Asthma severity, atopic status, allergen exposure, and quality of life in elderly persons

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Background: Although asthma can be associated with significant airflow obstruction in those over the age of 65, it is often underdiagnosed and undertreated.

Objective: To describe severity of asthma, allergy skin test sensitivities, indoor allergen exposures, and the impact on quality of life (QOL) and health status in elderly persons with asthma.

Methods: A cross-sectional data analysis with 80 elderly persons with asthma recruited from medical, geriatric, and allergy/immunology tertiary care centers. Asthma severity was determined by symptoms and measurements of lung function. House dust specimens were collected from mattresses and bedroom carpets and analyzed separately for the major allergens of house dust, using monoclonal antibody-based immunoenzymetric assays. QOL was measured using Juniper’s Asthma Quality of Life Questionnaire. Health status was measured using the Short Form Health Survey Medical Outcome Questionnaire which included Ferrans and Powers’ Quality of Life Index subscales.

Results: Two-thirds of participants had either moderate or severe persistent asthma. Skin tests to a battery of common airborne allergens were positive to at least one allergen in 56 of the 75 participants tested (74.7%). Reservoir dust allergen levels were often high enough to place participants at risk of symptoms or at risk of developing sensitization. Increased asthma severity was associated with significantly lower QOL and a trend toward decreased health status.

Conclusions: Asthma is a significant chronic problem in the elderly. Atopy was common. Asthma severity impacts on these participants’ QOL and health status. Results support interventions aimed at identifying allergens precipitating attacks and reducing them in the home.

Do you awaken during the night or early in the morning with coughing or wheezing? 6) Do you have wheezing or coughing after exercise? 7) Have you used any medication that helps you breathe better? 8) Are your symptoms relieved when these medications are used?

Exclusion criteria were: 1) chronic illnesses impairing lung function besides asthma; 2) severe chronic sinusitis or severe nasal polyps; and 3) significant cognitive impairment. Eighty persons met enrollment criteria and agreed to participate. Asthma severity was determined using the National Asthma Education and Prevention Program’s criteria which are based on symptoms and measurements of lung function, specifically percentage of predicted forced expiratory volume of air in 1 second (FEV1). Demographic data and data from physical examinations, interviews, investigator observations of the indoor environment, and home dust collections for aeroallergen quantification were obtained. Allergy skin testing was performed. QOL and health status were measured by assessing the elderly’s physical, social, mental, environmental, and emotional well-being using established instruments.

Environmental Evaluation
We used a questionnaire to obtain information about characteristics of homes which could be risk factors for the development or worsening of asthma. Questions included age of home, ownership, use of air conditioning and humidifiers, type of heating system, and flooring surface in various rooms (carpeting, hardwood, or other). We inquired about participants’ smoking habits and presence of pets. Objective information about the home was obtained using a checklist. Observations focused on: 1) Are mattresses, box springs, and pillows encased in allergen impermeable encasings? 2) Is there wall-to-wall carpeting, hardwood floors, tile, or combinations? 3) Are there stuffed animals, pets, mold, or signs of high humidity? An overall rating of the home was assigned with a range from 1 for very neat and clean (dust- and dirt-free) to 5 for dirty with visible clutter and heavy amounts of dust present.

House Dust Specimen Collection
We conducted home visits to collect dust samples, spirometry readings, and bedroom humidity measurements. Dust specimens were obtained from 79 homes (98.8%) using a hand-held vacuum cleaner (Douglas Redivac Model #6735, Scott-Fetzer, Walnut Ridge, AZ) fitted with a disposable filter. The areas vacuumed for 2 minutes each were 2M2 of the upper surface of the mattress (if encased, then surface of the cover was vacuumed) and 1M2 of bedroom floor or carpet on the side of the bed where the participant stood when getting out of bed.

Types and Quantities of Home Indoor Allergens
Dust specimens were analyzed separately from each of the above sites. Samples were first sieved (50 mesh) to obtain fine dust free of large particles (>300 μm in diameter). The fine dust was then extracted (100 mg/2 mL buffer for 16 hours at 23° C) and supernatant samples quantitatively analyzed for major allergens of house dust. These include house dust mites (Der f 1 and Der p 1), cat (Fel d 1), dog (Can f 1), and cockroach (Bl a g 1). Measurement of allergens was done using standardized monoclonal antibody-based immunoenzymetric assays. Der p 1 plus Der f 1 >20 μg/g of fine dust; Fel d 1 >80 μg/g; and Can f 1 >80 μg/g were considered significant levels of allergens. A detectable level of cockroach allergen (>0.4 U/g) was considered significant.

