

Allergen avoidance in a day-care center

Munir AKM, Einarsson R, Dreborg S. Allergen avoidance in a day-care center.

Allergy 1996; 51: 36–41. © Munksgaard 1996.

The predominant sensitizing allergens in Swedish asthmatic children are furred pet animals. Poor ventilation and increased indoor humidity cause accumulation of pet allergens indoors. Indirect contacts with cats also increase pet allergen exposure. We investigated whether the concentration and the total amount of cat (*Fel d I*) and dog (*Can f I*) allergen in dust from various surfaces in a day-care center were influenced by extensive renovation, installation of a new ventilation system, ventilation of floors, and avoidance by families and personnel of direct and indirect contacts with pets. The cleaning routine in the day-care center was changed extensively after renovation. Old mattresses, pillowcases, curtains, sofas, and soft toys were removed, and new materials were purchased. Dust was collected from various surfaces before and after renovation from table and chair surfaces, floors, curtains, mattresses, pillows, cushion-like toys, and sofas on five occasions during a 12-month period. *Fel d I* and *Can f I* allergen levels were determined by sandwich ELISA. The reduction in the total amount of both *Fel d I* and *Can f I*/sampling area was more pronounced than the reduction in the concentration of allergen/g of dust. After renovation, the mean cat and dog allergen concentration was decreased by six and 10 times, respectively. After 1 year, the total amount of cat allergen was lower in all areas (from 24 ng to <1 ng/sampling area, $P < 0.05$). Already at the first sampling after renovation, the total amount of dog allergen had decreased more than 10 times. In a previous study, we found the median concentration of cat and dog allergen to be 10–30 times higher in ordinary day-care centers. Our present study demonstrates that children changing from a normal center to the renovated center would be exposed to much lower levels of cat and dog allergen. Combined measures such as installation of mechanical ventilation, ventilated floors, regular extensive cleaning, and, probably most important, avoidance of direct and indirect contacts with pets, should decrease cat and dog allergen exposure in day-care centers.

A. K. M. Munir, R. Einarsson, S. Dreborg

Department of Pediatrics, University Hospital, Linköping, Sweden

Key words: allergen avoidance; *Can f I*; ELISA; *Fel d I*; renovation.

A. K. M. Munir, MD, PhD
Department of Pediatrics
University Hospital, 14th Floor
581 85 Linköping
Sweden

Accepted for publication 23 October 1995

The predominant sensitizing allergens in Swedish asthmatic children are furred pet animals, causing sensitization twice as often as house-dust mites (1, 2). Several previous studies have found the levels of pet allergens to be higher than the mite allergen levels in dust from various environments of children (2–4).

High amounts of cat allergen were found in homes from which the animal had been removed for more than 5–10 years (5, 6). High levels of cat/dog allergen were also found in places where these pets had never been kept (4, 7, 8).

In previous studies, we observed that poor ventilation and increased indoor humidity not only increase the risk for mite infestation, but also cause

accumulation of pet allergens indoors (2, 3). In addition, we observed that pet allergen exposure may occur by indirect contact (9).

A number of methods aiming at reducing pet allergen levels have been proposed, including the use of HEPA- or microfilter vacuum cleaners (9), washing cats (10), removal of cats (6, 11), and removal of carpets and furniture (11).

In this study, we investigated whether the levels of cat (*Fel d I*) and dog (*Can f I*) allergens, in dust from various surfaces in a day-care center were influenced by extensive renovation, installation of a new ventilation system, ventilation of floors, and avoidance of direct and indirect contacts with pets by families and staff.

Material and methods

Study design

A day-care center in Linköping was selected for the purpose of making an "allergen-free day-care center" for allergic children. For improvement of the indoor environment, extensive renovation was undertaken; e.g., reconstruction of the floors and installation of mechanical ventilation and ventilated floors. During renovation of the floor, several channels for ventilation were made under the floor surface. These channels are not visible from outside but are connected to the ventilation system of the building. The ventilated floors keep the floors dry and protect floor material from moisture. The changes made in the day-care center during the renovation are listed in Table 1. After renovation, where applicable, painting was done with low-emitting, water-based colors. Water-based paints are devoid of irritant substances, such as phenol or formaldehyde and other irritants. Dust was collected from various surfaces before and after renovation (Fig. 1).

