

Predictors of Cat Allergen (Fel d 1) in House Dust of German Homes With/Without Cats

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Summary. *Background:* Exposure to cat allergen is a major risk factor for sensitization and the development of asthma in many parts of the world. The study was designed to examine the levels of cat allergen (Fel d 1) in homes of two German cities and to determine predictors of Fel d 1 exposure. *Methods:* We collected dust samples from 405 randomly selected homes in Hamburg ($n = 201$) and Erfurt ($n = 204$). In each apartment dust samples were taken from living room floor (LR), bedroom floor (BR), and mattress surface (MA) using vacuum sampling and analyzed by two-site monoclonal antibody ELISA. Environmental variables were assessed by questionnaire to obtain information on factors supposed to have an impact on the Fel d 1 levels in house dust. The effects of possible predictors of Fel d 1 were assessed by multiple linear regression models. *Results:* Fel d 1 was present in 98% of the homes (395/405), ranging from 0.015 to 7.278 $\mu\text{g/g}$ dust (GM 0.486 $\mu\text{g/g}$). The levels were similar in floors (GM for LR 0.575 $\mu\text{g/g}$ and BR 0.469 $\mu\text{g/g}$) and in MA (GM 0.424 $\mu\text{g/g}$). Higher allergen concentrations ($> 2 \mu\text{g/g}$) were detected in 99% of the homes keeping cats, in 55% of homes that had had a cat during the last year, and in 28% of the homes without a cat. Fel d 1 levels were significantly higher in homes with a cat (628–682-fold, MA, floor) and in homes in which a cat had previously lived (11–12-fold, floor, MA) than in homes that never had a cat. Furthermore, after controlling for possible other confounders, Fel d 1 levels were significantly higher in summer and in homes with low frequency of cleaning and low ventilation rate. *Conclusion:* It could be confirmed that keeping a cat has the highest impact on Fel d 1 concentration. Besides, a continuous influx of Fel d 1 in homes without cat, as a result of direct or indirect cat contact outside the home, is likely. High frequencies of dusting and ventilation might reduce cat allergens in homes with and without cats.

Keywords: cat allergen, house dust, housing characteristics, occupant characteristics, indoor allergens

Introduction

In Western countries, aside from house dust mite, sensitization to cat allergen occurs frequently in allergic subjects [1]. Exposure to cat allergen causes sensitization in

15%–60% of atopic individuals and is responsible for acute asthma attacks as well as prolonged bronchial hyperresponsiveness [2–5]. Also, if a sensitized person is exposed to low or moderate levels of cat allergen, the inflammation of the mucous membranes in the airways may be maintained. Therefore, it is insufficient to assess the cat allergen

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exposure only on the basis of whether or not a cat is kept in the house. In order to understand the etiology of allergic disease, it is necessary to study the environmental factors that determine the distribution and concentration of indoor allergen and the effect of exposure on sensitization and symptoms. Therefore, a joint project was established to investigate the influences of *Indoor* factors and *Genetics* in Asthma (INGA) in Germany [6]. As part of this study levels of the major cat allergen (Fel d 1) were determined in house dust of two German cities, Hamburg (Western Germany) and Erfurt (Eastern Germany). The background for selection of this study population is the finding that atopic sensitization against cat (skin test and specific IgE) was more prevalent in Hamburg than in Erfurt [7]. Furthermore, few information on hidden cat allergen exposure in house dust in German buildings has been reported so far. The goal of this paper is to describe the Fel d 1 concentrations in these homes and to analyze predictors of Fel d 1 levels.

Material and Methods

Study Population

A total of 405 homes in the cities of Hamburg and Erfurt were included in the INGA study and visited from June 1995 through November 1996. The study population consisted of a subset of the subjects who had participated within the European Respiratory Health Survey (ECRHS) [8]. Details of the selection of the study population were described elsewhere [6].

Sampling of House Dust and Allergen Measurement

In each house, three dust samples were taken in a standardized manner [9] by vacuuming an area of 1 m² for 2 min from living room (LR) and bedroom (BR) floors and mattresses (MA). Dust was collected on cellulose filters using ALK sampling devices (ALK allergen mouthpiece, Hørsholm, Denmark). The dust samples were stored at -20°C until extraction. The allergens were extracted from the sample dust plus filter paper as described previously [10].

