
Influence of cat characteristics on Fel d 1 levels in the home

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Background: Previous studies investigating cat characteristics and cat allergen production focused on clinical experiments that quantified allergen from either the shaved skin or the fur of the animal; however, these studies did not address these experimental relationships in the home.

Objective: To determine the relationships between cat characteristics and cat allergen isolated from household dust.

Methods: Fel d 1 allergen levels in dust from homes participating in a population-based study of environmental effect on allergy development were analyzed using a standard monoclonal antibody-based assay. Cat characteristics were based on interviews conducted during home visits by study personnel.

Results: Households with any cats had higher geometric mean Fel d 1 levels than households without cats (32.88 vs 0.43; $P < .01$), and cat allergen levels increased with increasing numbers of cats in the home ($P < .01$). Length of cat hair, cat sex, reproductive status, and time spent indoors were analyzed; the only characteristic associated with higher levels of Fel d 1 was whether the cat had been neutered or spayed.

Conclusions: Having cats in the home is significantly associated with increased Fel d 1 levels, and having more cats in the home is correlated with more cat allergen. Cat reproductive characteristics may be associated with measurable differences in cat allergen levels.

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INTRODUCTION

Previous studies investigating cat characteristics and cat allergen, Fel d 1, production have focused on clinical experiments in which a few cats had areas of their bodies shaved and allergen production evaluated. In these studies, the allergen was quantified from either the shaved skin¹ or the fur of the animal²; however, these studies did not address these relationships in a setting outside the laboratory. Other studies collected Fel d 1 samples from homes but had limitations such as investigating few cat characteristics using only altered (neutered or spayed) animals³ or investigating household rather than cat characteristics.⁴ The aim of this analysis was to determine the relationships between cat characteristics and cat allergen isolated from household dust as part of a large population-based study.

METHODS

The Wayne County Health, Environment, Allergy, and Asthma Longitudinal Study is an ongoing cohort study in the Detroit area designed to examine the relationships between early life exposures such as pets and endotoxin and allergic diseases in early childhood. Briefly, pregnant

women are recruited during a prenatal visit to a Henry Ford Health System Clinic. Interviews are conducted at recruitment and at home visits at 1, 6, and 12 months post partum.

Dust samples are collected at the 1-month postpartum visit, and dust from the floor of the infant's bedroom is evaluated for cat allergen. Dust is obtained by affixing a 140-thread count unbleached muslin collection sock specially designed to fit the nozzle of a vacuum and with this nozzle vacuuming 1 m² of the floor along the side of the infant's bed for 2 minutes. The volume of dust collected varied, depending on household characteristics and hygiene practices. The collection sock containing the dust sample is placed in a sterile plastic bag, frozen to -80°C , and shipped frozen to our collaborating laboratory at the Medical College of Georgia for analyses of the dust. Dust is emptied from the collection sock into a funnel fitted with a mesh filter (pore size, 292 nm) (Spectrum Inc, Laguna Hills, California). The funnel is placed in a 10 × 75-mm sample tube that is inserted into a rack on an orbital shaker. After shaking for 1 hour, the fine dust has fallen into the assay tube and the coarse debris remains in the funnel. The filtered dust is then weighed and extracted before being analyzed for Fel d 1. The dust sample is assayed using standard monoclonal antibody assays (Indoor Biotechnologies Ltd, Charlottesville, Virginia), with a lowest detectable limit of 0.10, and units for allergen dust measurements are micrograms of allergen per gram of fine dust. The assay standards have been standardized by Martin Chapman, PhD, at the University of Virginia. This research was approved by the Henry Ford Health System institutional review board.

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Cat characteristics were based on maternal report during a home visit personal interview. Women were asked how many cats were living in the home, and for each cat the following data were collected: breed (if known), hair length (long or short), sex, altered status, weight, and time indoors. Sex was determined by asking if the cat was a male or female, and then altered status was clarified by asking whether the cat was neutered or spayed. Although it would have been ideal to have study field staff trained to confirm the sex and reproductive status of the cat and cat hair length, it was beyond the scope of this investigation to perform these data collection measures.

We calculated geometric means with SDs because Fel d 1 was not normally distributed. Wilcoxon rank sum statistics were calculated for all 2-group comparisons, and Jonckheere-Terpstra tests for trend were used for 3-group ordinal comparisons. Effect modification was evaluated using stratified analyses, and confounding was evaluated using a change in effect criteria of greater than 10% comparing the linear regression models of log-transformed Fel d 1.

RESULTS

Table 1 provides Fel d 1 measurements by household cat ownership. Households with any cats in the home had higher Fel d 1 levels than households without cats, and cat allergen levels increased with increasing numbers of cats in the home (Spearman correlation $r = 0.26$; $P < .01$). Households with 1 cat ($n = 59$) were then analyzed for differences in cat allergen levels by cat characteristics: length of hair, sex, reproductive status, and time spent indoors (Table 1). Of the 1-cat household comparisons, there was only 1 characteristic that was associated with higher levels of Fel d 1: whether the cat had been neutered or spayed. Overall, the geometric mean for sterilized cats vs unaltered cats was 33.45 vs 5.16 $\mu\text{g/g}$. This difference was more striking for male cats (42.51 vs 3.53 $\mu\text{g/g}$) than for female cats (23.66 vs 9.12 $\mu\text{g/g}$). Length of cat hair, cat sex, and time the cat was indoors daily were all not found to be associated with Fel d 1 levels in the home.