Characteristics of children and staff members

An agreement was made between the authorities, the personnel, and the parents attending this center

not to keep any pets at home. Pets were not allowed to enter the center. Children and parents also avoided direct and indirect contacts with pets. If, for any reason, any of the children or staff members were in contact with pets, they were advised to change their clothes before going to the center.

Characteristics of the center and cleaning habits after renovation

After renovation, all old materials such as mattresses and pillowcases, curtains, sofas, and soft toys were removed, and new material was purchased. The cleaning routines were also changed extensively after renovation. A brief description is given in Table 2.

Dust sampling and determination of *Fel d 1* and *Can f 1*

Thirty-five dust samples were collected from seven surfaces on five occasions during the 12-month period from June 1993 to June 1994. Sampling was done in the children's play room, the bedroom, and the dining room. The samples were collected using ALK filters (ALK, Hørsholm, Denmark). Dust was sampled from table and chair surfaces, floors, curtains, mattresses, pillows, cushion-like toys, and

Table 1. Building characteristics and changes made in allergy avoidance center during renovation

	Before renovation	After renovation
Floors	No basement, no ventilated floor	Basement with ventilated floor, air changes = 10 l/s
Walls	Wallpaper 4 years old	Removal of old wallpaper, puttying, and polishing; attachment of new wallpaper
Ceilings	Paint 4 years old	Scraping off old paint and removal of absorbent layer, followed by vacuum cleaning; new paint with low-emitting, water-based color
Indoor heating elements	Placed 4 cm away from walls	Placed 12 cm away from walls for easy cleaning between elements and wall surfaces
Ventilation	Only out-blowing system; air changes = 3.5–4.5 ach	Both in- and out-blowing system; air changes = 4.5–5.5 ach
Indoor humidity	Not measured	17–22% (relative humidity)
Indoor temperature	20–21°C	19–22°C

ach = air changes per hour.

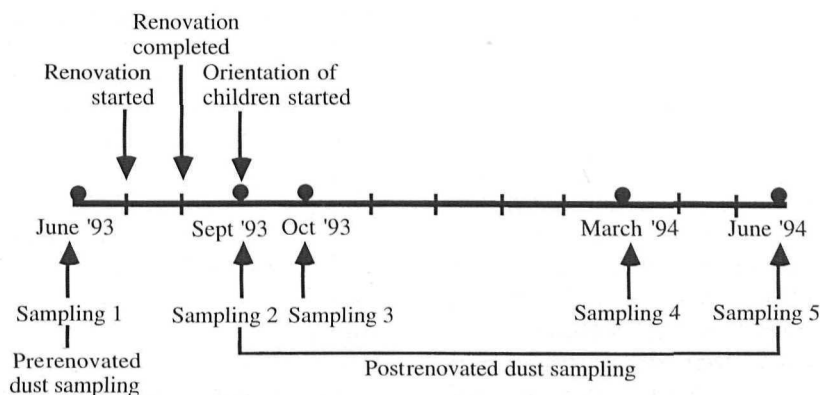


Fig. 1. Schematic representation of design of study.

Table 2. Changes made in cleaning routine in allergy avoidance center after renovation

	Before renovation	After renovation
Floors	Wet sweeping two times/week; no vacuum cleaning	First vacuum cleaning and then wet sweeping, daily
Tables and chairs	Wet brushing of chairs daily	Wet brushing daily
Curtains	Long curtains, more than 5 years old, cleaned once a year	New short curtains, washed alternate months
Mattresses and pillowcases	Washed with detergent alternate months	Same
Pillows	Never washed	Washed with detergent alternate months
Sofas	Cleaned by brushing, very seldom	Vacuum cleaned daily
Soft toys	Toys more than 5 years old; never cleaned	New toys, washed alternate months
Doormat	No doormat	New doormat, vacuum cleaned daily and changed for new one every week
Vacuum cleaner	Vacuum cleaner more than 5 years old	New vacuum cleaner with filter device
Vacuum cleaning of room corners, closets, windowpanes, bookshelves, and walls	Very seldom	Daily

sofas. Dust sampling was standardized by time and area, i.e., plain surfaces for 1 min/m² with a total area of 5 m² and upholstered surfaces for 2 min/m² with a total area of 2 m² (4).

After sieving the dust, extraction was done in phosphate-buffered saline (pH 7.6), and the content of major cat (*Fel d I*) and dog (*Can f I*) allergens was determined by sandwich ELISA, as described previously (12).

