

# Cat and dog allergen in mattresses and textile-covered floors of homes which do or do not have pets, either in the past or currently

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The aim of this study was to measure the levels of cat and dog allergen in homes of families that had either never kept pets or kept or had kept cats or dogs. From a small residential area outside Stockholm consisting of 250 houses with similar exteriors 70 homes were included. Dust samples were collected from mattresses and textile-covered floors. The levels of cat and dog allergen were analysed by ELISA. Fel d1 was found in mattress dust in all 70 homes, median 0.5 µg/g [0.24–8.89 µg/g (quartiles)] and textile-covered floors 0.7 µg/g (0.20–2.52 µg/g). Can f1, was found in 98% of the collected samples, mattress dust 1.89 µg/g (0.70–9.20 µg/g) and textile-covered floor dust 2.5 µg/g (1.04–2.72 µg/g). There was a positive correlation ( $p < 0.001$ ) between allergen levels in dust from mattresses and textile-covered floors for both Fel d1 ( $r = 0.68$ ) and Can f1 ( $r = 0.78$ ). The highest levels of cat and dog allergen were found in homes with furred pets ( $p < 0.001$ ). A significant ( $p < 0.001$ ) difference was seen in the levels of Fel d1 and Can f1 between the homes of former pet-owners and homes without pets. In summary; cat and dog allergens are present in homes regardless of whether such animals live in the house or not. Mattresses seem to be an underestimated reservoir for pet allergens even in homes without pets. It is important to note that the homes of former pet owners have much lower levels of allergen than current pet owners.

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Allergic diseases have increased in the Western world over the last few decades, especially among children and youths (1, 2). In Sweden 50–70% of children with asthma exhibit a specific allergy to furred pets (3). Furthermore, sensitisation to furred animals is now as common as sensitisation to tree and grass pollen, and is found more frequently in the cities than in the countryside (4). In southern Sweden 23% of children own cats or dogs and in northern Sweden the corresponding figure is 34% (5). According to the European Community Respiratory Health Survey, data has shown that 34% of Swedish households keep furred pets and 57% of households had kept pets in the past (6). In Europe the keeping of pets is believed to have increased two-fold in the last 20 years (7).

Since the keeping of pets has become more common, it is very likely that direct as well as indirect

exposure to pet allergen has increased in society (8). Several studies have shown that direct exposure to pets is a risk factor for becoming sensitised to pets, and for developing allergic symptoms (9, 10). Besides, if a sensitised person is exposed to low or moderate levels of allergen, i.e. by indirect exposure to pet allergen, the inflammation of the mucous membranes in the airways may be maintained (11).

The aim of this study was to investigate the presence of cat and dog allergen in homes with and without cats or dogs, and to determine the levels of pet allergen in homes of former pet owners in relation to the time since the pet was removed.

## Materials and methods

The study was performed in 1991 in a small area consisting of 250 houses in a suburb of Stockholm.

All the houses were built at the end of the 1960s by the same building company. They were all terraced, had one storey and were intended for a single family.

A questionnaire was sent to all households and was answered by 123 (49%). Eighty-four (68%) volunteered to participate in an extended investigation of the indoor environment. However, certain criteria had to be fulfilled to be included in the study: the families should have lived in their houses for at least one year, and should consist of at least two people. No major renovation or restoration, except for improvement in ventilation, should have been done since the house was built, and no reorganisation should have been done due to allergic disease. In every household, at least one mattress should have been used regularly for at least one year. In total, 70 of the 84 homes fulfilled these criteria.

Twenty-four of the houses were equipped with mechanical exhaust and supply ventilation, thirty-six had natural ventilation only and the remaining ten had improved their natural ventilation with exhaust-air fans in kitchen and/or bathroom. During a period of two weeks the 70 homes were inspected by at least two of the authors. The families had been asked not to change the bedding for two weeks preceding the visit, and to abstain from vacuum cleaning their mattresses and the textile-covered floor under the sofa table in the living room. A questionnaire on family size, standards of living and cleaning routines, type of ventilation system, types of mattresses and possession of furred pets in the family or among friends and neighbours was answered by one family member. Based on the questionnaires the homes were divided into four groups:

- Group 1. Homes in which a cat or dog was kept at present.
- Group 2. Homes in which cat or dog had been removed at least one year earlier.
- Group 3. Homes with no present or previous pets, but where the family had friends or neighbours who kept cat or dog.
- Group 4. Homes with no former or present pet contact.

Two homes were visited by dogs at least once a week, and were thus included in group 1. One family had been minding dogs daily three years before the study was carried out, and their home was therefore included in group 2.

