

Short communication

House-dust mites and summer cottages

Background: Estimated indoor climate conditions in unheated summer cottages offers house-dust mites unfavorable temperature and feeding conditions while giving them optimum humidity conditions. We aimed to estimate the exposure level of house-dust mites in summer cottages.

Methods: A total of 37 summer cottages were sampled for house dust and storage mites in three locations and the results compared with samples from 33 patients suspected of house-dust mite allergy and living in ordinary houses. The processed dust samples were investigated by microscopy and exposure levels given as number of mites per 0.1 g dust.

Results: The summer cottages were without exception all heavily infested with threefold or higher concentrations of both house dust and storage mites in comparison with ordinary houses. In unheated summer cottages were found tropical high concentrations of house dust and storage mites with a median concentration of house-dust mites in mattress dust of 2000 house-dust mites/g of dust which corresponds to an average of 40 µg allergen/g of mattress dust.

Conclusions: As a probable consequence of high indoor air humidity conditions in unheated summer cottages in winter, dust samples contained threefold or higher concentrations of house dust and storage mites. Indoor humidity conditions thus more than compensated for lack of continuous supply of skin scales from human beings and an unfavorable low indoor air temperature. The uniform high mite exposure in summer cottages is likely to imply disease deterioration in patients already allergic to mites.

J. Korsgaard, H. Harving

Department of Chest Diseases, Aarhus University
Aalborg, Aalborg, Denmark

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Jens Korsgaard MD, PhD
Department of Chest Diseases
Aalborg Sygehus Syd
9000 Aalborg
Denmark

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House-dust mites *Dermatophagoides pteronyssinus* and *D. farinae* have their natural habitats in house dust and nests of birds and mammals (1). The fact that the highest concentrations of mites in dust from houses actually occur in dust from beds (2) has led to the assumption that house-dust mites were dependent on human proximity for survival and growth.

House-dust mites causes allergic asthma in predisposed individuals with a threshold limit value (TLV) of 100 mites/g of dust. Exposure above this level implies an increased risk of being sensitized and development of mite-allergic asthma (3). Likewise the disease activity in mite asthma is dependent on exposure above this TLV of 100 mites/g of dust. A reduction in exposure below this level imply a reduction in symptoms to near-cure as described when moving patients to specially designed mite-free dwellings (4) and when moving mite-allergic patients to mite-free mountain residences (5). The exposure reduction is promising as treatment of mite-allergic patients although till now largely unsuccessful (6).

Culture experiments with house-dust mites (7) have identified their optimal food as human skin scales. They have an optimum temperature of 25°C and have continued growth with temperatures between 15 and 32°C. They tolerate even subzero temperatures for

several days. They have an optimum relative humidity (RH) for population growth of 60–70% RH, but they do not tolerate RHs for prolonged periods of time outside the range of 55–85% RH either because of desiccation (8) or because of overgrowth of fungi at high humidities.

In contrast to house-dust mites, storage mites (mostly *Lepidoglyphus destructor* and *Acarus siro*) prefer (9) higher indoor air humidities, and have an optimum of 90% RH. They desiccate and die with a RH below 60%. Storage mites produce their own allergens known to cause allergic asthma with only a limited allergenic cross-reactivity with house-dust mites (10, 11).

The aim of this study was to investigate house-dust mite and storage mite population sizes in surroundings of extreme indoor climate conditions with low temperatures, high RHs and no human proximity for at least 6 months a year in a group of winter-uninhabited Danish summer cottages.

Material and methods

From the Municipal Register in Ebeltoft, Denmark a list of 150 random selected owners of a summer cottage was provided.

The 150 summer cottage owners were asked by mail during the Easter holiday in April 1998, where the summer cottages are usually opened after winter, to collect three different dust samples in separate vacuum cleaner paper bags from the whole surface of a mattress (vacuumed for 2 min), from 1 m² of bedroom floor just beside the bed (vacuumed for 2 min) and lastly from 1 m² in the center of the living room (2 min of vacuuming). They also received a questionnaire asking about basic conditions in their particular cottage.