We also investigated whether bigger or older cats would be associated with higher Fel d 1 levels, predicting that bigger

Table 1. Fel d 1 Levels by Household Cat Ownership,^a WHEALS Cohort, Detroit

	Households, No.	Fel d 1, $\mu\text{g/g}$			P value
		GM	GSD	Range	
Any cats in home					<.01 ^b
No	577	0.43	5.60	0.05–878.00	
Yes	104	32.88	13.12	0.05–2314.79	
No. of cats in home ^c					<.01 ^d
0	577	0.43	5.60	0.05–878.00	
1	59	20.80	11.63	0.06–2314.79	
≥ 2	44	68.91	12.05	0.05–2262.85	
In 1-cat homes					
Length of cat hair ^c					.51 ^b
Short	29	17.02	13.58	0.06–2314.79	
Long	11	22.39	8.31	0.25–973.18	
Sex of cat					.76 ^b
M	35	22.42	13.47	0.06–2314.79	
F	24	18.64	9.69	0.30–1275.84	
All cats					.02 ^b
Unaltered	15	5.16	10.36	0.06–151.68	
Altered	44	33.45	10.28	0.30–2314.79	
Male cats					.03 ^b
Unaltered	9	3.53	13.49	0.06–98.86	
Neutered	26	42.51	10.16	0.52–2314.79	
Female cats					.42 ^b
Unaltered	6	9.12	7.06	0.85–151.68	
Spayed	18	23.66	10.70	0.30–1275.84	
Time cat indoors (daily)					.70 ^b
0–12 h	9	16.05	7.44	0.80–602.12	
13–24 h	50	21.79	12.68	0.06–2314.79	

Abbreviations: GM, geometric mean; GSD, geometric standard deviation; WHEALS, Wayne County Health, Environment, Allergy, and Asthma Longitudinal Study.

^a Reported by the mother.

^b Wilcoxon rank sum test.

^c Missing data.

^d Jonckheere-Terpstra test for trend.

Table 2. Fel d 1 Levels by Residential Characteristics, WHEALS Cohort, Detroit

	No cats in the home					Any cats in the home				
	Households, No.	Fel d 1, μ g/g			<i>P</i> value ^a	Households, No.	Fel d 1, μ g/g			<i>P</i> value ^a
		GM	GSD	Range			GM	GSD	Range	
Flooring type					<.01					.02
Bare	123	0.30	6.38	0.05–878.00		31	13.33	11.69	0.06–602.12	
Carpeted	419	0.46	5.34	0.05–578.06		63	48.49	13.72	0.05–2314.79	
Environment					<.01					.08
Urban	325	0.31	4.91	0.05–878.00		31	16.99	11.67	0.06–471.51	
Suburban	252	0.65	6.05	0.05–578.06		73	43.52	13.30	0.05–2314.79	

Abbreviations: GM, geometric mean; GSD, geometric standard deviation; WHEALS, Wayne County Health, Environment, Allergy, and Asthma Longitudinal Study.

^a Wilcoxon rank sum test.

cats would deposit greater amounts of Fel d 1 on the floor than smaller cats and that the longer a cat was in the home, the more Fel d 1 would collect across time. Neither characteristic was found to be associated with cat allergen levels (Spearman correlation $r = 0.08$, $P = .55$; and $r = 0.10$, $P = .45$; respectively).

Table 2 provides Fel d 1 levels by residential characteristics. When comparing homes with carpeted floors vs those with bare floors stratifying for household cat status, we found that homes with carpeted floors had higher Fel d 1 levels than homes with bare floors, and these differences were statistically significant. For homes without cats, cat allergen levels between homes in the city of Detroit and not in the city were significantly different, with suburban areas having significantly higher levels of Fel d 1 than urban areas. In homes with cats, the same trend was evident but only approached statistical significance. We did not have a sufficient sample size to precisely determine whether floor surface or urban location modified the associations between cat characteristics and Fel d 1 levels; however, these data indicated that these factors were not likely effect modifiers. Neither factor confounded the observed associations between cat characteristics and Fel d 1 levels.

DISCUSSION

This investigation into cat characteristics and their association with Fel d 1 levels found that consistent with published literature,⁵ having cats in the home is significantly associated with increased Fel d 1 levels and that having more cats in the home is correlated with more cat allergen. However, we did not locate any publications that showed tests for trend with an increasing number of cats in the home.

We also found that cat reproductive characteristics may be associated with measurable differences in cat allergen levels. The Fel d 1 levels by cat characteristic that we report may vary from others in the literature^{1,2} because of factors such as the age of the cat, pet cleaning and hygiene, and the season the sample was taken; however, these

characteristics are not likely to be associated with the reproductive status of the cats; thus, they would not explain the observed differences. Using floor type categorizations from the published literature,^{5,6} we found that homes with carpeted floors had more Fel d 1 than those with bare floors in households with and without cats. We also found that living in the suburbs was associated with higher Fel d 1 levels than living in the city of Detroit.

Some limitations of the analysis include having small groups for more specific cat characteristic analyses, having an allergen sample from only 1 site in the home at a single point in time, and a lack of information regarding pet ownership of any previous occupants. In contrast to other publications that were experimental in design, we have a larger sample size and allergen measurements taken from actual residences. This may explain the difference in results between this work and that of those whose results were based on collecting samples directly from the cats.²

Similar to other publications, we found that Fel d 1 levels were statistically significant only in male cats; however, these findings were opposite the experimental studies that showed that neutered male cats had lower Fel d 1 levels than their intact counterparts.² The present study and experimental studies showed that Fel d 1 levels did not differ significantly between spayed and intact female cats. Although these data show that homes with unaltered cats have lower levels of cat allergen than homes with altered animals, we are not endorsing that pet owners not have their cats neutered or spayed in efforts to minimize cat allergen levels in the home. In fact, these data show that with additional cats in the home, which may happen if cats are not altered, allergen levels significantly increase. Further research into cat characteristics and Fel d 1 levels in the home may solidify the role of spaying or neutering cats in cat allergen production.

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