Cat allergen Fel d 1 was measured with 2-site mAb ELISA, according to the instructions of the manufacturer (Indoor Biotechnologies, Clwyd, UK) [10]. The cat allergen standard UVA 94/01 (containing 1.6 U/ml) was used for calculation of the results, whereas 1U corresponds to 4 µg of Fel d 1.

Building Characteristics and Occupant Behavior

A screening questionnaire was completed to obtain detailed information on type and age of the home, story and

size of the dwelling, type of heating, age of carpets and mattresses, pets, signs of dampness, packing of the windows, ventilation and cleaning habits in the home. Ventilation was classified as good, medium, and poor according to the number of hours per week the window was fully and/or partially opened. Based on the questionnaires the homes were divided into homes in which a cat was kept at present, homes with no present cat, but cat present during last year, and homes with no cat present or previously present.

Relative humidity and temperature were measured with Tynytalk II Data Loggers (Gemini Data Loggers (UK) LTD) for a period of 7 days starting at the day where dust samples had been taken. The data loggers were placed in the living room, roughly 2 m above floor level. Sampling season was categorized as Winter (October–March) and Summer (April–September), according to climate in Germany.

Data Analysis

The distribution of the Fel d 1 levels expressed as µg/g dust was not normal. Concentrations were natural log (ln) transformed to normalize the distribution. Mean concentrations were therefore expressed as geometric means (GM) with 95% confidence intervals (CI). Allergen levels below lower limit of detection (LOD) were estimated by one half of the LOD (7.5 ng/g Fel d 1). Correlations between sampling locations were analyzed by means of the Spearman rank order correlation coefficient. The Wilcoxon-test and the Kruskal-Wallis test were used to analyze the relationship between Fel d 1 levels and housing and occupant characteristics. Multiple linear regression analyses were performed including housing and occupant conditions which were found to have at least a marginal significant association ($p < 0.10$) with Fel d 1 levels in the nonparametric analyses. Associations between Fel d 1 levels and explanatory factors were presented as means ratios, that is, the ratio of the geometric mean in the respective category versus a reference category. Parameter estimates β are also presented in the table and R^2 as the proportion of the variance of the Fel d 1 concentrations explained by the variables in the regression model. Statistical significance was set at a conventional 5% level. All analyses were performed using the Statistical Analysis System (SAS 6.12, Cary, NC, USA).

Results

Fel d 1 Concentrations

Fel d 1 was present in 97.5% of the homes (395/405), ranging from 0.015 to 7.278 µg/g dust (GM 0.486 µg/g) from either mattresses or floors of living room and bed-

Table 1. Concentrations and distribution of Fel d 1 in different locations in 405 homes

	Fel d 1 level ($\mu\text{g/g}$) in			
	floor dust of living room (LR) N = 405	dust of bedroom (BR) 365	LR/BR (mean) 405	mattress 405
Geom. mean	0.571	0.465	0.641	0.420
Minimum	<0.015	<0.015	<0.015	<0.015
25-percentile	0.093	0.072	0.092	0.058
Median	0.244	0.214	0.232	0.166
75-percentile	1.676	1.518	1.842	1.537
Maximum	5273.90	7277.84	4083.549	3232.82

Table 2. Univariate analyses showing factors associated with geometric mean floor levels of Fel d 1 (95% CI) in 405 homes (with and without cat) and 337 homes without cat