The 150 house owners were only asked once and from this single invitation 37 (25%) house owners participated and constitute the study group.

Patients suspected of house-dust mite allergy and who by mail sent dust samples for routine mite analysis (by JK) in the period from 1 January 1998 until 30 June 1998 served as a control group. A total of 33 patients with two dust samples were included in the control group and of these 33 patients 10 also had evaluable dust samples from floor in living room. All control samples originated from ordinary houses inhabited throughout the year.

The collected dust samples were processed for microscopic examination by mixing 0.1 g dust with 10 ml 90% lactic acid in a 10 cm Petri dish and colored with a few crystals of Lignin Pink. Mite counts are given as number of mites found per 0.1 g of dust. A mite count of 100/g of dust corresponds to an exposure of 2 µg group I allergen/g of dust.

From 25 years monthly average of outdoor temperature and humidity in Denmark (Denmarks Meteorologic Institute, personal communication) estimated indoor temperatures and humidities were calculated for homes not heated and not inhabited during the wintertime. In the summer period, indoor air temperatures and humidities were the same as outdoor air (Fig. 1). For comparison, indoor temperatures and humidities were also estimated for normal houses inhabited and heated in winter (Fig. 1).

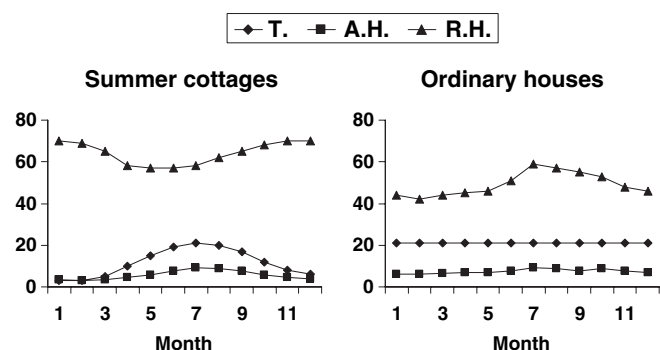


Figure 1. Estimated monthly average indoor air humidities and temperatures for unheated summer cottages. When occupied in summer opening of window and doors equals indoor and outdoor air conditions. In winter, unoccupied and unheated cottages have indoor temperatures 3°C higher than outdoor temperature but the same absolute humidity as outdoor air. From a constant year-round indoor temperature of 21°C indoor air relative humidities were calculated from outdoor air absolute humidity with addition of 3 g/kg for December–March, 2 g/kg for April and November, 1 g/kg for May and October and 0 g/kg for June–September. Outdoor conditions are 25 years monthly averages of temperature and humidity (Danish Meteorologic Institute, personal communication).

Results

Estimated indoor temperatures in the unheated and uninhabited summer cottages varied from a minimum of 3°C in January to a maximum monthly average of 21°C in July (Fig. 1). The monthly average indoor temperature was ≤ 15°C in 8 of the 12 months with an annual average of only 11.6°C. The low winter indoor temperatures together with an average winter indoor absolute humidity around 4 g water vapor/kg dry air results in average winter RHs of 70% RH as 3-month average for December, January and February (Fig. 1).

The summer cottages were rather uniform with median size of 64 m² and 25 years of age. The cottages were inhabited on average 10 of 52 weeks/year and 90% of the houses were occupied 22 weeks a year or less. None of the houses was inhabited more than 40 weeks/year. The cottages were mostly wooden houses (91%) with relatively well-insulated windows (94% of the houses were constructed with double-glazed windows). In 10 (30%) the owners used a slight winter heating with indoor temperatures between 5 and 10°C, while the rest did not use any kind of winter heating. The use of carpets on the floors were widespread where 70% and 73% had partly or fully carpeted floors in bedroom and living room respectively.

