

Short communication

Allergic sensitization owing to 'second-hand' cat exposure in schools

Background: Environmental allergen loads play an important role in triggering symptoms in atopic individuals. While a number of previous studies have shown that cat allergens (Fel d 1) can be found in school dust samples, no study has provided evidence that public places contribute to increased atopic sensitization rates in children.

Methods: We employed data collected in a health survey of school children living in Germany in order to examine the association between the proportion of class- and schoolmates reporting cat contact and sensitization rates in children.

Results: Among 1893 children, 8.7% were sensitized to cats. Those sensitized were 5–7 times more likely to have received an asthma diagnosis or to have reported wheezing. Pupils without regular contact with cats were twice as likely to test positive for major cat allergen when the proportion of schoolmates with cat contact was high. No such relation was observed amongst children reporting regular cat contact.

Conclusions: Our study suggests that allergens in school environments contribute to allergic sensitization and atopic diseases such as asthma. Thus, methods to reduce the allergen load in classrooms should be considered.

**B. R. Ritz¹, B. Hoelscher², C. Frye²,
I. Meyer², J. Heinrich²**

¹Department of Epidemiology, School of Public Health, UCLA, Los Angeles, CA, USA; ²GSF-National Research Center for Environment and Health, Institute of Epidemiology, Neuherberg, Germany

Key words: allergic sensitization; asthma; cats; school children.

Dr B. Ritz
Department of Epidemiology
School of Public Health
UCLA
PO Box 951772
Los Angeles
CA 90095-1772
USA

Accepted for publication 1 October 2001

According to the multicenter European Community Respiratory Health Survey (ECRHS) (1), 9% of European adults are sensitized to cat allergen (serum specific immunoglobulin (Ig)E > 0.35 kU/l) and in Northern European countries this allergen is strongly related to asthma and bronchial hyper-reactivity (BHR) (2,3). The National Health and Nutrition Examination (NHANES) II survey reported that while at least 2% of the general population in the United States is allergic to cats, only a third of these individuals live in a household with a cat (4). Parents of atopic (5) children are commonly advised to remove cats because levels of cat allergen are on average two orders of magnitude higher in homes of cat owners (6,7). However, a number of recent studies suggested that air borne cat allergen is ubiquitous in the environment (8–16). Some authors argued that high environmental allergen load might be the main reason why removal of pets from homes often does not lead to the anticipated decrease in symptoms in

allergic individuals (17). In fact, ECRHS suggested that not only cat ownership but, in addition, community prevalence of cat ownership influences the prevalence of cat sensitization in a population (1).

A recent study (18) reported that in children allergic to cats who reported no contact with furred pets asthmatic symptoms worsened when they returned to school after holidays, if they attended classes in which more classmates owned cats. While a number of studies have shown that allergens can be found in school dust samples, no study has yet provided evidence that public places such as schools contribute to the sensitization of children who do not own a cat and have no regular contact with cats. We address this question using data from a survey of German school-age children originally designed to assess the relation between overall health, respiratory health, allergies, and environmental pollution from industry and mining (19). These data provided us with the opportunity to examine whether sensitization rates of children who report no regular contact to cats increased with the number of cat owning class- or schoolmates.

Material and methods

Subjects and materials

The surveyed children live in three areas of Saxony-Anhalt, a state in eastern Germany. Our analyses are based on data from the third survey of environmental risk factors, respiratory health and atopic diseases in these children and a detailed description of the study design and the survey population has previously been published (19). Between 1998 and 1999, 2767 pre- and elementary school children aged 5–14 were recruited from the towns and neighboring communities of Bitterfeld, Hettstedt, and Zerbst. Teachers distributed questionnaires to the children's parents eliciting information about health of the child as well as social and environmental factors. The overall response rate was 75.9%. All children whose parents consented to participate in the study underwent physical examinations at their schools during the 1998–99 school year and had blood drawn. Data concerning contact to cats and classroom membership was available for 2218 children from 74 schools including 174 classes grades K through 6. However, because some parents and children did not consent to provide a blood sample, specific IgE immune-response data is only available for 1893 of these children. The blood was immediately frozen and stored at -20°C , and the same laboratory analyzed all samples in 1999.

The study was approved by the Ethics Commission of the University of Rostock Ethics Committee and was carried out in accordance with the institutional guidelines for the protection of human subjects. Informed consent was obtained from all parents of the participating children.

Immunological assays

Total serum IgE was determined with the RAST-FEIA-CAP technique (Pharmacia, Freiburg, Germany). Allergic sensitization to common aeroallergens (house dust mite *Dermatophagoides pteronyssinus*, *Cladosporium herbarum*, cat, mixed grasses, and birch pollen) was assessed by specific serum IgE measurements, using the RAST-FEIA-CAP system (Pharmacia). We defined sensitization to cat allergen as a dichotomous outcome (serum specific IgE <0.35 kU/l) or a five-level outcome according to RAST-classes 0–4: (0) <0.35 ; (1) 0.35 – <0.7 ; (2) 0.7 – <3.5 ; (3) 3.5 – <17.5 ; (4) ≥ 17.5 .