Characteristics	Homes with and without cat			Homes without cat		
	<i>n</i>	Fel d 1 GM (μg/g)	<i>p</i>	<i>n</i>	Fel d 1 GM (μg/g)	<i>p</i>
Place of residence						
Erfurt	204	0.371 (0.251–0.548)	0.0001	178	0.153 (0.123–0.189)	0.0001
Hamburg	201	1.124 (0.738–1.711)		159	0.325 (0.244–0.434)	
Season						
Summer	206	0.862 (0.558–1.332)	0.0573	167	0.248 (0.188–0.327)	0.2108
Winter	199	0.475 (0.324–0.696)		170	0.192 (0.152–0.243)	
Housing characteristics						
Story of dwelling						
Ground floor	145	0.902 (0.546–1.489)	0.0158	115	0.237 (0.178–0.315)	0.0647
1st floor	77	0.918 (0.418–2.018)		64	0.281 (0.153–0.514)	
2nd/3th floor	111	0.478 (0.297–0.770)		97	0.214 (0.162–0.282)	
4th floor and higher	72	0.351 (0.187–0.659)		61	0.148 (0.105–0.209)	
Size of dwelling						
≤70 m²	186	0.447 (0.298–0.671)	0.0514	167	0.218 (0.166–0.286)	0.8990
>70 m²	219	0.875 (0.580–1.320)		170	0.218 (0.171–0.278)	
Occupant characteristics						
Homes without cat contact	314	0.185 (0.156–0.218)	0.0001	314	0.185 (0.156–0.218)	0.0001
Cat in home during last year	22	2.422 (0.860–6.823)		22	2.422 (0.860–6.823)	
cat present at home	68	136.48 (82.34–226.218)				
Smoking in the home						
No smoking	226	0.482 (0.337–0.688)	0.0240	194	0.201 (0.160–0.252)	0.1201
Smoking	173	0.962 (0.592–1.564)		138	0.254 (0.187–0.344)	
Vacuuming floor						
Daily	34	0.366 (0.136–0.987)	0.2286	28	0.158 (0.080–0.313)	0.0552
More often a week	173	0.784 (0.481–1.276)		139	0.205 (0.152–0.277)	
Once a week	162	0.523 (0.344–0.796)		138	0.204 (0.159–0.262)	
Scarce	31	0.989 (0.394–2.480)		28	0.530 (0.271–1.039)	
Dusting (wet or dry)						
More often a week	121	0.351 (0.203–0.607)	0.0004	102	0.113 (0.088–0.146)	0.0001
Once a week	197	0.734 (0.490–1.101)		163	0.251 (0.195–0.323)	
Once a month	66	0.990 (0.485–2.021)		56	0.412 (0.238–0.713)	
Seldom	20	1.601 (0.395–6.491)		15	0.362 (0.146–0.898)	
Ventilation of living room						
Often	138	0.527 (0.316–0.881)	0.1328	117	0.195 (0.141–0.269)	0.4389
Average	147	0.537 (0.345–0.836)		125	0.213 (0.160–0.283)	
Seldom	120	1.007 (0.571–1.778)		95	0.259 (0.184–0.366)	

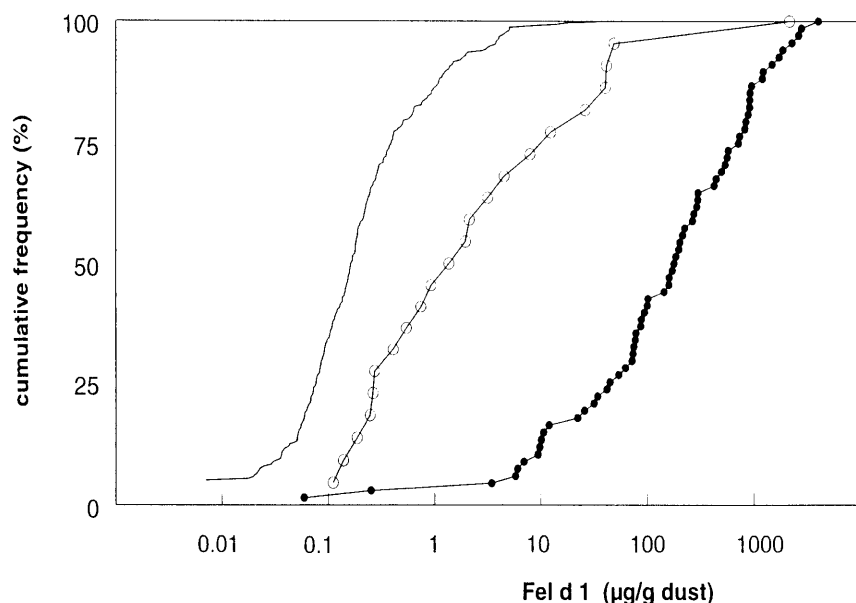


Figure 1. Cumulative frequency of Fel d 1 levels in dust from floors of living room and bedroom in homes with and without cats. — homes that never had a cat, —○— homes that previously had a cat, —●— homes with keeping cat.