Allergy Skin Testing
A battery of allergen skin tests was performed on the volar aspect of the forearm to determine allergic sensitivity. Participants refrained from taking antihistamines or antidepressants for at least 72 hours before testing. Medications with known prolonged suppression of skin tests were withheld for longer periods of time. The method used was prick testing the skin using a Dermapick device (Greer Laboratories, Lenoir, NC).

Positive (1.8 mg/mL histamine base) and negative (50% glycerinated saline) skin test controls were simultaneously applied using a battery of extracts, all supplied by Greer Laboratories. The extracts tested were: birch (1:20 wt/vol), oak, mixed (1:20 wt/vol), Kentucky blue grass (1:20 wt/vol), Bermuda grass (1:20 wt/vol), mixed ragweed (1:20 wt/vol), English plantain (1:20 wt/vol), Alternaria tenuis (1:20 wt/vol), Cladosporium mix (1:20 wt/vol), cat (10,000 BAU/mL), dog, mixed breeds (1:20 wt/vol), Dermatophagoides pteronyssinus (10,000 AU/mL), Dermatophagoides farinae (10,000 AU/mL), and cockroach mix (German and American, 1:20 wt/vol). The tests were read 15 minutes after application. A test was considered positive if it produced a wheal with a mean diameter (mean of maximum and 90% midpoint diameters) of ≥3 mm greater than the saline control.

QOL
Juniper’s Asthma Quality of Life Questionnaire, Interviewer Administered was used to measure QOL. This instrument contained 32 questions divided into four areas or domains: activity limitations, symptoms, emotional function, and environmental stimuli. Response options for each item were scored on a seven point scale, with 1 indicating the maximum impairment and 7 indicating no impairment. All items were weighted equally. Results were expressed as the mean score per item for each of the domains and for an overall QOL score. This questionnaire was validated in an 8-week single cohort study of 39 participants. The instrument differentiated participants who responded to treatment or who had natural fluctuations in their asthma from those who remained stable.

Health Status
Health status was measured using the Short Form Health Survey Medical
Outcome Questionnaire which included Ferrans and Powers’ Quality of Life Index subscales, and factored in socioeconomic status and family parameters.\textsuperscript{11,12} Participants rated their health as excellent, very good, good, fair, or poor. Eight questions rated limitations in activities of daily living as: 1) limited for more than 3 months; 2) limited for 3 months or less; or 3) not limited at all. Six questions rated how participants had been feeling over the past month, including whether health limited their social activities or whether they were feeling downhearted. Four questions rated how participants felt about their health. Scores ranged from 0 to 100, with higher score representing better health.

**Spirometry**

Spirometry was performed in participants’ homes using a Welch Allyn spirometer (Welch Allyn, Skaneateles Falls, NY). This instrument met specifications of the American Thoracic Society.

**Use of Asthma Medications**

Participants were asked about the use of prescribed medications including drug names, doses, and frequency of use. Medications were coded and classified according to action. Data about medications were collected to find out how well Expert Panel Report guidelines were being followed (National Asthma Education and Prevention Program, 1997).\textsuperscript{5}

**Statistical Analysis**

Frequency distributions, means, and cross-tabulations were used to evaluate data quality and identify associations between home allergen levels, sociodemographic variables, asthma severity, health status, and QOL measures. Allergen levels were dichotomized into those placing participants above or below risk for developing symptoms of asthma or allergy sensitization. The allergen quantities for each specificity determined whether participants were classified into a risk level regardless of their skin test sensitivities. The proportional association between the allergen categories and asthma severity, health status, and QOL measures was then evaluated by using cross-tabulation or means comparison, respectively. Asthma severity was further dichotomized into severe persistent and mild intermittent asthma. The statistical association between the allergen quantities for each specificity was classified into a risk level regardless of the other categories to evaluate its probability, conditioned upon the number of allergens above risk for symptoms, and other risk factors, such as age of dwelling. Both SAS (Ver 6.12, Cary, NC) and SPSS (Ver 8.0, Chicago, IL) analytical tools were used in the analysis.

**RESULTS**

**Study Population**

Eighty participants were enrolled from April 1997 to July 1998. One declined a home visit while five declined skin testing. Demographic characteristics are summarized in Table 1. The mean age of participants was 73.5 ± 5.4 years. Mean FEV\textsubscript{1} as a percentage predicted was compatible with a population having moderate to severe asthma. A total of 65% had either moderate or severe persistent asthma. Characteristics of homes considered risk factors for having high house dust mite levels are summarized in Table 2.

Allergy skin tests were positive to at least one allergen in 56 of the 75 (74.7%) of the study participants who were tested. Cat hair in 24 participants (33.8%) was the allergen specificity that was most frequently positive (Fig 1). Forty-two (53.2%) were skin test positive to at least one indoor allergen. Four of the five most prevalent positive skin tests were to the indoor allergens, cat, cockroach, dog, or *D. farinae*.

