Original Article

Individualized Household Allergen Intervention Lowers Allergen Level But Not Asthma Medication use: A Randomized Controlled Trial

Emily DiMango, MD[a], Denise Serebrisky, MD[b], Surinder Narula, BS[a], Chang Shim, MD[b], Claire Keating, MD[a], Beverly Sheares, MD[a], Matthew Perzanowski, PhD[c], Rachel Miller, MD[a], Angela DiMango, MD[a], Howard Andrews, PhD[d], David Merle, BS[d], Xinhua Liu, PhD[d], Agustin Calatroni, MA, MS[e], and Meyer Kattan, MD[a] *New York and Bronx, NY; Chapel Hill, NC*

What is already known about this topic: Cockroach and mouse allergens appear to be the most important allergens associated with asthma morbidity in inner-city residents. Intervention trials for reducing household allergens report mixed results in terms of improving asthma morbidity.

What does this article add to our knowledge? Individualized household allergen intervention does not lead to incremental reduction in asthma step-level care.

How does this study impact current management guidelines? This study highlights the need for further studies to inform current guidelines for allergen avoidance in individuals with asthma.

BACKGROUND: Environmental exposures to indoor allergens are major contributors to asthma symptoms, particularly in inner cities. The effectiveness of household allergen reduction as an adjunct to National Asthma Education Prevention Program guideline–based pharmacologic therapy in asthma has not been prospectively studied.

OBJECTIVE: To study the effect of individualized allergen reduction on ability to reduce asthma pharmacologic therapy over 40 weeks.

METHODS: We performed a randomized controlled trial to determine the effect of multifaceted indoor allergen avoidance measures on the ability to reduce asthma controller therapy in adults and children residing in New York City who were both sensitized and exposed to at least 1 indoor allergen. Asthma treatment and control were optimized in all subjects before randomization.

RESULTS: A total of 125 subjects were randomized to receive individualized household allergen reduction and 122 received a sham intervention. Subjects in the intervention group significantly reduced all measured allergen levels (cat, dog, dust mite allergens in the bedroom, cockroach and mouse allergens in the kitchen and bedroom); those in the control group reduced only dust mite and mouse allergens in the bedroom and cockroach allergen in the kitchen. Participants in the intervention arm reduced National Asthma Education Prevention Program–based therapy from step 4.4 at randomization to 3.50 postintervention (range, 0-6); participants in the control arm reduced medication from step 4.4 to 3.4 ($P = .76$). There were no differences in other measured asthma outcomes.

CONCLUSIONS: Targeted allergen avoidance measures do not allow for reduction in asthma pharmacologic therapy compared with usual care in patients already receiving optimal controller therapy. © 2016 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2016;■:■-■)

Key words: *Asthma; Allergens; Cockroach; Mouse; Asthma controller*

[a]Columbia University Medical Center, New York, NY
[b]Departments of Medicine and Pediatrics, Jacobi Medical Center, Bronx, NY
[c]Department of Environmental Health Sciences, Mailman School of Public Health, Columbia University, New York, NY
[d]Department of Biostatistics, Mailman School of Public Health, Columbia University, New York, NY
[e]Rho Federal Systems Division, Chapel Hill, NC

This study was funded by the Agency for Healthcare Research and Quality (grant no. 1 R01 HS019384-01).

Conflicts of interest: E. DiMango has received research support and travel support from the Agency for Healthcare Research and Quality (AHRQ). B. Sheares has received research support from the National Institutes of Health. M. Perzanowski has received research support from the National Institutes of Health (NIH), the Centers for Disease Control and Prevention, the Assistant Secretary for Preparedness and Response, and the U.S. Department of Housing and Urban Development and has received travel support from the California Department of Health. R. Miller has received research support from the NIH and receives royalties from UpToDate. X. Liu has received research support from the AHRQ and the NIH. M. Kattan has received research support from the AHRQ and the NIH and is on the Novartis and Sanofi Advisory Boards. The rest of the authors declare that they have no relevant conflicts of interest.

Received for publication October 5, 2015; revised January 14, 2016; accepted for publication January 21, 2016.

Available online ■■

Corresponding author: Emily DiMango, MD, Columbia University Medical Center, 622 West 168th St, New York, NY 10032. E-mail: ead3@columbia.edu.

2213-2198

http://dx.doi.org/10.1016/j.jaip.2016.01.016

Abbreviations used
ACT- Asthma Control Test
AQLQ- Asthma Quality of Life Questionnaire
ETS- environmental tobacco smoke
NAEPP- National Asthma Education and Prevention Program

Environmental exposures to indoor allergens are major contributors to asthma morbidity among individuals in all geographic regions. Household exposure to allergens is of particular concern among inner-city individuals, where time spent indoors and high incidence of sensitization to indoor allergens exist and correlate with asthma severity in a dose-dependent fashion.[1-8] Despite the effectiveness of existing pharmacologic treatments for most patients with asthma, there is heightened concern over the adverse effects of these agents over the short- and long-term, contributing to poor adherence to medication regimens.[9-13] Asthma management guidelines emphasize the need for individualized environmental control measures for the treatment of asthma, but there is conflicting evidence of the efficacy of such measures and widely variable adherence to these recommendations by patients and providers.[14,15]

