

Aeroallergen sensitization in pediatric allergic rhinitis in Singapore: Is air-conditioning a factor in the tropics?

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Singapore is a unique blend of a tropical environment with a high standard of hygiene and public health care. The objective was to define the prevalence, clinical characteristics, and environmental risk factors of specific aeroallergen sensitization in pediatric allergic rhinitis patients in this unique environment. The method adopted was a retrospective analysis of allergic rhinitis patients, undergoing aeroallergen skin prick testing (SPT), in the outpatient specialty clinic of the KK Children's hospital, from July 2001 to June 2002. A total of 202 patients were included, 161 (80%) males, 167 (83%) Chinese, age mean 7.6 yr (range 2–14 yr). The most prevalent clinical symptoms were: watery rhinorrhea 61%, blocked nose 61%, sneezing 52%, snoring 17%, and epistaxis 12%. SPT results were positive for house dust mites in 97% of children, pets (20%), molds (19%), pollens (15%), and kapok (10%). Mold sensitization was significantly more prevalent in households without air-conditioning (aircon), 49% vs. 10% with aircon (odds ratio 9.4, 95% CI 3.8–22.9). Polysensitization (sensitization to three or more allergens) was similarly more prevalent in households without aircon, 51% vs. 14% with aircon (odds ratio 6.4, 95% CI 2.8–14.7). It was concluded that indoor aeroallergen sensitization is the major associated factor with clinical allergic rhinitis in children in Singapore. Patients living in households without air-conditioning are at increased risk of mold sensitization and polysensitization.

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Studies in Singapore and other tropical environments have identified the house dust mites as the major sensitizing agents associated with symptomatic allergic respiratory disease in children (1, 2). In Singapore, research has concentrated on sensitization to and identification of the *blomia tropicalis* allergenic epitopes, but limited data exist on the environmental risk factors for other specific sensitizations.

Indoor environmental factors modulate the quantity and specificity of indoor allergens (3–6). House dust mites have specific known environmental requirements of humidity and ambient temperature for optimal growth (7) and the indoor environment in Singapore is a good promoter of increased house dust mite content (4). The warm

and humid environment is also ideal for the proliferation of indoor molds and other aeromycota.

We aimed to define the prevalence, clinical characteristics, and environmental risk factors of specific aeroallergen sensitization in pediatric allergic rhinitis patients in Singapore.

Methods

A retrospective analysis through the medical records of patients undergoing aeroallergen skin prick testing (SPT) in the outpatient specialty clinic of the KK Children's hospital from July 2001 to June 2002.

Patients were included in the analysis if they had clear evidence of environmental sensitization,

(ascertained by SPT with a standard panel of aeroallergens) and documentation of a symptomatic period of minimum 2 months with at least two out of the following: watery rhinorrhea, blocked nose, itchy nose, sneezing, or night cough. All diagnoses of allergic rhinitis were confirmed by a specialist in Pediatric Otolaryngology.

Data acquisition

The complete hospital medical records of all patients were reviewed. Whenever possible, environmental exposure data were confirmed through a direct telephone survey with a standard risk assessment questionnaire including information on exposure to house pets, passive smoking, and use of air-conditioning in households and children's bedrooms. Data on housing and social risk factors were not consistently obtained and, therefore, not included in the analysis.

SPT tests

All tests were performed in the respiratory laboratory by an experienced technician using commercial allergen extracts and the GreerPick SPT device (Greer Laboratories, Lenoir, NC) and evaluated by an experienced pediatric allergist. A wheal diameter of 3 mm or more in excess of the negative control was considered a positive test result. The allergens included in our standard panel are: *Dermatophagoides farinae*, *Penicillium notatum*, *Hormodendrum hordei*, *Alternaria tenuis*, *Aspergillus fumigatus*, *Ceiba pentandra*, *Melaleuca quinquenervia*, *Accacia* spp., *Eucalyptus globulus*, *Juniperus monosperma*, *Salix nigra*, *Artemisia annua*, *Artemisia vulgaris*, Southern Grass Mix Concentrate, cat hair and dog epithelia.

Statistical analysis

Relative risk of sensitization and associated risk factors were calculated using binary logistic regression analysis. Multivariate regression analysis was also performed to elicit confounding interactions.

Results

A total of 273 patients underwent SPT for environmental allergens in our clinic during the study period. Out of them, 71 patients did not meet either the clinical inclusion criteria or were negative to all tested allergens. The other 202 patients fulfilled the inclusion criteria, 161 were males (80%), 167 were Chinese (83%), with a mean age of 7.6 yr (range 2–14 yr). Median

duration of symptoms was 2 yr (min 0.2, max 10, third quartile 3).

The most prevalent clinical symptoms were: watery rhinorrhea 61%, blocked nose 61%, sneezing 52%, snoring 17%, and epistaxis 12%. The prevalence of asthma and atopic dermatitis was 33% and 13%, respectively, in this group of children and 7% had concomitant symptoms of all three related diseases. History of previous hospitalization was elicited in 44% of children, while allergy-related hospitalizations occurred in 19%. A diagnosis of asthma was a significant risk factor for allergy-related hospitalization (odds ratio 8.5, 95% CI 2.0–36.5).