Results were expressed as concentration of allergen per g of dust and total amount of allergen per sampling area, calculated from the total amount of dust collected, i.e., concentration of allergen times weight of dust collected.

Since the amount of dust obtained after renovation was very low, only the content of *Fel d I* and *Can f I*, but not that of mite allergen, was measured. In all, 31 dust samples were available for analysis of cat allergen and 15 samples for analysis of dog allergen.

Statistical analysis

The Wilcoxon signed rank test was used to observe any difference between pre- and postrenovation (October 1993 or March and June 1994) sampling.

Results

Concentration of allergen per g of dust

The concentrations of *Fel d I* per g of fine dust from the various indoor locations are plotted in Fig. 2. Renovation was associated with a sixfold reduction in the mean allergen concentration; i.e., from 140 ng/g in prerenovated sampled dust to 25 ng/g in dust from the first postrenovation sampling. Statistically, this difference was not significant. The reduction after 1 year, however, was still more pronounced. In that time, the mean allergen

level was 16 ng/g. No cat allergen could be detected in 6/7 samples from the same locations used before the renovation; i.e., there was about a 10-fold reduction in the concentration of allergen.

When all sampling sites were considered separately, it was observed that during the first winter, the cat allergen concentration decreased on all but two surfaces (mattresses and cushion-like toys). The lack of decrease in the levels of cat allergen on these surfaces may be due to the fact that during this period two children were brought to the center by their grandfather, who kept a cat in his car.

Renovation was associated with more than 10-fold reduction in the mean allergen concentration of *Can f I*; i.e., from 484 ng/g in prerenovated sampled dust to 38 ng/g in dust from postrenovation sampling. The reduction 1 year later, however, was not possible to measure as the amount of dust collected was not sufficient for analysis of dog allergen.

Total amount of allergen per sampling area

The total amounts of the cat allergen *Fel d I* from the various sampling sites are given in Fig. 3. The mean total amount per sampling area was about 12 times higher in prerenovation dust (24 ng/sampling area) than in dust sampled during the first winter after renovation (2 ng/sampling area) (NS). During this period the total amount of *Fel d I* was reduced in all but two sampling sites. However, after 1 year the total amount was lower in all areas ($P < 0.05$).

The mean total amount of *Can f I* per sampling area was about 18 times higher in prerenovation dust (66 ng/sampling area) than in dust sampled on the first occasion after renovation (3.7 ng/sampling area).

Comparison with ordinary day-care centers

Earlier, we investigated the levels of cat and dog allergens in dust from seven day-care centers in the

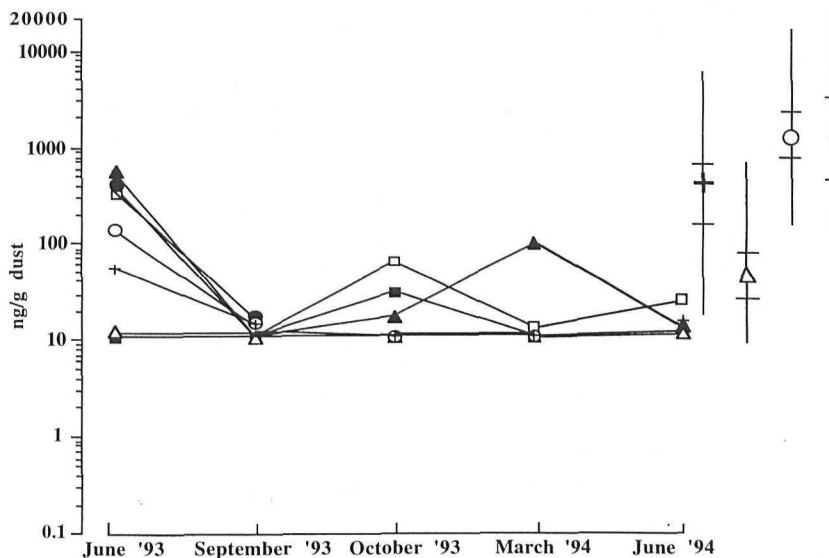


Fig. 2. On left, concentration of *Fel d I*/g of dust from various surfaces in allergy avoidance day-care center. Sampling was done from tables and chairs (+), floors (Δ), curtains ($\circ$), mattresses ($\blacksquare$), pillows ($\square$), sofas ($\bullet$), and cushion-like toys ($\blacktriangle$). On right, median concentration (95% CI and range) of *Fel d I* in dust from 22 children's sections in seven day-care centers in Linköping (10).

