

Occupational Exposure to Indoor Allergens in Finnish Trained Home-Helpers: a Pilot Study

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Abstract: Occupational Exposure to Indoor Allergens in Finnish Trained Home-Helpers: a Pilot Study: Sirpa PENNANEN, et al. Kuopio Regional Institute of Occupational Health—The presence of allergies, respiratory symptoms and skin-prick reactions was evaluated in trained home-helpers (THH), and indoor allergen levels were measured at their work sites. A questionnaire was answered by 118 THHs and forty THHs consented to skin-prick tests. The indoor allergen levels in the settled house dust from the clients' homes of 17 prick tested THHs were determined by two-site monoclonal antibody ELISA methods. Forty-eight percent of the THHs had one or more symptoms at least weekly. The presence of respiratory symptoms and atopy was not particularly high in THHs. Prick tests revealed that 11 THHs (28%) had positive reactions to one or more of the allergens tested. A significant correlation was observed between the frequency of reported symptoms and positive prick reactions. Fel d 1 was found in 98% and Can f 1 in 96% of the dust samples, but Der p 1 in only 21% of the samples, though the levels remained rather low. The sensitization threshold suggested for cat allergen (1 µg/g) was exceeded in 26%, and that for dog allergen (2 µg/g) in 32% of the sites studied. These results showed that THHs are occupationally exposed to allergen levels sufficient to result in sensitization. (*J Occup Health 2002; 44: 140–144*)

Key words: Can f 1, Fel d 1, Der p 1, Occupational exposure, House dust, Sensitization, Prick test, Storage mites, Trained home helper

The allergens of fur-bearing pets (Fel d 1 and Can f 1) have been identified as the predominant indoor allergens in Scandinavia^{1–3}, so that it is difficult to avoid exposure

to cat and dog allergens, since these allergens are ubiquitous even in such places as public buildings and public transport^{1, 4, 5}. Pet allergens were previously reported to have a two-fold greater effect on sensitization than house-dust mites do in Swedish asthmatic children⁶. About 70% of Scandinavian children with perennial asthma were shown to be sensitized to cat and/or dog dander¹, though allergy to dogs seems to be less common than cat allergy.

Animal danders are also potential occupational sensitizers for farmers, laboratory animal workers and veterinarians^{7–9}. In addition, storage mites have been documented as a cause of allergic symptoms, especially in rural occupational settings, such as in farms, dairy barns and grain elevator stores^{10–12}. At the moment, there are no occupational exposure limits for environmental allergens.

Trained home-helpers (THH) and other cleaning workers also represent a potential group of employees who are likely to be exposed to indoor allergens to a great extent, but nothing is known about their occupational exposure or sensitization to indoor allergens. The aim of this study was to tentatively evaluate the prevalence of allergy, respiratory symptoms, and skin-prick reactions in THHs and to measure indoor allergen levels at their work sites.

Material and Methods

Questionnaire and selection of subjects

A questionnaire was distributed to 150 female THH who worked in an urban district in Eastern Finland. The subjects were asked to report their background information, the presence of allergic diseases, and allergic or irritation symptoms (Table 2) over the past three months, as well as the person's opinion of the occupational origin of their symptoms. The response rate was 79% (n=118). When no responses were provided to

Received Aug 6, 2001; Accepted Jan 24, 2002

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the symptom questions, this was interpreted as indicating no symptoms.

A representative subsample of 45 workers were asked to participate in the skin-prick tests, and 40 of them (89%) agreed. Those (n=28) who had cleaning as a part of their job description and who had regular clients were asked to participate in the environmental monitoring. Out of these 28 THHs, 11 dropped out either because their clients did not consent to the study or for other personal reasons.

The Ethics Committee of the Finnish Institute of Occupational Health approved the study, and written informed consent was given by all prick test participants.