room, respectively. The geometric mean, minimum, maximum, median and the 25th and 75th percentile of Fel d 1 levels for the three sampling locations are summarized in Table 1. Fel d 1 levels were higher in floor dust (GM for LR 0.575 µg/g and BR 0.469 µg/g) than in mattress dust (GM 0.424 µg/g), but the differences were not statistically significant. Statistically significant correlations were found for Fel d 1 in the different sampling locations, ranging from 0.786 to 0.807. Since Fel d 1 levels were highly correlated between the living room and bedroom, Fel d 1 concentration for floor dust was calculated as an average of these two locations and used in all further analyses.

Keeping a Cat and Fel d 1 Concentrations

In order to evaluate the influence of cats on the levels of Fel d 1, dust from homes where a cat was kept ($n = 68$) or had been kept during the last year ($n = 22$) and homes without direct exposure to cats ($n = 314$) were compared (Figure 1). The concentrations of Fel d 1 in the houses with cat were as much as 738 and in homes where cats had been kept in the past 12 months about 13-fold higher than those found in homes without a cat. Furthermore, we found significantly higher Fel d 1 levels ($p = 0.0004$) in the floor dust samples (GM 0.183 µg/g; CI: 0.155–0.217) than in mattress samples (GM 0.122 µg/g; CI: 0.100–0.149), but only in the homes of non-cat owners.

Levels of Fel d 1 exceeding the proposed threshold level for cat sensitization (2 µg/g) [11] were found in 28.9% of the floors or mattresses. High allergen concentrations (> 2 µg/g) were detected in 98.5% of the homes keeping cats, in 54.5% of homes that had had cat during last year and even in 27.5% of the homes without cat.

Associations Between Fel d 1 Concentration and Housing/Occupant Characteristics

The results of the univariate analysis of the associations between Fel d 1 levels in floor dust and several housing and occupant characteristics are shown in Table 2. Fel d 1 levels were associated in any case by place of residence, season, story, and size of the dwelling, as well as individual occupant characteristics, e. g., cleaning habits and smoking.

To identify factors that are of importance for the allergen levels independent of cat keeping, we tested separately several environmental factors in homes without keeping cat. We found similar associations between cat allergen and the other characteristics also in homes without keeping a cat, but significant differences could be observed just for cat in the homes during last year, the place of residence and the cleaning procedures. The allergen levels tended to be lower in dust with increasing floor level and in well-ventilated homes. No seasonal variation was observed in the homes of non-cat owners. Other categorical variables such as age of mattress or carpet, presence of carpeting, amounts of dust, and type of bedding were not significant associated with the allergen levels in our study (results not shown). Likewise, we did not find any relation between the concentration of Fel d 1 and the indoor climate as humidity and temperature of homes.

Table 3 presents the results of the multiple linear regression analysis for Fel d 1 concentrations in floor and mattress dust over the whole data set (homes with and without cat). The multiple regression analysis confirmed that the cat itself was the most important factor among all variables. The concentrations of Fel d 1 in the houses with cat remained about 682-fold higher than those found in homes without a cat, when adjusted for the parameters

Table 3. Multiple association of different housing characteristics and the Fel d 1 levels in homes with and without cat (floor: $n = 403$; $R^2 = 0.71$; mattress: $n = 398$, $R^2 = 0.65$) and in homes without cat (floor: $n = 335$, $R^2 = 0.22$; mattress: $n = 331$, $R^2 = 0.19$). Based on ln-transformed data

