

House-dust mites and associated environmental conditions in Danish homes

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The concentration of house-dust mites (*Dermatophagoides pteronyssinus*) was investigated in 96 Danish homes with one or more members suffering from asthma. The air-exchange rates, humidity, and temperature were measured in all the homes. A positive correlation was found between indoor air humidity and mite concentration ($P < 0.01$), and an inverse correlation ($P = 0.027$) between house-dust mite concentration and indoor air-exchange was found. Homes of mite-allergic persons had a higher concentration of house-dust mites than did those of the non-mite-allergic group. House-dust mite concentration was above the proposed limit of 10 mites/0.1 g dust in 76% of the homes of persons allergic to mites and in 48% of the homes of nonsensitive persons. The high proportion of homes infested with house-dust mites suggests an increased prevalence of house-dust mites in Danish homes. The results support the concept that reduced ventilation in homes involves a risk of increased house-dust mite exposure.

Key words: air-exchange; *Dermatophagoides*; humidity; mites; prevalence.

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Since the demonstration of house-dust mites (*Dermatophagoides pteronyssinus*) as an important source of allergen in house dust, the association between exposure to house-dust mites and sensitization to mite allergens has been reported from many parts of the world (9). The prevalence of house-dust mites is, geographically, unequally distributed because of climatic differences. Furthermore, within a defined region, the concentration of house-dust mites varies considerably in different homes. One of the major factors determining the density of house-dust mites in dust from homes is the level of indoor air humidity (2). The magnitude of mite exposure is important as a risk for sensitization (5), and guidelines have been proposed (9) which define levels with definite risk for development of house-dust mite allergy.

Detailed studies of mite concentration in homes illustrating the distribution of mites in relation to proposed levels of risk are rather limited. In Denmark, previous studies (4) have shown that about 25% of randomly selected homes had mite counts above the proposed threshold limit value (TLV) of 10 mites per 0.1 g dust.

In the present study we have evaluated the prevalence of house-dust mites in the homes of families with one or more members suffering from asthma or atopic dermatitis. The investigation was performed as part of a healthy building project for asthmatics.

Material and methods

A total of 96 homes of families with one or more members suffering from asthma or atopic dermatitis was investigated. The investigation was part of the selection of participants (cases and controls) for a healthy building project for asthmatics. The participants were either persons interested in moving to the healthy buildings or control persons for the same project, randomly selected among asthmatic patients that had been referred to the chest clinic, University Hospital of Aarhus, within the last 5 years.

The homes were investigated during the winter season, October–April 1984–6. They were located in the region of Aarhus, Denmark, a coastal city at an altitude of no more than 50 m above sea level.

All patients had a clinical examination including skin prick test for common allergens. Sensitivity to house-dust mites, *D. pteronyssinus*, was based on a positive skin test and a positive radioallergosorbent test > 0.70 PRU/ml (RAST, Pharmacia, Sweden). Of the 96 families, 34 had one or more members who were allergic to house-dust mites.

Dust samples were collected from the patient's mattress and the bedroom floor around the bed. One square meter of the surface area of each sampling site was vacuumed (maximum suction $\div 0.1$ bar) for 2 min with a portable, hand-held vacuum cleaner with disposable, paper bags. Once the dust was collected, the bags were placed in a plastic "Ziplock"

Table 1. Median and interquartile range (IQR) of outdoor temperature ($^{\circ}\text{C}$) and absolute humidity (g/kg) in the sampling period

	Temperature	Absolute humidity
Median	7.1	3.8
IQR	2–10.2	3.2–4.6

storage bag and were kept at -18°C until counted. Processing of samples, counting, and identification of mites were performed as described previously (7).

In all the homes, air-exchange rate, indoor air humidity, and temperature were measured. The air-exchange was measured in the bedroom by a tracer gas decay method, and results were expressed as the fraction of the total air volume in the room that is changed per hour (ACH). Measurements were carried out with windows and doors closed and without human activity. Continuous measurements of temperature and air humidity in the bedroom were made for 16–24 h on a hygrothermograph. For further details of the measurements, see Harving et al. (3). Absolute indoor air humidity (AH) was calculated from simultaneous measurements of relative humidity and temperature.

Local meteorologic data were obtained each day from the Danish Institute of Meteorology.

Results

All the patients had dust samples collected from their homes during the winter period, with a median outdoor temperature of 7.1°C and a water content of the outdoor air (absolute humidity) of 3.8 g/kg (Table 1).