Reservoir dust in bedroom carpets/floors was more frequently positive for levels placing participants at risk of symptoms or sensitization than dust collected from mattresses (Fig 2). Forty-two participants (53.2%) had carpet/floor or mattress dust mite gr 1 allergen (Der p 1 + Der f 1) levels >20 μg/g. Of these, 11 of 42 (26.2%) were skin test positive for dust mites. Of the 37 currently exposed to gr 1 mites <20
µg/g, 13 (35.0%) were skin test-positive. The mean allergen levels in bedroom floors/carpets for Der gr 1 was 27 µg/g ± 56 µg/g.

Bedroom carpet/floor dust from 19 households (24.1%) had detectable cockroach allergen ranging from 0.4 to 17.2 U/g and 4 of the 19 (21.1%) had positive skin tests to cockroach. Of the 56 who had undetectable levels of cockroach, 17 (30.4%) had positive skin tests. A total of 15 participants had cats (19.0%) and 20 had dogs (25.3%). Of 24 skin tests positive to cat, 5 (20.8%) participants had a cat. Of 21 skin tests positive to dog, 6 (28.6%) participants had a dog.

With increasing asthma severity, there were statistically significant differences for each of the four QOL domains and for total QOL (Table 3). For health status, with increasing severity, there were statistically significant differences for four of the six subscales. However, total health status did not quite reach statistical significance with increasing severity (P = 0.06). There was no detectable association between quantity of allergens in homes and severity of asthma (data not shown).

Asthma Medications
More than three-fourths of all participants used β₂-agonist drugs taken regularly or as needed whereas over two-thirds used inhaled steroids regularly. Almost 50% used a β₂-agonist regularly, whether they felt they needed it or not (Table 4).

DISCUSSION
We describe a selected sample of 80 elderly participants with asthma. We found almost two-thirds had moderate or severe persistent disease. This indicates that asthma is a significant chronic problem in the elderly. Further, asthma is a serious concern in the very old, with 16 of our participants (20%) > 80 years old. Long-standing asthma has been associated with greater severity of airway obstruction as measured by FEV₁ compared with recent onset asthma. Home environments conducive to house dust mite and mold growth were common, including older dwellings, high indoor relative humidities and temperatures in bedrooms, and nonencased mattresses. It is difficult to control mites unless relative humidity is below 50% and mattresses are encased in allergen impermeable encasings.16

We found that atopy, demonstrated by positive allergy skin tests, was common (Fig 1). A total of 74.6% of our participants had at least one positive test to a battery of common airborne allergens. This contrasts with the findings of other investigators. A prevalence of positive skin tests in only 36.6% of a cohort of older patients has been described.2 In a cross-sectional analysis of asthma participants from the Netherlands, it was reported that allergen skin test sensitivity decreases with age to all allergens except grass pollen. In our study, Bermuda grass was the second most prevalent positive skin test. This may indicate the potency of this allergen and its widespread prevalence in that the elderly have had regular exposure to it. In our participants, five of the seven most prevalent reactions were to indoor allergens (Fig 1). Most of the increase in asthma prevalence in children has been attributed to sensitivity to indoor allergens.1 Our findings suggest that the same may be true for the elderly with asthma.

We found high levels of house dust mites, cockroach, cat, and dog in homes. Levels were often high enough to place participants at risk of asthma exacerbations. Data suggest that the high allergen levels found in the homes of older adults with asthma are from living in homes with carpeting, older furnishings, high indoor relative humidities, and nonencased mattresses. In children, studies have demonstrated that there is a greater risk of sensitization to house dust mites and to cockroach20,27 for those currently exposed to high allergen levels. However, we found a greater percentage of positive mite skin tests in those
exposed to low levels of mites compared with those exposed to higher levels (26.2% vs 35.0%). Likewise, we found a greater percentage of positive cockroach skin tests in those who had undetectable levels than those exposed to detectable levels (21.1% vs 30.4%). The differences in skin test reactivities and exposures between children and adults to house dust mites and cockroach may indicate that past exposures are more important in adults than current exposures.

Cockroach allergen is known to be a major cause of asthma, especially among children living in inner cities. Also, exposure to cockroach allergen has been found to be a significant predictor of decline in FEV1 in older asthmatic adults who have positive skin tests to cockroach. Since our participants often were sensitized to cockroach and had high levels in bedroom carpets, this suggests that cockroach exposure is a significant cause of asthma in these older adults. Exposures to furred pets are important triggers for asthma. In this elderly cohort, avoidance of furred animals would be the recommended treatment. Yet almost 25% of participants who kept a dog or cat were skin test-positive to the animal they possessed and, thus, at high risk of symptoms.