Respective vs. reference group	Homes with and without cat Fel d 1 levels in floor dust				Homes without cat Fel d 1 levels in floor dust			
	n	β	MR (95% CI)	p	n	β	MR (95% CI)	p
Place of residence								
Erfurt	202		1		176		1	
Hamburg	201	0.24	1.27 (0.89; 1.82)	0.1841	159	0.36	1.44 (0.99; 2.09)	0.0559
Season								
Summer	205		1		166		1	
Winter	198	-0.46	0.63 (0.44; 0.91)	0.0139	169	-0.40	0.67 (0.46; 0.98)	0.0384
Housing characteristics								
<i>Story of dwelling</i>								
Ground floor	146		1		116		1	
1st floor	77	0.20	1.22 (0.77; 1.91)	0.3993	63	0.07	1.07 (0.67; 1.71)	0.7691
2nd/3th floor	109	-0.12	0.88 (0.58; 1.34)	0.5578	96	-0.05	0.95 (0.62; 1.45)	0.8119
≥4th floor	71	-0.41	0.66 (0.41; 1.08)	0.0971	60	-0.17	0.84 (0.51; 1.40)	0.5079
<i>Size of dwelling</i>								
>70 m ²	219		1		170		1	
≤70 m ²	184	0.32	1.37 (0.98; 1.93)	0.0666	165	0.23	1.26 (0.90; 1.77)	0.1858
Occupant characteristics								
Homes w/o cat contact	313		1		313		1	
Cat in home during last year	22	2.41	11.18 (5.43; 23.04)	<0.0001	22	2.46	11.69 (5.95; 22.99)	<0.0001
Cat present at home	68	6.52	681.79 (439; 1058)	<0.0001				
<i>Vacuuming floor</i>								
Daily	34		1		28		1	
More often a week	172	0.44	1.55 (0.84; 2.85)	0.1598	138	0.02	1.02 (0.54; 1.92)	0.9537
Once a week	162	0.11	1.11 (0.58; 2.12)	0.7456	138	-0.32	0.73 (0.37; 1.41)	0.3448
Seldom	35	0.56	1.94 (0.83; 4.52)	0.1243	31	0.04	1.04 (0.44; 2.46)	0.9256
<i>Dusting (wet or dry)</i>								
More often a week	121		1		102		1	
Once a week	196	0.55	1.92 (1.28; 2.87)	0.0017	162	0.89	2.45 (1.62; 3.70)	<0.0001
Once a month	66	0.75	2.13 (1.22; 3.71)	0.0083	56	1.05	2.86 (1.61; 5.08)	0.0004
Seldom	20	0.56	1.93 (0.86; 4.34)	0.1119	15	1.01	2.75 (1.15; 6.58)	0.0237
<i>Ventilation of living room</i>								
Often	138		1		117		1	
Average	146	0.37	1.45 (0.96; 2.21)	0.0798	124	0.44	1.55 (1.02; 2.36)	0.0419
Seldom	119	0.48	1.62 (1.04; 2.53)	0.0342	94	0.44	1.55 (0.98; 2.44)	0.0613

Table 3 (continued).

Respective vs. reference group	Homes with and without cat				Homes without cat			
	<i>n</i>	β	Fel d 1 levels in mattress dust MR (95% CI)	<i>p</i>	<i>n</i>	β	Fel d 1 levels in mattress dust MR (95% CI)	<i>p</i>
Place of residence								
Erfurt	200		1		174		1	
Hamburg	198	0.47	1.61 (1.06; 2.44)	0.0268	157	0.69	1.99 (1.27; 3.11)	0.0028
Occupant characteristics								
No cat	311		1		311		1	
Cat in home during last year	20	2.51	12.27 (5.20; 28.97)	<0.0001	20	2.5	12.20 (5.28; 28.20)	<0.0001
Cat present at home	67	6.44	628.53 (382; 1035)	<0.0001				
Dusting (wet or dry)								
More often a week	120		1		101		1	
Once a week	194	0.39	1.48 (0.96; 2.28)	0.0765	160	0.46	1.58 (1.00; 2.50)	0.0534
Once a month	64	0.90	2.47 (1.36; 4.49)	0.0033	55	0.96	2.62 (1.38; 4.98)	0.0035
Seldom	20	0.71	2.03 (0.83; 4.99)	0.1235	15	0.61	1.84 (0.68; 5.02)	0.2315

as shown in Table 3. Furthermore, more than ten-fold higher Fel d 1 levels were measured in homes that had removed the cat during the past 12 months compared to homes without a cat.