Statistical methods

Employing logistic regression models for dichotomous (RAST-class 0 vs. ≥ 1) and ordinal outcomes (RAST class 0–4) we examined whether a child's risk of testing positive for cat allergens increased with the percentage of class or schoolmates reporting regular contact with cats. We created quartiles of indirect cat exposure per class and school according to the proportion of children reporting regular contact to cats for each class and school. We controlled for the influence of other potential risk factors for sensitization by including in the regression models factors such as age, sex, parents or siblings having received a diagnosis of asthma and/or atopic diseases, and having removed a pet from the household owing to symptoms in the past. Having had contact with cats or dogs during the first year of life did not change the effect estimates presented in Table 2.

Results

Amongst the 1893 children included in our analyses 36.1% reported to have regular contact to cats and 8.7% (164) tested positive (>0.35) for specific IgE to major cat allergen from *Felis domesticus* (Fel d 1). Table 1 shows that cat sensitization does not differ for children with regular contact with cats and those reporting no regular

cat contact. Yet for only 62 (38%) of the children testing positive parents reported regular contact to cats, an additional seven children had had contact with cats early in life, and in four additional cases parents had removed animals from the home because the child experienced symptoms. Thus, for the majority of children testing positive for cat allergen parents reported that the child currently or in the past did not have regular contact with cats. Amongst the children who had tested positive for cat-specific IgE, 42 children previously received a diagnosis of asthma and 45 a diagnosis of allergies or hay fever (19 received both diagnoses), while for about a third (57 children) parents reported that the child neither experienced allergic symptoms nor had received a diagnosis of asthma or hay fever. Concerning symptoms, parents reported that 37 sensitized children had recently suffered from (nightly) cough and/or wheezing, and 102 had experienced hay fever type symptoms in the past 12 months such as itchy nose, reddened eyes, and sneeze attacks.

We found that most of the children who were sensitized to cats (140 out of 164) additionally tested positive for at least one other allergen (common grasses, pollen, mites, or moulds) and the proportion of children not sensitized to any allergen was higher among cat owners.

Our results presented in Table 2 show that testing positive for cat-specific IgEs depended on the percentage of classmates or schoolmates who reported regular cat contact (Table 2). For pupils who themselves have no regular contact to cats, the risk of testing positive for cat-specific allergens increased in a dose-response fashion with the percentages of pupils reporting regular cat contact. No such relation was observed for children with regular cat contact (OR_{highest vs. lowest quartile in school} = 0.86; 95% CI 0.35–2.10). Also, we did not find a clear dose-response pattern for atopic sensitization to other (noncat) allergens; yet, for those children without regular cat contact the risk for mould and pollen sensitization increased by approximately 50% if many class/school mates reported cat contact (highest quartile; results not shown). We collected information about dog ownership but did not measure specific sensitization (IgE) to dogs. More children without rather than with cat contact reported regular contact with dogs (61% vs. 40%, respectively), but controlling for regular dog contact in our models did not change the reported results.

Neither direct nor indirect contact with cats was related to reports of hay fever type or asthmatic symptoms (cough and wheeze) during the past 12 months. However, children who tested positive for cat allergens had a five-fold increased risk for having received an asthma diagnosis and a more than seven-fold increased risk for 'wheeze during the last 12 months' and about a two-fold increased risk for cough or displaying other atopic symptoms.

Table 1 RAST sensitization to major cat allergen Fel d 1 in 1893 children with and without regular contact with cats

Regular contact with cats											
Number (%) of sensitized children and cat allergen level (in kU/l)											
	< 0.35		0.35- <0.7		0.7- <3.5		3.5- <17.5		≥ 17.5		Total
No	1108	91.6%	35	2.9%	38	3.1%	16	1.3%	13	1.1%	1210
Yes	621	90.9%	17	2.5%	26	3.8%	12	1.8%	7	1.0%	683