In mattress and bedroom floor dust, threefold higher concentrations occurred in the summer cottages while the concentration in dust from living room showed twofold higher concentrations in the summer cottages compared with ordinary houses (Table 1). For mattress dust none of the summer cottages had concentrations below the suggested TLV of 100 mites/g dust (Fig. 2), three summer cottages had mattress dust concentrations between 101 and 1000 mites/g of dust while as many as 30 (91%) had concentrations that exceeded 1000 house-dust mites/g of mattress dust.

For storage mites a median of 30 storage mites were found in mattress dust from summer cottages compared with a median of zero in 33 mattress dust samples from ordinary houses (Table 2). The predominant species of storage mites found in both summer cottages and ordinary houses were *L. destructor* and *A. siro*. Tarsone-

Table 1. The median and 90% percentiles of concentrations (numbers per 0.10 g dust) of house-dust mites in dust samples from mattresses, floor in bedroom and floor in living room from 37 summer cottages and 33 ordinary houses

	Mattress dust		Bedroom floor dust		Living room floor dust	
	Summer cottage	Ordinary houses	Summer cottage	Ordinary houses	Summer cottage	Ordinary houses
n	37	33	37	33	37	10
Median	196	62	52	14	14	8.5
Percentile	101–936	0–340	3.2–141	0–169	1.6–104.8	0–85
P-value	<0.001		0.153		0.362	

The two groups were compared with Mann–Whitney U-test.

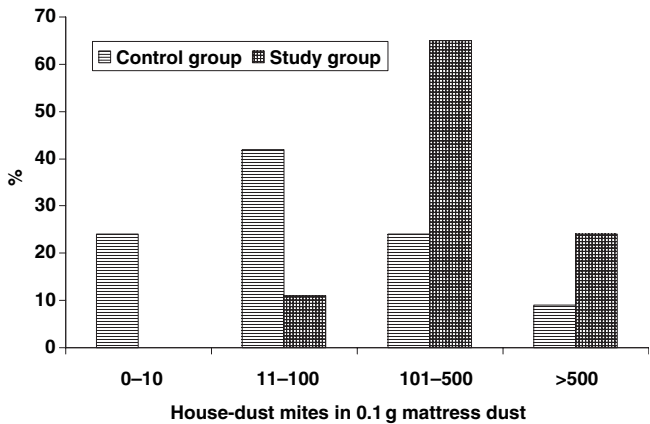


Figure 2. Histogram on the distribution of concentrations of house-dust mites in 0.1 g mattress dust samples from either 37 summer cottages or 33 ordinary houses inhabited by patients suspected of house-dust mite allergy ($P < 0.001$, Mann-Whitney U -test).

mid mites as well were found in larger concentrations in summer cottages where five of 33 mattress dust samples from ordinary houses contained one or more *Tarsonemus* spp. per 0.1 g dust compared with 18 of 37 mattress dust samples from summer cottages ($\chi^2 = 7.42$, $P < 0.01$).

Concentrations of house-dust mites in dust from bedroom and living room floor were correlated to type of floor in summer cottages. The median concentration in bedroom floor dust was 75, 42 and 10 in rooms with wall-to-wall carpets, partly carpeted floors and with no carpets respectively (Kruskal-Wallis test: $P = 0.011$). In dust from living room floors the median concentration of house-dust mites was 17, 16 or 5 in rooms with wall-to-wall carpets, partly carpeted floors and with no carpets respectively (Kruskal-Wallis test: $P = 0.103$). For storage mites the concentrations were independent of type of flooring in both bedroom floor dust ($P = 0.506$) and living room floor dust ($P = 0.557$).

For the 37 summer cottages other variables such as weeks of occupation per year, signs of dampness with window condensation in bedroom or living room, age and type of mattress, the use of light winter heating, size

and construction type of summer cottage did not correlate to any of the mite population sizes in any of the individual locations.