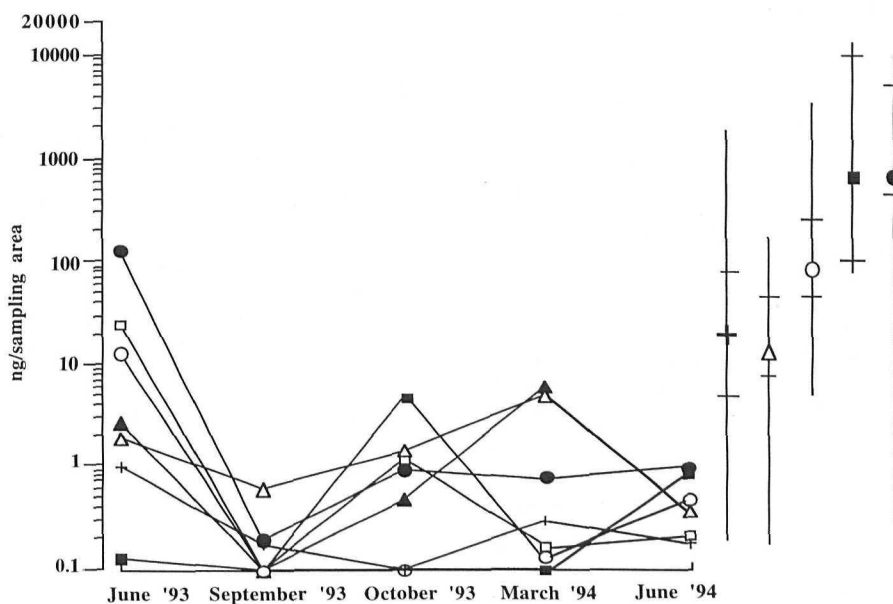


Fig. 3. On left, total amount of *Fel d I*/sampling area in dust from various surfaces in allergy avoidance day-care center. On right, median total amount (95% CI and range) of *Fel d I*/sampling area in dust from 22 children's sections in seven day-care centers in Linköping (10). Symbols as in Fig. 2.

same city (4). The levels of dog allergen (median, 4300 ng/g, $n=22$) in the ordinary day-care centers were significantly higher than the levels of cat allergen (median, 1600 ng/g, $n=22$). Since then, few samples were analyzed for dog allergen in this study. For comparison, the levels of cat allergen in those centers are given in Figs. 2 and 3. As illustrated, the concentrations and the total amounts of cat allergen in the 22 children's sections of the ordinary

day-care centers by far exceeded the levels in the renovated, adapted day-care center.

Discussion

Before renovation, the levels of cat/dog allergen in dust from the day-care center studied by us were lower than the levels previously found in other centers in the same city (4). This may be due to the

fact that since 1989 this center had had good ventilation, and that in this center none of the children or staff members were in contact with cats/dogs, whereas in other day-care centers the ventilation was relatively poor. Only recently had installation of new ventilation systems been considered in day-care centers, and many children and staff members were in contact with cats regularly (4). In schools, we found rather high levels of cat allergen on chair surfaces, and there was an association between the levels of cat allergen on chairs and the number of students and teachers who had cats at home (8). Thus, since pets are not allowed in Swedish schools and day-care centers, our results support our previous finding that pet allergens are brought to schools and day-care centers in the clothes of children and staff members who keep pets at home (4, 8).

We did not observe any statistically significant difference between the allergen levels in dust sampled before and during the first winter after renovation. However, the mean allergen levels, both concentration, i.e., amount per g of dust, and total amount per sampling area, were reduced by six and 12 times, and 13 and 18 times for cat and dog allergen, respectively. Furthermore, after 1 year, the cat allergen level in all but one sample was reduced to nondetectable levels. The reduction in the levels of cat allergen after renovation was due to the combination of increased ventilation, ventilation of floors, regular extensive cleaning, and, probably most important, avoidance of contact with cats.