Examination of the dust samples included the counting of 16081 mites. The identification of the mites showed that 79% were *Dermatophagoides*, 11% *Tarsonemus*, and 5% other genera. There was no difference between mattress and floor dust as regards the relative distribution of the different genera. In this study, only results of *Dermatophagoides* concentration are presented. The mite counts in mattresses showed an uneven distribution in both groups (Fig. 1). No relation was found between the amount of dust collected in a sample and the density of the mites.

Table 2 shows the median mite density in bedrooms (mattresses and floor). Mite-allergic persons had a median exposure of house-dust mites in mattresses of 27 mites/0.1 g dust, while non-mite-allergic persons were significantly less ($P = 0.032$) exposed, having a median count of 8 mites/0.1 g dust. When we compared exposure to mite densities above the limit of 10 mites/0.1 g dust, the difference was apparently more pronounced ($P < 0.01$), with 76% (26/34) of mite-allergic and 48% (30/62) of non-mite-allergic persons being exposed above the limit value.

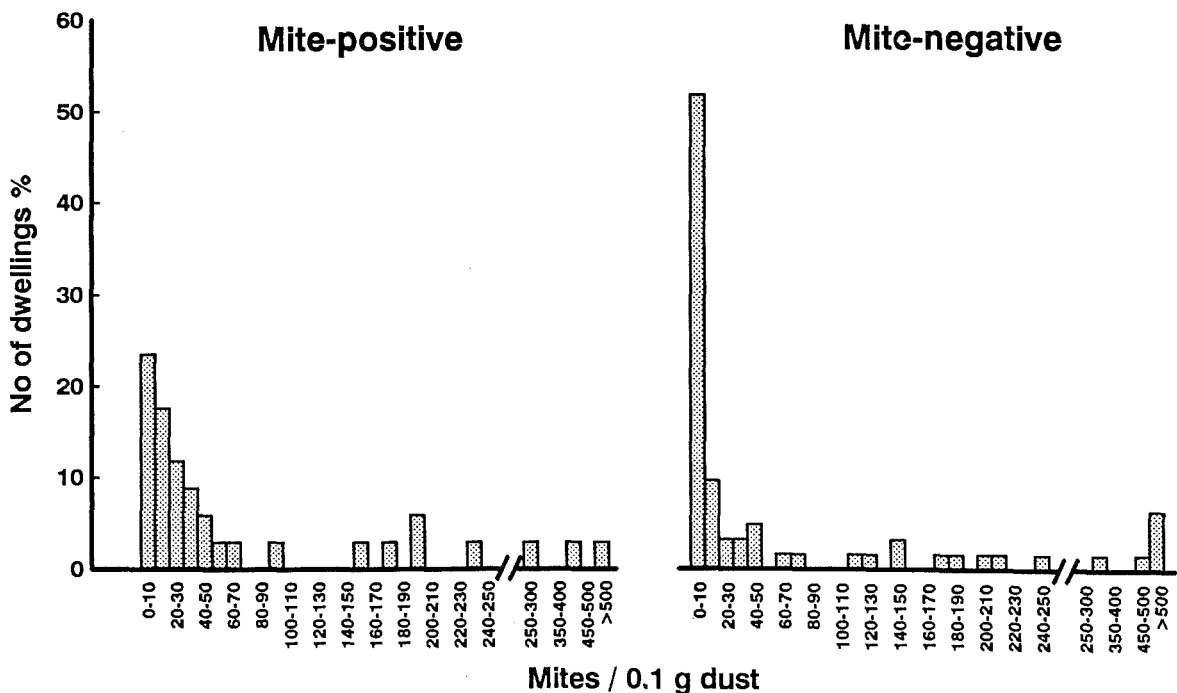


Fig. 1. Frequency histograms of house-dust mite (*D. pteronyssinus*) density in mattresses of patient with or without mite allergy.

Table 2. Median density of house-dust mites (*D. pteronyssinus*) in bedroom of 96 patients with or without mite allergy

	Mites/0.1 g dust				<i>P</i>
	Mite-positive <i>n</i> =34		Mite-negative <i>n</i> =62		
	Median	IQR	Median	IQR	
Mattress	27	10–92	8	1–79	0.032
Bedroom floor	22	6–43	7	2–37	n.s.

IQR: interquartile range. Statistics: Mann-Whitney U test.

Indoor environmental data showed a median air-exchange rate of 0.27 air changes per hour (ACH) in the bedroom. The median indoor temperature was 19°C (interquartile range (IQR): 17.5–21) and the absolute indoor air humidity was 6.8 g/kg (IQR: 5.9–7.8).

