

Original Article

Sensitization and Exposure to Pets: The Effect on Asthma Morbidity in the US Population

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What is already known about this topic? Both dog and cat ownership and sensitization are common in the United States. It is known that exposure to pets can increase asthma symptoms for those who are sensitized to the particular pet allergen.

What does this article add to our knowledge? Exposure to elevated levels of dog or cat allergen in the bedrooms of sensitized patients with asthma increases the number of asthma attacks dramatically. Using data from a study based on the US population, this study quantifies that increase on a national level.

How does this study impact current management guidelines? This study highlights the importance of implementing environmental allergen control in homes of patients with asthma who are sensitized to and have pets at home.

BACKGROUND: Although pets are found in more than 50% of US homes, the effect of pet allergen exposure on asthma morbidity in the US population is not well documented.

OBJECTIVE: To determine the effect of dog and cat allergen exposures on asthma morbidity in the US population.

METHODS: The National Health and Nutrition Examination Survey is a representative sample of civilian US population. Data on asthma, dog and cat allergen levels in bedroom dust, as well as

specific IgE to dog and cat were analyzed for all participants 6 years or older.

RESULTS: Pets are common in the United States, with more than 50% of households having a dog or a cat or both. The prevalence of allergic sensitization in the National Health and Nutrition Examination Survey population was similar for dog and cat, with both being approximately 12%. Among those who were sensitized, exposure to elevated levels of pet allergens was associated with an increased prevalence of asthma and asthma attacks. Indeed, 44.2% of the asthma attacks were attributable to exposure to high levels of dog allergen in the bedroom among patients with asthma sensitive to dog and 30.3% were attributable to cat allergen exposure among the comparable cat-sensitive and exposed group. Projecting these results to the US population indicates more than 1 million increased asthma attacks each year for the dog-sensitive and exposed group and more than 500,000 increased asthma attacks for the cat-sensitive and exposed population of patients with asthma.

CONCLUSIONS: Exposure to elevated levels of dog and cat allergens among those sensitized individuals with asthma is associated with excess asthma attacks. Reducing pet allergen exposures has the potential for a significant decrease in asthma morbidity. Published by Elsevier Inc. on behalf of the American Academy of Allergy, Asthma & Immunology (*J Allergy Clin Immunol Pract* 2017;■:■-■)

Key words: Asthma; Pets; Hospitalizations; Allergen exposure; Cat; Dog; Allergen sensitization

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The influence of pets in the development of asthma, allergy, and exacerbation of existing asthma is complicated. Sensitization to dog and/or cat allergen in early life is a strong predictor of the development of childhood asthma.¹ The National Health and Nutrition Examination Survey (NHANES) III found that more cases of asthma could be attributed to sensitization to cat allergen

Abbreviations used

NCHS- National Center for Health Statistics

NHANES- National Health and Nutrition Examination Survey

UAS- universal allergen standard

than any other sensitization.² On the contrary, other investigations have demonstrated a protective effect of pets in early life on developing sensitization^{3,4} and asthma.¹

However, it is known that when sensitized individuals with asthma are exposed to allergens to which they are sensitized, their asthma can become more severe and/or difficult to manage.⁵ To date, the impact of dog and cat allergen exposures on asthma morbidity among sensitized individuals has not been investigated at the national level, although sensitization to dog (11.8%) and cat (12.1%) is common in the US population,⁶ and pet ownership is even more common—a 2012 American Veterinary Medical Association survey reported 36.5% of US households having a dog and 30.4% having a cat.⁷ The NHANES 2005-2006 is the first study of a nationally representative sample to collect dust from US homes, analyze the dust for dog and cat allergens, draw blood to assess dog and cat sensitization, and evaluate asthma morbidity. The home dust allergen assay data did not become available until 2014 because of delays in the laboratory analysis phase of this component.⁸ These data offer a unique opportunity to determine the importance of dog and cat exposure on asthma morbidity in the US population.

METHODS

The NHANES 2005-2006 was a population-based survey conducted by the National Center for Health Statistics (NCHS) to determine the health and nutritional status of the civilian, non-institutionalized US population. Its protocol was approved by the NCHS Institutional Review Board.⁹ Signed consent was obtained from all participants 18 years and older. For minors, a parent/guardian provided permission to participate and written assent was provided by children aged 7 to 17 years.