Skin-prick tests

The skin-prick tests for seven allergens were performed, and a qualified nurse interpreted the results. The following allergen extracts were used: animal dander of cat and dog, two house dust mites (*Dermatophagoides farinae* and *D. pteronyssinus*; 10 HEP, ALK-Abello, Denmark), and three storage mites (*Acarus siro* 1:100 w/v, *Lepidoglyphus destructor*, *Tyrophagus putrescentiae*; 10 HEP, ALK-Abello, Spain). Histamine hydrochloride (10 mg/ml) was used as a positive control. The largest diameter of the weal and the diameter perpendicular to it were measured 15 min after applying the allergen. The reaction was considered positive if the size of the weal was $\geq 3 \times 3$ mm, when the corresponding size of the weal produced by histamine hydrochloride was $\geq 4 \times 4$ mm, or if the size of the weal was $\geq 2 \times 2$ mm, when the corresponding size of the weal produced by histamine hydrochloride was 3×3 mm. Reactions producing weals smaller than the criteria mentioned above were considered negative.

Environmental monitoring and indoor allergen analysis

The working conditions of 17 skin-prick tested THHs were observed during one working day, and settled dust samples for indoor allergen analyses were collected from clients' homes by an investigator. From each client, written consent for vacuuming was received before sampling. Overall, 57 homes were visited within about one month (November–December 1998).

In each home, one sample of settled house dust was collected on cellulose acetate/cellulose nitrate filters (Millipore AAWP09025 AA, pore size 0.8 μm ; Millipore Corporation, Bedford) by vacuuming an approximately 1-m² area from mattresses, bedroom carpets, or stuffed furniture with a vacuum cleaner (Miele s 251i; Miele, Inc.) with a Cutler-type nozzle. A total of 57 samples were collected. The site for vacuuming was selected according to the tasks carried out by the THH, thus providing a sample representative of her exposure during the investigation. One to five dust samples were collected to describe the daily allergen exposure of each THH.

The filters were stabilized under constant conditions

for two days before and after the sampling. Dust collected on the filters was weighed and stored at -20°C for about a week until extraction. Dust samples were extracted in phosphate-buffered saline (pH 7.4) containing 0.05% (v/v) Tween-20 and 1% bovine serum albumin (1% BSA PBS-T) in an average volume of 20 ml/g of dust in a shaker (125 rpm) at room temperature for two hours. Extracts were centrifuged (5000 rpm, 15 min) at $+4^{\circ}\text{C}$, and the supernatants were stored at -20°C for about a month until allergen analyses.

The levels of major cat (Fel d 1), dog (Can f 1), and house dust mite (Der p 1) allergens were analyzed by two-site monoclonal antibody ELISA methods³. All allergen-specific reagents and standards were purchased from Indoor Biotechnologies Ltd., UK. The detection limit for Fel d 1, Can f 1, and Der p 1 was 1.056 ng/ml, 0.809 ng/ml, and 0.080 ng/ml, respectively.

Statistical analyses

The data were analyzed with the SPSS 8.0 program (Statistical Package for Social Sciences).

The relationship between smoking and the prevalence of allergic diseases and symptoms was tested with the χ^2 test, and the representativeness of the samples of 40 (for skin-prick tests) and 17 THH (for occupational monitoring) for the whole population (n=118) with regard to the background information of the subjects as well as to the prevalence of allergic diseases and symptoms was tested with the Mann-Whitney test. The χ^2 test was used to determine the dependence between the prevalence of symptoms and the skin-prick test results. The allergen levels in the dust samples were expressed as means, standard deviations, medians, and ranges. If the result was below the detection limit, that value divided by 2 was used in the statistical analysis. The distributions of allergen concentrations were examined with the Kolmogorov-Smirnow test, which showed that the data were not normal-distributed, so that a non-parametric test was used for statistical analysis. The Mann-Whitney test was used to establish the dependence between the allergen levels and the prevalence of allergic diseases and symptoms as well as the skin-prick test results.