But the season, the frequency of housecleaning and ventilation remained significantly associated with the Fel d 1 level in floor dust. Fel d 1 levels of the dust sampled in winter were significantly lower (37%) than in summer. Frequent cleaning of the homes was associated with a decrease of Fel d 1 level of more than 50% ($p < 0.05$) and the allergen concentration tended to be lower with increasing ventilation rate.

The other factors, such as the story and size of the dwelling, had only a weak effect on allergen level. We saw a tendency of lower Fel d 1 levels in floor dust with increasing floor level and higher allergen levels in smaller dwellings ($\leq 70 \text{ m}^2$). The place of residence did not affect Fel d 1 levels in floor dust after adjustment in particular for keeping a cat. Similar results were obtained when only the homes of non-cat owners were included in the regression analysis. However, the adjusted R^2 of this model deteriorated to 22% compared to 71% with the whole data of homes with and without cat.

The final multiple regression model for the mattress included the same variables: place of residence, season, story and size of the dwelling, cat, ventilation, and mattress vacuuming. Beside the cat itself, place of residence and high frequency of cleaning were significantly associated with the Fel d 1 levels on mattresses. The other variables showed similar association to Fel d 1 levels as in

the floor model. Thus, the regression analysis explained 65% of the variance of Fel d 1 concentrations in the dust of mattresses.

Discussion

Cats are among the most common household pets in urban areas and are considered to be important sources of indoor allergen and significant causes of sensitization and allergic diseases. It has been previously reported that cat allergen can be found in virtually all homes, and although there are significant differences in allergen content in homes with and without cats, surprisingly high levels of Fel d 1 were found in many homes that were without a cat [12]. The levels of Fel d 1 in house dust presented in this paper confirm the findings of other studies [13, 14, review in 15]. In this study, the levels of cat allergen in dust of homes with cats have been about one or two orders of magnitude higher than in homes where the cats are not present. The mean daily production of Fel d 1 from cats is approximately $3\text{--}7 \mu\text{g}$ [16]; however, there is day-to-day and diurnal variability in Fel d 1 shedding from individual cats. Thus, the range of allergen levels is considerable. The range of Fel d 1 levels could be explained by gender, castration, washing routines or different breeds, too. Similar levels of allergen were in some cases found in homes that held or had held cats and in homes that had never had a cat. Therefore, it has been suggested that cat

allergen is transported into houses without cats on the clothes of inhabitants, or the cat owners who come to visit [6]. Recently, Almqvist et al. [17] have shown, that the cat allergen is transferred from cat owners' clothes to non-cat owners' clothes. The allergen levels found in dust from clothes indicated that cat allergen is carried e. g., to school in cat owners' clothes and is transferred there to the clothes of children without cats. In our study we found significantly higher Fel d 1 levels even in homes without cat in Hamburg (GM 0.325 µg/g) than in Erfurt (GM 0.153 µg/g). Since there are more cat owners' in Hamburg (21%) than in Erfurt (13%), this result could reflect the passive transport of allergen into houses without cats. Furthermore, there is an other indirect hint for the passive transport of Fel d 1 on the clothes by our results, too. We found significantly higher levels of cat allergen in dust of floor compared to mattress in non-cat owners homes. This is likely to be due to the fact that mattresses are not in the direct contact with clothes which can be contaminated with cat allergen. Higher Fel d 1 concentrations in floor dust than in mattress dust were also detected in other studies [13, 18, 19]. In contrast, we could not demonstrate a significant difference of Fel d 1 between sampling location in homes with cat. Hypothetically, this can be explained by the fact that it may be more difficult or impossible to eliminate the Fel d 1 from an indoor environment when the allergen source is within the building per se. Additionally, the adherent properties of Fel d 1 may be an important aspect of their contaminating capacity; thus, walls and other surfaces can also contribute to the reservoir of cat allergen [20]. Furthermore, previous studies have shown that Fel d 1 is a relatively stable molecule and is associated with a range of particle size including a proportion less than 2.5 µm in diameter. These smaller particles remain airborne even in undisturbed conditions and are readily transportable. Thus, the high correlation between sampling location could be explained by these findings.