The rate of smoking among study participants (11.1%) is comparable with that of a previous study of adults with asthma in which 7 of 52 (13.5%) indicated that they smoked. In a study of 46 elderly participants with asthma, it was found that FEV1 was lower in those who smoked compared with those who did not smoke. However, there was no significant difference in FEV1 values between those who smoked > 20 pack years and those who smoked < 20 pack years.

Although the majority of our sample had high levels of indoor allergens, we did not find a correlation between home allergens above significant levels and severity of asthma measured by FEV1. There is a complex relationship between exposure to allergens and asthma severity. It is difficult to determine the role that any one allergen plays in exacerbating an individual’s asthma. There is an interplay between allergens that cause sensitization, those that enhance the allergic response, and those that actually trigger asthma attacks. All of these factors interact to

Table 3. Quality of Life and Health Status by Asthma Severity in the Study Sample

<table>
<thead>
<tr>
<th>Measure, with subscales</th>
<th>Asthma Severity*</th>
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<tbody>
<tr>
<td></td>
<td>Mild persistent</td>
</tr>
<tr>
<td>Aesthetic Quality of Life</td>
<td>N</td>
</tr>
<tr>
<td>Activity limitations†</td>
<td>75</td>
</tr>
<tr>
<td>Symptoms‡</td>
<td>77</td>
</tr>
<tr>
<td>Emotional function‡</td>
<td>77</td>
</tr>
<tr>
<td>Environmental stimuli‡</td>
<td>77</td>
</tr>
<tr>
<td>Total QOL‡</td>
<td>75</td>
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<tr>
<td>Health Status</td>
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<tr>
<td>Pain</td>
<td>69</td>
</tr>
<tr>
<td>Physical Functioning‡</td>
<td>76</td>
</tr>
<tr>
<td>Role Functioning†</td>
<td>76</td>
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<td>Social Functioning†</td>
<td>76</td>
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<tr>
<td>Mental Health</td>
<td>76</td>
</tr>
<tr>
<td>Health Perception‡</td>
<td>76</td>
</tr>
<tr>
<td>Total Health Status§</td>
<td>69</td>
</tr>
</tbody>
</table>

* Units = means (standard deviation)
† P<0.01
‡ P<0.05
§ P=0.06
determine whether wheezing occurs and to what degree.\textsuperscript{6,30}

We found that elderly participants with moderate or severe persistent asthma had significantly lower QOL scores than those with mild asthma. Others have observed that the elderly with asthma have significantly lower QOL scores than those without asthma.\textsuperscript{3,9} Those with asthma reported more negative feelings about life in general, described health as being poor, and had a higher degree of impairments in activities of daily living.\textsuperscript{3} These findings imply that those with more severe asthma are less likely to engage in domestic behaviors, including dusting and vacuuming. Avoidance of these activities would result in higher levels of indoor allergens, ultimately causing more severe asthma.\textsuperscript{31}

Although inhaled steroids are considered the first line of treatment for long term control of persistent asthma,\textsuperscript{5} almost one-third were not taking these medications. For quick-relief medication, most were taking a short-acting inhaled \( \beta_2 \)-agonist agent or an inhaled anticholinergic. Many were using these regularly, rather than the recommended way, which is as-needed only.\textsuperscript{3} The use of short-acting inhaled \( \beta_2 \)-agonists on a daily basis, or increasing use, indicates the need for additional long-term control therapy.

Our study has several potential limitations. First, although this was a randomized trial, the analyses are based on cross-sectional data obtained at the beginning of the study. With the use of cross-sectional data, previous exposures can not be evaluated. However, that 31.7\% of participants living in houses with low cat allergen (<80 \( \mu \)g/g) were nevertheless sensitized to cat suggests that previous exposures are likely to be clinically relevant. Second, because participants were obtained from one geographical area of the country, the general prevalence of sensitization must be interpreted cautiously. Third, many of our participants were recruited from a review of hospital discharge records which may have biased toward more severe degrees of allergy skin test sensitivity. Fourth, because records of when our participants first developed asthma are not available, it has been difficult to factor in the impact of past exposures to potent indoor allergens on the development of severe asthma. Because of these limitations, one must use caution in extending these results to the elderly population with asthma in general.

**CONCLUSION**

We found that asthma in the elderly is not rare. We had no difficulty identifying and enrolling 80 elderly subjects with asthma. It is often of a moderate to severe persistent severity, accompanied by positive allergy skin tests and high allergen levels in homes. Our findings support doing allergy skin tests on elderly subjects with asthma, especially with moderate to severe persistent severity, to identify allergens in the environment precipitating asthma attacks. This would be combined with interventions to reduce allergens in the home and with the use of medications that combat inflammation in the airways. The overall expectation is that asthma severity should decrease with a resultant increase in the QOL among the elderly with asthma.

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**REFERENCES**


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