A significant correlation ($P < 0.01$) was found between mite counts and AH (Fig. 2). Furthermore, a significant correlation ($P < 0.02$) was demonstrated between age of the home and mite counts, an increased mite exposure occurring in old dwellings.

Building ventilation and indoor air humidity are inversely related, and a positive correlation exists between indoor humidity and mite counts. We therefore compared air-exchange rates with mite density and found an inverse correlation ($P = 0.027$), indicating a significantly higher risk of mite exposure in houses with a low ventilation (Table 3).

Discussion

The results of the present study have confirmed the relationship between the density of house-dust mites and indoor air humidity (1, 6, 8, 10–12). Our data show that house-dust mites are especially abundant

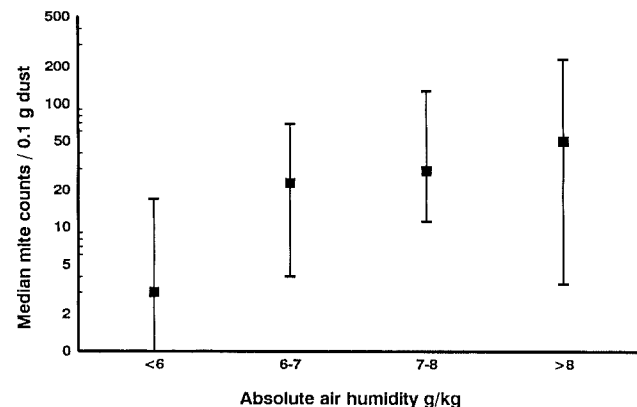


Fig. 2. Median and interquartile range of house-dust mite counts (*D. pteronyssinus*) in mattresses according to different levels of air humidity in bedrooms.

Table 3. Density of house-dust mites (*D. pteronyssinus*) in mattress dust related to the bedroom tightness expressed as air-exchange rate (ACH: air changes per hour). Statistics: χ^2 -test

Air exchange rate (ACH)	Mite density (mites/0.1 g mattress dust)		
	0–10	11–100	> 100
≤ 0.25	25	9	13
25–50	4	11	7
> 50	14	10	4
<i>P</i> =0.024			

in houses with AH above 7 g/kg air, which is the proposed TLV (9). Our findings also confirm that homes of mite-sensitive persons have a higher mite concentration than do those of the nonsensitive group (5).

The amount of dust collected during standardized sampling procedures is related to the frequency of cleaning and vacuuming. As regular cleaning has been regarded as important for the control of house-dust mites (9), we compared house-dust mite counts with the amount of dust in each sample. We did not find any correlation; hence, the present data do not support the contention that frequent cleaning results in low mite concentration.

The level of indoor humidity is a result of moisture production from human activities and the rate of removal of this moisture. The removal rate is mainly dependent on the difference in water content between the outdoor and indoor air, and the amount of fresh air supply to the dwelling. Excessive dampness of newer houses is often a result of increased building tightness (9). The differences in building tightness become especially evident in winter when windows and doors are closed. During this period the gradient between indoor and outdoor humidity is high, especially in buildings with low air-exchange rates.

In view of the relationship between humidity and building tightness, it is of interest to investigate the relation between indoor/outdoor air-exchange and house-dust mite concentration. The present study is the first to demonstrate that house-dust mite abundance in bedroom mattresses correlates with the air-exchange rate, high mite concentration occurring in poorly ventilated rooms. Further study of this relation may lead to a TLV for minimal ventilation in homes for prevention of house-dust mite exposure.

House-dust mite concentrations in Danish homes have previously been measured by Korsgaard (4) in 1977. In an unselected sample of 75 houses, 26% had levels above the recommended TLV of 10 mites/0.1 g dust. In the present study we found that 48% of the homes of non-mite-allergic persons and 76% of the homes of the mite-allergics had mite counts above this level.

On the assumption that the group of persons not sensitive to house-dust mites were unselected in relation to house-dust mite density, the present data can be compared with the previous measurements of 1977 (4), which were performed by the same method. This comparison shows a significantly higher median concentration in the present study, suggesting an increasing prevalence of house-dust mites in Danish homes. This is consistent with the fact that the air-exchange rate has been reduced and air humidity increased in Danish homes during the same period as a result of energy-conservation measures (3).

The risk of house-dust mite allergic asthma increases 8-fold when the inhabitants are exposed to more than 100 mites/0.1 g dust (5). The indication of an augmented exposure to house-dust mites points towards a future growth in incidence of allergy to house-dust mites.

The present study demonstrates a relation between house-dust mite concentration and indoor air-exchange and supports the concept that reduced ventilation in dwellings involves a risk of increased house-dust mite exposure.

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