Our results support the assumption that the major controlling factor for levels of cat allergen in residences is presence or absence of a cat [13]. Furthermore, our data demonstrate that the allergen elimination from an indoor environment is extremely difficult, even when the source of specific allergen was removed. Thus, we found significantly ten-fold higher Fel d 1 levels in homes in which cat had been removed at least one year earlier compared to non-cat owners. This is in accordance with the finding by Wood et al. [21], who showed that the Fel d 1 levels in carpets decreased slowly after cat removal.

In our study the number of cat-owners was higher in Hamburg ($n = 42$) than in Erfurt ($n = 26$), which mostly explains the regional differences in Fel d 1 levels. After controlling for keeping a cat in multiple analyses the differences in Fel d 1 concentrations nearly disappeared.

Since the cat allergen is actually a ubiquitous allergen, we studied other home or occupant characteristics to find out further confounders for the Fel d 1 exposure. We ob-

served significantly higher Fel d 1 levels in dust sampled in summer compared to winter. On the other hand, studies from the United States [22] and Sweden [13] found higher amounts of Fel d 1 in winter, and the authors ascribed the increase to cats spending more time inside during the colder months. Factors that might control seasonality of cat allergen levels remain obscure. We speculate that the higher Fel d 1 concentrations in summer are associated with fur shedding cycles of cats. Furthermore, season is a surrogate measure for a combination of other important factors (e. g., humidity, ventilation, airborne particles). Previous studies have shown that indoor Fel d 1 levels are influenced by ventilation of the homes [23], but not by the humidity of the area [24], although damp homes have been reported to have higher cat allergen levels [25].

Although the relationships between dust and air concentration of Fel d 1 are argued controversially [23, 26], high allergen levels in dust in summer could also be explained by the finding that amounts of airborne particles are significantly higher in homes with high RH (e. g., $\geq 45\%$) [25]. Furthermore, indoor levels of particulate matter are often higher in homes with smokers as in homes without smokers, too [27]. This fact could also explain why Fel d 1 levels were higher in homes with smokers in our study. Munir et al. [25] observed a significant correlation between the concentration of Fel d 1 allergens in dust and the number of small airborne dust particles. Airborne particles or airborne allergen levels were not measured in this study. Although our data are based on measurement in settled dust, our findings suggest that poor ventilation contributes to accumulation of cat allergen indoors. Moreover, other factors, e. g., regular use of vacuum cleaners or other cleaning procedures, reduced allergen levels. Studies by Custovic et al. [28] showed also that regular vacuum cleaning in hospitals is effective in substantially reducing cat allergen.

Our results indicate that it is necessary, in addition to house dust mite allergens, to determine also Fel d 1 concentrations in studies on allergen exposure and health effects since the cat allergen is ubiquitous in German homes, too. So far it is not known what level of cat allergen causes sensitization. Two cat allergen levels of 2 and 8 µg/g of house dust have been suggested as the threshold values for sensitization [29, 30]. However, a much lower incidence of sensitization to cat has been reported among Swedish children exposed to < 1 µg/g Fel d 1 in their homes [31]. Similarly, in the German Multicenter Atopy Study [32], cumulative rates of sensitization to Fel d 1 among children with a family history of atopy were 5% to 6% in the first 3 years of life if Fel d 1 exposure exceeded 0.2 µg/g dust.

Our final multiple regression model confirms that the cat was the most important factor affecting cat allergen levels in the house dust. Additionally, season, and cleaning procedures were significantly associated with allergen levels. In conclusion, the measurement of Fel d 1 is needed mainly in homes without keeping a cat to assess hidden

exposure to cat allergens and avoidance measures. Furthermore our results show, when compared with Erfurt, a significantly higher percentage of individuals in Hamburg were exposed to cat allergen at the time of the INGA study (1995/96). This could be the reason for the higher sensitivity to cat in Hamburg than in Erfurt as found in the European Community Respiratory Health study (ECRHS) in the years 1990–1992 [7]. Additional studies are prepared to examine whether the higher concentration of Fel d 1 in homes from Hamburg could contribute to the higher prevalence of atopy.

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