SPT results were positive for *D. farinae* in 97% of children, pets (20%), molds (19%), tree pollens (12%), grass/weeds (11%), and kapok (9%). Sensitization to indoor aeroallergen was practically universal. Pollen sensitization was seen in 15% of patients. Mold sensitization was significantly more prevalent in households without air-conditioning, 49% vs. 10% with air-conditioning (odds ratio 9.4, 95% CI 3.8–22.9). Polysensitization (sensitization to three or more allergens) was similarly more prevalent in households without air-conditioning, 51% vs. 14% with air-conditioning (odds ratio 6.4, 95% CI 2.8–14.7). Multivariate regression analysis revealed no additional factors associated with this significant increase in risk for mold sensitization and polysensitization.

Passive smoking was found in 22% of households. Smoking in the house carried a slight increased risk of having a diagnosis of asthma (odds ratio 1.3, 95% CI 1.02–1.7).

A furry pet was reported in 19% of households. There was no difference in the prevalence of cat or dog sensitization in patients where a cat or a dog was present in the household compared to patients who did not own a pet.

Discussion

The preponderance of Chinese in our atopic patient population is probably due not only to our general population makeup but also to genetic susceptibility factors at least partially elucidated (8–12). Male preponderance in children with allergic rhinitis is well documented world-wide (13) as well as in Singapore (14).

Although SPT with commercially available extracts have significant drawbacks (qualitative rather than quantitative, poor definition of allergenic epitopes and in the case of mold extracts, poor stability of allergenic content), they are still considered the 'gold standard' for the diagnosis of IgE-mediated aeroallergen

sensitization. The use of *D. Farinae* as our house dust mite allergen extract stems from the available information on prevalent sensitization in our population (1, 15) in spite of perhaps limited cross-reactivity with the *Blomia Tropicalis* (16) and because of the lack of available standardized *B. Tropicalis* allergen extracts.

We have observed a previously undocumented increase in the relative risk of mold sensitization in symptomatic children with allergic rhinitis, living in households without air-conditioning. As all air-conditioning systems have a significant drying effect on the indoor ambient air, it is reasonable to assume that relatively lower humidity in air-conditioned homes gives rise to a lower environmental burden of molds and aeromycota (i.e., less exposure) and, therefore, to a lower sensitization rate. Existing data on indoor mold burden and the effects of environmental humidity on it does suggest that increased dampness maximizes indoor exposure to airborne molds and spores (5, 17–21). Though extensive data are available on the house dust mite fauna in homes in tropical Singapore (1, 4, 22), no quantitative data on indoor mold burden in children with symptomatic respiratory allergy in Singapore are available at this time.

Extensive data have been accumulated on the effects of air filtration and air-conditioning systems on the dust mite burden in the homes of children with respiratory allergies and the clinical symptoms of disease. The issue still remains controversial, as summarized well in a recent review by Custovic et al. (23). The data deriving mainly from temperate climate areas do not address the issue of mold burden, mold sensitization, or the different effect a lowered ambient humidity may have in an extremely humid tropical environment.

The increased risk of polysensitization (positive skin test reactions to three or more allergen extracts) is mostly secondary to the presence of mold sensitization. Approximately 60% of patients sensitized to any mold showed positive skin test responses to more than one mold species. As previously documented, multiple positive reactions to different fungal extracts may be due to independent sensitization to many fungi species or due to sensitization with cross-reacting allergens produced by many fungi (24). Almost universally, children with mold sensitization in our patient group were also sensitized to other aeroallergens.

There are some weaknesses associated with our study. As with all retrospective analyses, there may be a sample selection bias. We have

attempted to minimize this by applying strict clinical and laboratory inclusion criteria. Only patients with well-documented clinical symptoms of allergic rhinitis as well as a doctor's diagnosis confirmed by specialist otolaryngological examination and a positive aeroallergen SPT were included in the analysis. The demographic and environmental data of patients with home air-conditioning systems (age, race, passive smoking, presence or absence of pets, etc.) did not significantly differ from patients without air-conditioning. In fact, most parents in the second group specified that an air-conditioning device was present in their homes, but was not in use. Multivariate regression analysis did not support any additional factors influencing the significant difference in mold sensitization rates between the two groups.

We also did not collect dust samples and so lack data on actual indoor aeroallergen exposure and the possible correlation with clinical symptoms overtime, both of which need to be assessed in any prospective follow-up study.

Conclusions

Indoor aeroallergen sensitization is the major associated factor with clinical allergic rhinitis in children in Singapore. Specific patterns of indoor allergen sensitization are associated with the presence or absence of air-conditioning in the homes of symptomatic children with respiratory allergy in a tropical environment. Mold sensitization, prevalent in 19% of our overall children population, is significantly increased in the group without home air-conditioning (49%). The clinical relevance and implications of this observation remain to be elucidated. A retrospective study is not an appropriate tool for assessing the significance of mold sensitization on the clinical symptoms of allergic disease, a randomized prospective trial looking at the impact of air-conditioning systems on sensitization patterns, mold sensitization, and clinical outcomes in our children population is needed.

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