The reduction in the total amount of allergen per sampling area was more pronounced than the reduction in the concentration of allergen per g of dust. In a previous study using modern vacuum cleaners equipped with HEPA (high efficiency particulate air) filters, we were unable to reduce either the concentration or the total amount of cat allergen in the homes of allergic children during a 5-week period (9). In the present study, both the concentration and the total amount of pet allergens were reduced by from six to more than 10 times during the first few months after renovation. This could be explained by the fact that in the homes of allergic children investigated earlier, sampling areas were continuously contaminated by visitors in direct or indirect contact with cats or dogs (9). In this study, in principle, none of the children were in contact with cats or dogs, or, if so, they changed their clothes before attending the center. Thus, taken together, our studies indicate that to reduce indoor cat and dog allergen exposure indirect contact with these pets should be avoided.

The most realistic comparison is to other day-care centers in the same community (4). Here the levels of allergen were 10–30 times lower in the

renovated center, meaning that children changing from a normal center to the renovated center would be exposed to much lower levels of cat/dog allergen.

The influence on symptoms of this degree of reduced exposure should be documented in the future.

In conclusion, our study demonstrates that combined measures, such as installation of mechanical ventilation, ventilated floors, regular extensive cleaning, and, probably most important, avoidance of direct and indirect contact with pets, may decrease the exposure to cat/dog allergen in day-care centers.

Acknowledgments

This work was supported by grants from the National Association for the Prevention of Asthma and Allergic Disease (RmA). We gratefully acknowledge the cooperation of Olof Johansson, safety engineer, Industrial Health Authority, Linköping Community, and Klas Lind, supervisor of the day-care center, Linköping Community, who helped in collecting dust and provided data on the technical description of the day-care center.

References

1. Croner S, Kjellman N-IM. Natural history of bronchial asthma in childhood – a prospective study from birth to 14 years of age. *Allergy* 1992;47:150-7.
2. Munir AKM. Exposure to indoor allergens and relation to sensitization and asthma in children. Linköping University Medical Dissertation, no. 412, Department of Pediatrics, University of Linköping. 1994:1-89.
3. Munir AKM, Einarsson R, Kjellman N-IM, Björkstén B. Mite (*Der p* I, *Der f* I) and cat (*Fel d* I) allergens in homes of babies with a family history of allergy. *Allergy* 1993;48:158-63.
4. Munir AKM, Einarsson R, Dreborg SKG. Mite (*Der p* I, *Der f* I), cat (*Fel d* I) and dog (*Can f* I) allergens in dust from Swedish day-care centers. *Clin Exp Allergy* 1995;25:119-26.
5. Egmar L, Emenius G, Axelsson G, Pershagen G, Wickman M. Direct and indirect exposure to cat (*Fel d* I) and dog (*Can f* I) allergens in homes. *J Allergy Clin Immunol* 1993;91:324.
6. van der Brempt X, Charpin D, Haddi E, de Mata P, Vervloet D. Cat removal and *Fel d* I levels in mattresses. *J Allergy Clin Immunol* 1991;87:595-6.
7. Enberg RN, Shamie SM, McCullough J, Ownby DR. Ubiquitous presence of cat allergen in cat-free buildings: probable dispersal from human clothing. *Ann Allergy* 1993;70:471-4.
8. Munir AKM, Einarsson R, Schou C, Dreborg S. Allergens in school dust. I. The amount of major cat (*Fel d* I) and dog (*Can f* I) allergen in dust from Swedish schools is probably high enough to cause perennial symptoms in most asthmatic children sensitized to cat and dog. *J Allergy Clin Immunol* 1993;91:1067-74.
9. Munir AKM, Einarsson R, Dreborg S. Indirect contact with pets can confound the effect of cleaning procedures for reduction of animal allergen levels in house dust. *Pediatr Allergy Immunol* 1994;5:32-9.

10. De Blay F, Chapman MD, Platts-Mills TAE. Airborne cat allergen (*Fel d I*): environmental control with the cat *in situ*. *Am Rev Respir Dis* 1991;143:1334-9.
11. Wood RA, Chapman MD, Adkinson NF, Eggleston PA. The effect of cat removal on allergen content in household-dust samples. *J Allergy Clin Immunol* 1989;83:730-4.
12. Chapman MD, Aalberse RC, Brown MJ, Platts-Mills TAE. Monoclonal antibodies to the major feline allergen *Fel d I*. II. Single step affinity purification of *Fel d I*, N-terminal sequence analysis, and development of a sensitive two-site immunoassay to assess *Fel d I* exposure. *J Immunol* 1988;140:812-18.

This document is a scanned copy of a printed document. No warranty is given about the accuracy of the copy. Users should refer to the original published version of the material.