Discussion

In this case of practical mite ecology, year-round favorable high humidity conditions overcome unfavorable feeding and temperature conditions with a threefold higher occurrence of house-dust mites and even larger differences in the occurrence of storage mites in unheated and cold but very humid houses. The results on feeding conditions are in accordance with the original observations of Spieksma (7) who found that several thousands of house-dust mites could be fed for months on as little as 250 mg skin scales. The human production of skin scales (in average 1 g/24 h/person) by far exceeds the demands of house-dust mites.

Denmark and the Nordic countries as a whole have rather cold and dry winters and many ordinary houses in Scandinavia have concentrations of house-dust mites below 100 mites/g of dust. This is also evident in the present results where at least one in four ordinary houses in the control group of 33 patients had concentrations of house-dust mites below the TLV of 100 house-dust mites/g of dust. The present results demonstrate that year-round high humidity in cottages without exception results in significant amounts of both house dust and storage mites. In fact, the median concentration of 2000 house-dust mite/g of mattress dust, which corresponds to 40 μ g of allergen, in geographical terms best compares with tropical areas as Sao Paulo, Brazil where the geometric mean concentrations of house-dust mite allergen Der pI was 38 μ g/g in mattress dust from 20 houses (12). The results demonstrated that houses unheated in winter, i.e. summer cottages and perhaps also in scout residences, camping huts and other mostly uninhabited holiday premises, have tropical high levels of mite concentrations with both house dust and storage mites despite a relatively cold and dry temperate climate.

Although there is no evidence of the clinical importance of these relatively short-term (days to a few weeks) high exposures in relation to development of sensitization and even disease development it is likely that disease deterioration will occur in mite-allergic persons. When mite-allergic children return from residence in mite-free mountainous areas (5) they deteriorate in <3 weeks. Even short-term holiday occupancy in summer cottages could very well increase medication needs in mite-allergic patients.

Sesay and Dobson (13) were the first to focus on bedding items as the place in the house where the highest mite concentrations occur. In this respect the microclimate created in occupied bedding with increased humidity has been considered responsible for this uneven distribution of mites in ordinary homes. We found

Table 2. The median and 90% percentile of concentrations (numbers per 0.10 g dust) of storage mites in dust samples from mattresses, floor in bedroom and floor in living room from 37 summer cottages and 33 ordinary houses

	Mattress dust		Bedroom floor dust		Living room floor dust	
	Summer cottage	Ordinary houses	Summer cottage	Ordinary houses	Summer cottage	Ordinary houses
n	37	33	37	33	37	10
Median	30	0	11	0	1	0
Percentiles	0-170	0-9.4	0-39.6	0-0.8	0-15	0-0.4
P-value	<0.001		0.001		0.011	

The two groups were compared with Mann-Whitney U -test.

fourfold higher concentrations of house-dust mites in mattress dust than in dust from bedroom floors in summer cottages, which correspond very well to previous Danish findings (14) of four to five times as many mites in mattress dust than in dust from bedroom floors in ordinary-inhabited houses (Table 1). This fourfold higher occurrence of mites in mattress dust than in floor dust in bedroom, however, was found in 37 cottages not in use for in average 42 of 52 weeks/year. This suggest that the almost universal finding of the highest concentrations in dust from bedding could be caused by a technical artefact, where dust from beds are very light and fibrous with a large surface area for each unit weight, while dust from floors are much more coarse and often filled with sand. The expression of mite occurrence as concentration of mites or allergen per unit weight of dust could cause this skewed picture of mite distribution in different locations in houses.

The difference in population proportions where house-dust mites constitute 95% of the flora in ordinary houses but 75% of the flora in summer cottages most likely illustrates the influence of the different humidity requirements of house dust and storage mites where storage mites prefer higher RHs (8). House-dust mites are still, however, the dominant part of mite flora in unheated houses without human proximity or delivery of skin scales for an average of 42 weeks/year.

Acknowledgment

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