Results

On average, the 118 responding THHs were 45 yr old, had a 14-yr career and visited five to six homes daily. Fourteen percent of them were smokers. The subjects attending the skin-prick tests (n=40) did not differ statistically ($p=0.369$ - $p=0.971$) from the whole population in regard to any of the background factors. The daily tasks of THHs included the handling of medications, bathing and dressing of clients, making beds, cleaning, doing laundry, cooking, washing dishes and helping the clients with their shopping.

The prevalence of self-reported allergic diseases and

Table 1. The prevalence of self-reported allergic diseases and symptoms among THHs

	Subject group		
	All respondents (n=118)	Skin-prick tested (n=40)	Environment investigated (n=17)
Self-reported (%)			
asthma	12	13	18
allergic rhinitis	46	36	35
dermatitis	40	33	29
Self-reported symptoms (%)			
irritation of eyes	19	18	29
nasal congestion or discharge	28	33	47
sore throat, hoarseness	15	15	29
cough	10	18	29
facial skin irritation	11	10	12
skin irritation on the hands	25	23	24

symptoms of the THHs are shown in Table 1. Allergic rhinitis and dermatitis were the most frequently reported allergic diseases in all groups. There was no significant difference between the groups in the prevalence of the diseases ($p>0.05$). No statistically significant relationship was found between smoking and asthma ($p=0.506$), smoking and allergic rhinitis ($p=0.827$), or smoking and respiratory symptoms ($p=0.443$).

Out of the 40 skin-prick tested subjects, 48% ($n=19$) had one or several symptoms at least weekly. Almost all of these THHs (95%) assumed that their symptoms were at least partly of occupational origin. The most commonly reported symptoms were nasal congestion or discharge and skin irritation on the hands (Table 1). The slight differences between the groups in the prevalence of symptoms were not statistically significant ($p>0.05$).

Of the skin-prick tested THHs, 11 (28%) had a positive reaction to one or more of the allergens in the prick test (Table 2). Eight (20%) subjects were prick positive to *T. putrescentiae*, four (10%) to *A. siro* and three (7.5%) to *L. destructor*. Only one person was sensitive to *D. farinae* and two to *D. pteronyssinus*. Correspondingly, one subject had a positive reaction to cat allergen and two subjects to dog allergen. A significant relationship was found between (any) positive response in the skin-prick test and symptoms ($p=0.049$). 14% of the 21 non-symptomatic THHs were prick positive, whereas 42% of the 19 symptomatic THHs had positive skin reaction to one or several allergens.

Pets (all cats) were found only in three homes at the time of sampling. In addition, the occupants of 24 homes had previously had pets (cat or dog) or recently had contact with a pet. The THH, the occupants, or their relatives usually cleaned the homes once a week by vacuuming and/or wet mopping.

Table 2. THHs with positive skin prick reactions

THH	Allergen						
	dog	cat	Der f	Der p	Aca s	Lep d	Tyr p
33	+	-	-	-	-	-	-
35	-	-	-	-	-	+	+
42	-	-	-	-	-	+	+
58	-	-	-	-	+	-	+
89	-	-	+	+	-	-	-
92	+	+	-	-	-	-	-
93	-	-	-	-	-	-	+
114	-	-	-	-	+	+	+
124	-	-	-	-	-	-	+
129	-	-	-	-	+	-	+
130	-	-	-	+	+	-	+

Der f = *Dermatophagoides farinae*, Der p = *D. pteronyssinus*, Aca s = *Acarus siro*, Lep d = *Lepidoglyphus destructor*, Tyr p = *Tyrophagus putrescentiae*.

The allergen levels in house dust collected from the homes are shown in Table 3. Fel d 1 was found in 98% and Can f 1 in 96% of the samples, but Der p 1 in only 21% of the samples. Three samples collected from the homes with cats had a significantly higher Fel d 1 concentration than those from homes without pets (111.7 $\mu\text{g/g}$ vs. 6.6 $\mu\text{g/g}$, $p=0.005$). The Can f 1 (1.8 $\mu\text{g/g}$ vs. 4.6 $\mu\text{g/g}$) and Der p 1 (0.003 $\mu\text{g/g}$ vs. 0.004 $\mu\text{g/g}$) concentrations were also slightly (but not significantly) lower in the homes with cats than in the others ($p=0.567$ and $p=0.506$, respectively). No statistically significant relationship was found between symptoms reported by the THHs ($n=17$) or the skin-prick test results and allergen levels in the working environments ($p=0.558$ and $p=1.00$).

