
acted using the then-available allergen, mesquite to which 16.2% reacted, and bermuda grass, which produced the largest proportion of reactors (32.2%). Nonasthmatics who reacted to house dust showed 1.9 times more PEF-BR than similar skin test-negative subjects between 15 and 54 years (p<0.05). Similarly, reactors to mesquite (a local allergen) showed more BR (24% vs 37%, p<0.10). Further, analyses show similar trends for dog allergen. They were positive but not significant for cat allergen. Bermuda grass reactivity was not related to BR, even though it is the most frequent positive skin test.

Prevalence rates of asthma, allergy, and BR were related also to environmental tobacco smoke particulate matter (PM) sizes 10 µm and 2.5 µm (PM10 and PM2.5), nitrogen dioxide (NO2), and formaldehyde. NO2 responses appear independent of the other responses and the formaldehyde response appears related to ETS particles.

Acute pulmonary responses to allergens and pollutants in susceptible and other subjects included PEF-related BR and symptoms. These were related to specific exposures temporally and spatially, especially in asthmatic children. Quantitative relationships between acute responses and several allergens, especially in asthmatics and those with BR, have been demonstrated.

In contrast to characterized “normals,” those classified as “atopics” and “peak flow responsive” (PEFR-BR) subjects showed increased nasal symptom responses with increased pollen (eg, ragweed and mulberry) and some mold concentrations. We think that one can differentiate these effects by assessing individuals who are allergic to specific antigens. Decline in lung function, as measured by the evening PEF, was associated with high concentrations of some pollen types (eg, mulberry), but only for individuals defined as “peak flow responsive.”

**Discussion**

The quantitative skin test-BR relationships shown in this population are comparable to those determined in collaborative studies in Italy and New Zealand. That is, methacholine BR responses using the provocative concentration causing a fall in FEV1 of 15 or 20%. (PCFEV) are quantitatively related to some, often the same, immunomarkers in nonlinear increasing relationships within the age groups tested (unpublished); PEF-BR had the same relationships to the specific immunomarkers of exposures as methacholine response, including with IgE, but PEF-BR relations plateau within the range tested (ie, has a different nonlinear relationship), especially with IgE. IgE usually disappears in multiple regression models relating BR to skin tests and relating acute respiratory responses to allergens and air pollutants. We are quite surprised that analyses to date show that acute allergen-related responses do not appear to interact with irritants in the induction of greater respiratory responses. Acute responses to air pollutants (eg, PM, ozone [O3], NO2) and allergens continue to be evaluated for further understanding of the respiratory response.

The process that starts with exposure to an allergen and its inhalation leads to immunoochemical changes that are measured by the immunomarkers. This response is based on the interactions of the inhaled allergen and the host immune system characteristics. The health outcome can be acute, even reversible, or lead to chronic changes and frank clinical disease, based on the characteristics of the exposure and the host. Even the immunologic status and BR themselves become pathologic conditions affecting long-term function.

In summary, immunologic sensitization, as indicated by skin tests as immunomarkers, is important in the acute and chronic pulmonary responses to allergens and to pollutants.

**References**

4. Lebowitz MD. Assessing health effects due to complex mixtures in populations at risk with a focus on respiratory effects. Environ Health Perspect 1991; 95:35-8

**Wood Smoke Exposure and Risk for Obstructive Airways Disease Among Women**

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Exposure to firewood, the most common biomass fuel used for cooking and heating in the developing world, was investigated as a potential risk factor for obstructive

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