Discussion

In order to reduce airborne allergen exposure for atopic children it has been proposed to remove all reservoirs of airborne cat allergens, i.e., to remove cats from homes, keep them outdoors, wash them weekly, and minimize surface areas such as carpeting and upholstered furniture to which cat allergens could attach (6). Yet, a number of recent studies examining the distribution of air borne cat allergen in homes with and without cats and public places, reported that while the highest levels of cat allergen are, as expected, found in homes with cats, these air-borne allergens are ubiquitous in the environment. The major cat allergen, Fel d 1, has also been found in Swedish and Norwegian school dust (8–10), in a number of public places in Michigan (11), and in homes without cats (12–14). Thus, even if parents of allergic children remove all or most allergen reservoirs from their homes, children will still be exposed to these allergens outside their home. While allergen levels in places without cats are typically much lower than those found in homes with cats, the fact that many individuals become sensitized to cats without ever having lived around cats suggests that environmental levels may be high enough to sensitize noncat owners (20). Furthermore, a recent study suggested that the relation between allergen levels in the environment and sensitization rates might not be linear (21). In this study, very high levels of cat allergen in homes induced IgG4 isotype

antibodies to Fel d 1 without evidence of sensitization or an IgE response, i.e., causing some children exposed to high levels of cat allergens to be ‘tolerant’.

Our study suggests that ‘second hand’ cat exposure in school environments increases the risk of cat sensitization in those school children whose parents reported that their children did not have regular contact with cats. Our results are corroborated by a recent study showing that children who are allergic to cats but do not have contact with cats at home showed worsening of asthmatic symptoms, peak expiratory flow, and increased medication use for asthmatic symptoms when they returned to school after holidays and attended classes where more than 18% of all classmates owned cats (18). Further support stems from studies conducted in Sweden and New Zealand reporting that cat allergen levels were higher in classrooms than in homes without cats, increased with the number of classmates and teachers who owned cats or had frequent contact with cats, and that children from homes with cats carried allergen on their clothes (8,22–24). The pattern of allergens observed in classrooms lead Munir et al. (8) to conclude that cat dander was most likely carried into classrooms on the clothes of a cat owner. These authors also suggested that apart from the prevalence of cat allergy being high in Sweden, environmental exposure to allergens might be the reason why children who are allergic to animal dander show continuous severe asthma without any known contact with cats.

Table 2 Positive RAST sensitization to cat allergen depending on the percentage of class or schoolmates with regular contact with cats in children who don't have regular contact with cats

		OR		OR ^b	
		Crude	p-trend ^a	Adjusted ^c	p-trend ^a
Cat owner (%)		N case 102, N control 1108		N case 91, N control 957 ^c	
Class percentile					
<25th	≤22	1.00		1.00	
25th–<50th	22–<35	1.16 (0.66–2.04)		1.04 (0.56–1.94)	
50th–<75th	35–<44	1.78 (1.01–3.14)		1.76 (0.94–3.28)	
≥75th	≥44	2.43 (1.35–4.39)	0.001	2.08 (1.07–4.05)	0.01
School percentile					
<25th	≤22	1.00		1.00	
25th–<50th	22–<31	1.41 (0.79–2.51)		1.44 (0.77–2.71)	
50th–<75th	31–<44	1.79 (0.99–3.24)		1.75 (0.91–3.36)	
≥75th	≥44	2.29 (1.25–4.20)	0.005	2.04 (1.02–4.06)	0.04

^a Trend test was performed using category means for each percentile in a logistic model

^b Adjusted for age, gender, exposure to cats or dogs during the first year of life, hay fever or asthma diagnosed in father, mother or siblings, having given an animal away because of child having symptoms

^c Adjusted N is smaller owing to some missing covariate information

Previously it has been suggested that exposure to more than 2 µg of Fel d 1 per gram dust increases the risk of sensitization (25), but much lower levels of airborne Fel d 1 (<500 ng/m³) are capable of causing upper and lower respiratory symptoms in subjects allergic to cats (13) and, thus, enough cat allergen may be present in places not frequented by cats to provoke sensitization and/or atopic symptoms.

Although children with more classmates who have regular contact with cats may be more likely to have friends who own cats and could be exposed to cats at friend's homes, owing to the small town and rural environment in which this study was performed we would expect parents in our study to know about such exposure and therefore report that their children have regular contact with cats. Thus, we conclude that 'second-hand' cat exposure in schools and classrooms might be an important factor contributing to the

sensitization of school children. Reducing allergen load in classrooms and school environments might be an important preventative measure to reduce sensitization to cat allergens in asthmatic and atopic children.

Acknowledgments

We would like to thank H. Schneller for the data handling, Dr I. Keller, Dr D. Bodesheim, Dr I. Hörhold and Dr E. Kirtzel for collecting blood, B. Hollstein, H. Machander, R. Müller, D. Albrecht, K. Fischer, B. Saul, I. May, Dr T. Engelskirchner, E. Jummel, and I. Mrohs for gathering regional data and local assistance. Furthermore, we would like to thank all teachers in Hettstedt, Zerbst, and Bitterfeld, the local school authorities and health care centers for their support, as well as all parents and children for their participation. This study was supported in part by the Federal Environmental Agency (Umweltbundesamt), grant no. 298 61 724.

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