Previously conducted studies demonstrate variable results regarding benefits of household allergen reduction on asthma morbidity.[2,5,16,17] Limitations of single household allergen avoidance trials have directed attention to multifaceted allergen reduction.[16-18] Limited numbers of clinical trials have evaluated multiple allergen avoidance, especially in adults. In 2004, the Inner-City Asthma Study reported on a multifaceted home-based environmental intervention for children with asthma, tailored to each patient's sensitization and environmental risk profile.[19] Individuals randomized to environmental intervention demonstrated significantly fewer symptoms days (0.8 fewer symptom days per 2-week period) compared with individuals in the control group.[5] However, in another multifaceted allergen avoidance study, Carter et al[20] studied the effect of avoidance of dust and cockroach in a group of inner-city children with asthma and demonstrated no improvement. Mouse allergen in the inner city has also received considerable attention given the prevalence of mouse allergen in 95% of inner-city households tested in the National Cooperative Inner-City Asthma Study and the dose-dependent correlation of mouse allergen with asthma morbidity.[3,21-24] However, intervention trials based on household mouse allergen have not be reported.

Further complicating the interpretation of study results is the fact that the effectiveness of multifaceted environmental intervention as an adjunct to guideline-based pharmacologic therapy has not been prospectively studied.[2,5,17,25] We hypothesized that household allergen reduction among patients with asthma living in New York City may improve asthma control and allow for significant reduction in need for pharmacologic therapy. We performed a randomized controlled trial in subjects receiving optimized asthma controller therapy to assess the effect of individualized, comprehensive, multifaceted indoor allergen avoidance measures on the ability to step down asthma controller therapy in adults and children with mild to severe persistent asthma who were both sensitized and exposed to specific indoor allergens.

METHODS

Participants

Nonsmoking adults and children with mild to severe persistent asthma (≥6 years) were invited to participate at either Columbia University Medical Center in New York, New York, or the Jacobi Medical Center in Bronx, New York, between March 2011 and July 2012. The study was approved by the institutional review board of each institution and was posted on clinicaltrials.gov (NCT0159311). Subjects were recruited from pediatric and adult asthma and primary care clinics at the institutions as well as through printed advertisements. Written informed consent was obtained from each subject or guardian. Adolescents aged 12 to 17 years provided assent. Enrolled subjects were either receiving controller therapy or had symptoms consistent with persistent asthma[26] if not receiving therapy. Additional inclusion criteria at screening included an FEV_1 value of 40% predicted or more and asthma confirmed by bronchodilator reversibility, defined as having a 12% or greater increase in FEV_1 15 minutes after the administration of 2 puffs of albuterol or a PC_{20} methacholine value of 8 mg/mL or less if not using inhaled corticosteroids or 16 mg/mL or less if using inhaled corticosteroids. Subjects had to sleep overnight at the same address at least 5 times per week, have a positive skin test result (or ImmunoCAP if $FEV_1 <$ 60% precluded skin testing) to protein extracts of at least 1 common indoor allergen including dust mite, German cockroach, mouse, Aspergillus mix, cat, and dog allergens. Skin testing was performed using the percutaneous MultiTest method (MultiTest II, Lincoln Diagnostics, Decatur, Ill). ImmunoCAP testing (ThermoFisher, Uppsala, Sweden) was performed as previously described.[27] Following screening, subjects continued their usual asthma therapy or its equivalent for 21 days to allow for characterization of asthma severity and control. For subjects not previously receiving controller therapy, the study physician determined appropriate therapy on the basis of National Asthma Education and Prevention Program (NAEPP) guidelines.[26] To standardize therapy, medications were transitioned on the basis of equivalency tables (Table I).[28,29] All medications were provided free of charge to the subjects; adherence was measured by built-in dose counter and pill count.

Home evaluation/dust collection

One to 10 days following screening, 2 trained home evaluators conducted a home visit. Visual assessment of the subject's home, recording evidence of exposure to second-hand environmental tobacco smoke (ETS), presence and number of pets, and condition of the living space, kitchen, bedroom, and bathroom, was performed. Two vacuumed settled dust samples were collected from the bed, bedroom floor, and kitchen as previously described[24] (see this article's Online Repository at www.jaci-inpractice.org for additional methods). Protein was extracted, and Musm1 (mouse), Bla g1 (cockroach), Der f1 (dust mite), Can f1 (dog), and Fel d1 (cat) allergen concentration was quantified by means of ELISA.[30] Evidence of exposure above a prespecified cutoff[31] (see Table E1 in this article's Online Repository at www.jaci-inpractice.org) to at least 1 allergen to which the subject was sensitized was required for study continuation. Subjects sensitized to only cat or dog were eligible only if they had a cat or dog in the home.

Run-in period (4 weeks)

At least 70% medication adherence was required to proceed to the run-in period. Asthma control was assessed on the basis of measured FEV_1 as well as subject recall of number of days with asthma symptoms, number of days with rescue medication use, and