Table 3. Cat (Fel d 1), dog (Can f 1), and house dust mite (Der p 1) allergen levels in settled house-dust samples (n=57) collected from homes visited by 17 THHs

	Allergen content ($\mu\text{g/g}$)		
	Fel d 1	Can f 1	Der p 1
Mean	12.2	4.5	0.004
Standard deviation	46.6	14.2	0.007
Median	0.2	0.7	0.001
Range	0.009–250.0	0.03–15.5	0.0002–0.045

for Can f 1, $p=0.961$ and $p=0.958$ for Fel d 1, and $p=0.584$ and $p=0.197$ for Der p 1, respectively).

Discussion

The presence of asthma reported by the THHs in this study was two- to three-fold higher than that among the entire Finnish population (5%) and farmers (4%)¹³. In adults, the prevalence of asthma is generally about 5 to 10%, being most prevalent in women¹⁴, which could partly explain the high prevalence in this study. Similarly, the prevalence of allergic rhinitis and dermatitis was two- to three-fold higher than the estimates for the general adult population (5–20%)¹⁵. The fact that in this study it is not known whether the reported allergic diseases were confirmed by a physician or not, hampers the evaluation of the presence of allergic diseases.

Tammilehto and co-workers¹⁶ reported the prevalence of occupational cough to be 12% in the Finnish general population and 25% in farmers. Similar prevalence of coughing (13–25%) has been found in the textile industry^{17, 18}. The equal presence reported here by THHs might not be solely caused by the indoor allergens studied, as their working environment contains several other agents, such as detergents and other chemicals, that may induce respiratory symptoms.

Until now, sensitization to storage mites has traditionally been associated with occupational exposure in farmers or related occupations^{10, 11, 19}. In the skin-prick tests, the prevalence of positive response to storage mites was 7.5%–20% in the THHs. This is in the same range as the prevalence of positive reactions seen in farmers, 10–21%^{10, 11, 19}. Our results indicate that storage mite allergens may exert a greater effect indoors than previously believed^{20, 21}. But since the home environment of the THHs was not monitored and there is no direct evidence of storage mites in the working environment, we cannot be sure whether the sensitization of the THHs is produced by private or occupational exposure.

The prevalence of cat, dog and house dust mite sensitization among the THHs, on the other hand, was relatively low compared to other studies^{22–24}, but these allergens were commonly found in the samples, though

the concentrations were relatively low. Nevertheless, the earlier proposed sensitization thresholds^{4, 25} for cat allergen (8 $\mu\text{g/g}$) and dog allergen (10 $\mu\text{g/g}$) were exceeded in 12% of the samples studied. The house dust mite allergen (Der p 1) levels were extremely low compared to the concentrations generally measured in house dust^{26–28} and corresponded to those reported in a previous Finnish study³. This suggests that in Finland house dust mites are not as important allergens as in warmer and more humid regions. This may explain the low prevalence of positive reactions to house dust mites among THHs.

No difference in the measured allergen levels was found between sensitized and non-sensitized THHs. This finding is in agreement with several other studies^{4, 23}, though Radon *et al.*²⁹ found a weak but significant relationship between Der p 1 exposure and Der p 1 sensitization. This may reflect the difficulty in measuring actual exposure. Single determinations of the allergen content in dust reservoirs are at best a proxy for exposure to common aeroallergens.

This pilot study shows that THHs are possibly exposed to higher amounts of indoor allergens than the general population. The prevalence of THHs sensitized to storage mites indicates that storage mites might be a more important indoor mite species than was previously recognized.

Acknowledgments: The Finnish Work Environment fund and the Academy of Finland supported this study. Kenneth Pennington kindly checked the English language.

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