Dust was collected from mattresses and textile-covered floors using a standard vacuum cleaner (Volta lite U 1840, Volta, Stockholm). A suction mouthpiece and a filter was connected to the vacuum cleaner tip (12). Only one dust collector with filter was used per household. After use the filter holders were carefully washed before they were re-used. The dust sampling was standardised by time. All the

vacuumed mattresses were of a standard size of approximately 2m<sup>2</sup>, and a similar area, 2m<sup>2</sup>, of the textile-covered floors in the living rooms were vacuumed. The textile-covered floor could be either a rug or a wall-to-wall carpet. Dust was collected from mattresses in bedrooms for 2 minutes and from textile-covered floors for 2 minutes. In 19 of the 70 homes dust was collected from both a bed (spring mattress) and a polyester mattress for 2 minutes each.

All dust samples were sent to Allergologisk Laboratorium (ALK), Hørsholm, Denmark. The dust was weighed, sieved and extracted in phosphate buffered saline pH 7.4 overnight at 4°C under constant rotation. After centrifugation the extracts were stored at -20°C until analysed. The concentration of major cat and dog allergens was determined by sandwich ELISA, according to the methods of Chapman et al. (13) for Fel d1 and Schou et al. for Can f1 (14). The detection limit for Fel d1 assay was set to 0.001 µg per sample and for Can f1 0.006 µg per sample. The allergen levels were expressed in µg per gram of dust.

The concentrations of Fel d1 and Can f1 were given as median values and quartiles. Nonparametric test (Wilcoxon rank sum test) was used for comparative analyses as normal distribution was not expected, and Spearman-Rank for correlation. Two-sided tests were used and  $p < 0.05$  was considered significant.

## Results

Twenty-five percent of the households possessed furred pets; 14% had cats and 11% had dogs. Cat allergen was found in all the homes ( $n=70$ ) with almost equal levels in dust from mattresses and textile-covered floors. The median level of cat allergen, Fel d1, in dust from mattresses was median 0.5 µg/g [0.24–8.89 µg/g (quartiles)] and in dust from textile-covered floors 0.7 µg/g (0.20–2.52 µg/g). A positive correlation was found for the level of Fel d1 in dust from mattresses and textile-covered floors ( $r=0.68$ ,  $p < 0.001$ ) (Fig. 1). The dog allergen, Can f1, was found in dust from mattresses in 68/70 households, 1.89 µg/g (0.70–9.20 µg/g) and in dust from textile-covered floors in 69/70 households, 2.5 µg/g (1.04–2.72 µg/g). There was also a positive correlation of Can f1 between the level of this allergen in dust from mattresses and textile-covered floors ( $r=0.78$ ,  $p < 0.001$ ) (Fig. 1).

Levels of Fel d1 and Can f1 in dust from mattresses and textile-covered floors was significantly higher in homes that contained cats or dogs (group 1,  $n=31$ ) compared to homes that previously contained cats or dogs (group 2,  $n=24$ ), than in homes with less pet contact (group 3,  $n=37$ ) and no pet contact at all

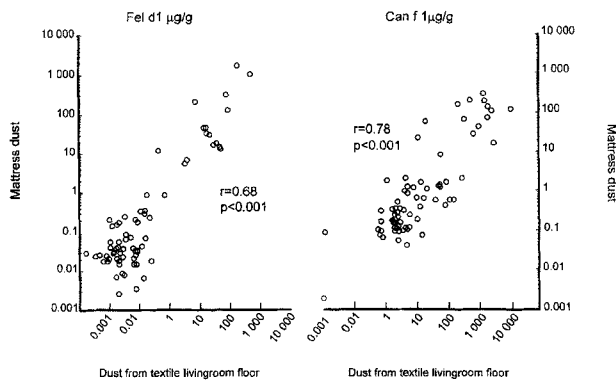


Fig. 1. Cat (Fel d1) and dog (Can f1) allergen levels in dust – correlation between mattresses and textile-covered floors.

(group 4,  $n=38$ ;  $p<0.001$ ). This was also true when several years had passed since the pet was removed. (Figs. 2 and 3). When comparing the two groups that had never had pets at home, i.e. groups 3 and 4, no significant differences were found in the levels of cat and dog allergen. An overlap in allergen levels between the four groups was noted.

In homes from where the cat or the dog had been removed more than 5–10 years earlier (group 2), higher levels of Fel d1 were found in dust from mattresses and textile-covered floors than the upper 95% level for Fel d1 in the group that had never had cats at home (Fig. 4). Interestingly, the levels of Can f1 in dust from mattresses was below the corresponding upper 95% level for Can f1 in all homes two years after removal of the dog (Fig. 5).