Trained technicians collected a single, combined sample of dust from the participant's bedroom bed and floor using a standardized protocol.⁸ A detailed description of dust collection, storage, and processing is provided in this article's Online Repository at www.jaci-inpractice.org. Dust samples were assayed for allergen concentrations using the universal allergen standard (UAS) and the MARIA assay (Indoor Biotechnologies, Charlottesville, Va). UAS values can be easily converted to earlier ELISA measures to compare with previously published values (see [Table E1](#) in this article's Online Repository at www.jaci-inpractice.org).¹⁰ Endotoxin levels were assessed with *Limulus* amoebocyte lysate assay.¹¹

Participants 6 years and older were tested for allergen-specific IgE antibodies to dog and cat dander with the ImmunoCAP 1000 System (Pharmacia Diagnostics, Kalamazoo, Mich), now known as Thermo Scientific ImmunoCAP specific IgE. The upper and lower limits of detection (LLOD) were 1000 kU/L and 0.35 kU/L, respectively. For samples less than the LLOD, the NHANES provided a value equal to the LLOD divided by the square root of 2; for those more than the upper limit, the NHANES provided a value of 1000 kU/L.

Outcome definitions

A participant was considered to have physician-diagnosed current asthma when the participant responded in the affirmative to the following questions: "Has a doctor or other health professional ever told you that you have asthma?" and "Do you still have asthma?"

Only participants with physician-diagnosed current asthma were questioned about asthma attacks ("During the past 12 months, have you had an episode of asthma or an asthma attack?") and about emergency care visits ("During the past 12 months have you had to visit an emergency room or urgent care center because of asthma?").

Sensitization to each allergen was defined as a specific IgE concentration of 0.35 kU/L or more. Elevated pet allergen levels were defined by literature-based morbidity thresholds for cat and dog (8 µg/g and 10 µg/g, respectively) on the basis of previous ELISA standards, which were converted to compare directly with the data generated by the use of the UAS in the MARIA assay (3.19 µg/g and 2.11 µg/g, respectively).¹⁰

Statistical analyses

Specific IgE and cat and dog allergen concentrations were log-transformed to establish normality. Differences in prevalence of sensitivity, exposure, and pet ownership across population characteristics were tested with the chi-square statistic.

The primary association of interest was between sensitivity and exposure (dichotomized at the morbidity threshold for each allergen) and asthma. Unadjusted and adjusted log odds were estimated with logistic regression and then converted to differences in probabilities by using the inverse-logit function $p = \exp[\alpha]/(1 + \exp[\alpha])$.¹² Differences were adjusted for age, sex, race/ethnicity, poverty index ratio, serum cotinine levels, and endotoxin. Interaction effects were assessed using a 2-way interaction between sensitivity and exposure.

Statistical significance was established a priori at .05 for main effects and .10 for interactions. The sample weight variable (WTAL2YR) was created by NCHS and used in all analyses to account for the analytic subsample to obtain unbiased national estimates. The survey design variables representing the sampling strata (SDMVSTRA) and PSU (SDMVPSU) were used to calculate the SEs for the complex survey design. Analyses were performed with R version 3.2 and survey package version 3.30¹² (R Foundation for Statistical Computing, Vienna, Austria) to adjust for the complex sampling design and confirmed with SAS version 9.1.3 (SAS Institute, Inc, Cary, NC) survey sampling procedures.

RESULTS

Of the 5845 participants in the home allergen sample aged 6 years or older, 5238 (89.6%) had blood drawn to assess allergen-specific IgE levels and home dust samples collected to measure allergen levels. No significant differences were noted between the full sample and this analytic subsample.

Pet ownership and pet allergen exposures

Current pet ownership was common, with 51.2% of the participants reporting either a dog (37.9%; SE = 1.99) or a cat (27.5%; SE = 1.81) present in their home and 14.3% reporting both ([Table I](#) and [Figure 1, A](#)). Among those with asthma, pet ownership was slightly higher, with 42.2% of the households having a dog and 31.2% owning a cat. Pet ownership varied across sociodemographic groups, with both dog and cat ownership being significantly more common among those who were

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