In the 19 homes from which dust from both spring bed mattresses and polyester mattresses were

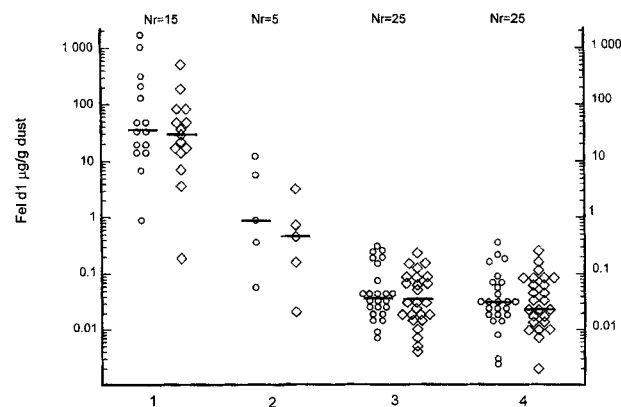


Fig. 2. Cat allergen (Fel d1) in dust from mattresses and textile-covered floors. 1) Homes with cat. 2) Homes which have previously kept a cat. 3) Homes without cat, but that have contact with cat through friends or neighbours. 4) Homes that have never had contact with cat. ○ = Mattress dust, ◇ = Textile-covered floor dust, — = Median.

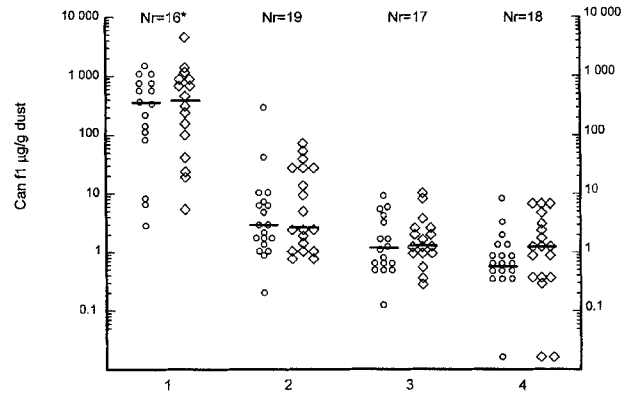


Fig. 3. Dog allergen (Can f1) in dust from mattresses and textile-covered floors. 1) Homes with dog. 2.) Homes which have previously kept a dog. 3) Homes without dog, but that have contact with dog through friends or neighbours. 4) Homes that have never had contact with dog. ○ = Mattress dust, ◇ = Textile-covered floor Dust, — = Median. \* Footnote: includes Two homes With "Dog day- care".

collected, no significant difference in allergen levels was found between mattress types (data not shown). In homes with cat and dog (group 1) one family had more than one cat and two families kept more than one dog. The levels of cat and dog allergen did not change when adjusted for the number of cats or dogs in the house. Neither did adjustment for cleaning routines or type of ventilation affect differences in allergen levels between the groups (data not shown).

## Discussion

This study showed that the levels of Fel d1 and Can f1 differed considerably depending on whether furred pets were kept or not. Thus, the highest aller-

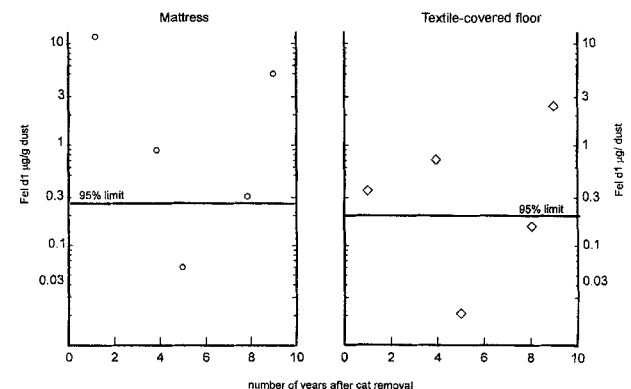


Fig. 4. Cat (Fel d1) in dust from mattresses and textile-covered floors in homes which have previously kept cat. ○ = Mattress dust, ◇ = Textile-covered floor dust.

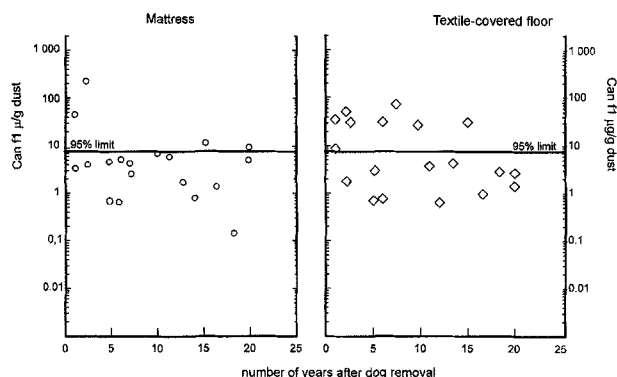


Fig. 5. Dog (Can f1) in dust from mattresses and textile-covered floors in homes which have previously kept a dog. ○ = Mattress dust, ◇ = Textile-covered floor dust.

gen levels were found in homes that had cats or dogs (group 1). However, the range of allergen levels was considerable and there was, furthermore, a variation in allergen levels within the study groups. Besides, there was an overlap in the levels of allergen Fel d1 and Can f1 between groups; similar levels of allergen were in some cases found in homes that held or had held cats or dogs and in homes without pets. Our results are in agreement with those in previous studies (15,16,17). A follow-up telephone enquiry ruled out the possibility of incorrect classification of the groups. Castrated male cats are supposed to produce and emit less allergen than non-castrated male or female cats (18). Washing the cat has been shown to reduce allergen emission (19). Hypothetically, the production and emission of allergen may differ between animal breeds. Thus, the range of allergen levels within the groups could be explained by gender, castration, washing routines and different breeds. In contrast the number of pets in the house did not seem to affect the allergen levels.

Within all groups (1–4) the levels of Fel d1 and Can f1 were rather similar in mattress dust and dust from textile-covered floors. However, a tendency toward higher levels of cat allergens in mattress dust, than in dust from textile-covered floors was seen (groups 2, 3 and 4). This tendency could possibly be explained by the increased intimacy of cats and is in line with the observations of Murray et al., who showed that cats spend more time in bedrooms than dogs (20).

Mattresses from the homes that kept or had kept a cat or dog (groups 1 and 2) contained considerable amounts of Fel d1 and Can f1 allergens. If we take into account that people spend a lot of time in bed, mattresses should be considered as important reservoirs for allergens and as sources of pet allergen. Our results differ from other studies, which show that dust from textile-covered floors contain higher

levels of Fel d1 and Can f1 than dust from mattresses (15, 16, 21). This difference may be explained by the fact that the families in our study were mostly non-allergic persons and lived in a selected area, with a homogeneous social structure and standard of living. Other similar studies have been based on homes of allergic patients. Allergen levels in dust from mattresses have been studied, but the focus has been on mites (22,23). Interestingly, allergen from pollen has also been found in mattresses (24). Thus, it is important to realise that after removal of a furred pet due to allergy in the family, mattresses may still be reservoirs for allergens.

Spring mattresses have been thought to collect dust and therefore to be unsuitable for allergic people. This would be especially true for people with mite allergy since mites seem to thrive in dust. However, levels of mite allergen in dust from beds with spring mattresses have not been shown to be higher than the levels from polyester mattresses (25). Wherever examined, cat and dog allergen levels in dust from a polyester mattress and a spring mattress from the same home were similar.

The levels of cat allergen found in dust from mattresses and textile-covered floors remained high 5–10 years after the cat had been removed. However, these data have to be interpreted with caution since only five homes, that had possessed cats earlier, were included in the study. In homes where the dog had been removed, the dog allergen seemed to disappear more rapidly in dust from mattresses than textile-covered floors. There is no obvious explanation for this difference between cat and dog allergen, but it has been suggested that such allergens may have different adherence properties, and that cat allergen seems more sticky (personal communication Martin Chapman and Euan Tovey). The allergens from these homes that previously had kept a cat or dog are not likely to originate from the former pets. A continuous influx of pet allergen in families without animals, as a result of direct or indirect pet contact outside the home, where no pet avoiding and no environmental control measures had been taken, is likely. This is in accordance with the finding by Wood et al. (21), who showed that the Fel d1 levels in carpets decreased slowly after cat removal, except in two homes in which aggressive environmental control measures had been taken. Such exceptions may have been avoided in our study by our inclusion criteria, i.e. that no further measures had been taken to avoid allergen after the removal of the pet.

Whether pet allergen in reservoir dust reflects the representative allergen load for atopic persons in comparison to airborne samples can be discussed. However, in a study of day care centres in Sweden ( $n=34$ ) we were able to demonstrate a correlation

between airborne Fel d1 compared to Fel d1 in settled dust (26). The dust was collected with personal low volume air samplers and stationary low volume air samplers with the use of an amplified ELISA. This has not been demonstrated by others (27).

If a pet is removed in order to reduce the allergen levels because of allergy in the family, extensive cleaning of the house is therefore recommended. Since beds, bedding equipment and textile-covered floors are important reservoirs for airborne allergens, washable materials may be preferable. When cleaning after pet removal, mattresses and other bedding equipment should be regarded as contaminated with allergens and, hence, be either exchanged or dressed in washable mattress and pillow covers.

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