

House dust mite allergens on different types of mattresses

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Summary

Beds and especially mattresses are important breeding grounds for house dust mites. We investigated whether supposed differences in the microclimate on water, spring and foam mattresses were reflected in the occurrence of house dust mite major allergens (*Der f I*, *Der m I*, and *Der p I*) in mattress dust. Fifty-one mattresses that had been in use for 8–25 months were sampled. Median concentration of total major allergens was 0.5 µg/g dust (range 0–45) with little difference between the three major allergens and between the three types of mattresses. Occurrence of mattresses with concentrations above and below the proposed risk level (2 µg/g) was similar in the mattress groups. However, the allergen concentration was above risk level in 56%, if washable underblankets were not applied, compared with only 21% in the group with such underblankets. In conclusion, mattresses tend to accumulate allergen rather rapidly. Neither heated water mattresses, spring nor foam mattresses seem to be of any advantage for mite allergics, whereas underblankets made of synthetic fibres in a cotton or synthetic cover, commonly used in Denmark, might play a beneficial role in reducing allergen exposure.

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Introduction

House dust mites, one of the major allergen sources in house dust, have proved difficult to eradicate, and results from controlled trials investigating various avoidance measures are equivocal [1–3]. The concentration of mites and mite allergens has been shown to be high on mattresses [4] where both humidity and temperature are increased, when in use. A common recommendation made by clinicians to mite-allergic patients is to buy new mattresses. The humidity and temperature are central for mite growth [5,6] and mattresses of different types could be assumed to attain different temperatures and to have different capacities to accumulate humidity. Such variation in microclimate might influence the mite fauna, and the aim of the present study was to investigate whether the concentration of allergens from house dust mite species differed on spring mattresses, foam mattresses, or water mattresses.

Materials and methods

Mattresses

Three firms selling different types of mattresses in the same geographic area were approached. They willingly accepted to supply lists of customers, and letters were sent to individuals who had bought new mattresses within 8–25 months prior to the intended dust sampling. In total, 88 persons were contacted, 51 of whom agreed to participate. Dust samples were then collected from 22 water mattresses, 12 spring mattresses, and 17 foam mattresses.

Housing conditions

As factors other than type of mattress might influence the growth of mites on mattress surface, for each home information was collected on cleaning, heating, and ventilation habits, and the use of carpets.

Dust collection

Each home was visited by the same investigator during 2 weeks in August, avoiding the winter months with their

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Table 1. Basic parameters, frequencies (medians) and ranges (no significant difference between groups)

	Type of mattresses		
	Water	Spring	Foam
Mattress			
Age (months)	12 (8–24)	19 (12–25)	19 (15–25)
Interval from last cleaning/vacuuming (days)	8 (2–84)	8 (2–60)	8 (3–120)
Underblankets			
Frequency (%)	100	70	71
Age (months)	12 (8–24)	36 (12–120)	20 (3–120)
Interval from last cleaning (months)	6 (1–12)	2 (1–6)	3 (0–36)
Eiderdown			
Age (years)	5 (0.5–20)	5 (1–25)	5 (0.5–20)
Washable (%)	59	42	53
Bedroom carpet			
Frequency (%)	64	45	59
Bedroom heated during winter			
Frequency (%)	61	67	65
Animals in bedroom			
Frequency (%)	18	18	23
Bedroom floor			
Interval from last vacuuming (weeks)	0.75 (0–6)	0.5 (0–3)	0.5 (0–4)
Bedroom window open during winter > 12 hr/day (%)	18	25	35
Condensation on windows during winter (%)	27	37	41

lower mite density [7]. The investigator performed dust sampling on mattress surfaces for 2 min/m², as recommended [8]. If double-sized, only 2 m² of the mattress were investigated. If supplied with an underblanket, the upper surface of this was sampled instead. In Denmark, an underblanket is most often a washable 0.5–1-cm thick pad made of synthetic fibres contained within a thin cotton sheet. Dust was sampled on a 38 cm² filter paper (pore size 6 µm). The nozzle (ALK, Hørsholm, Denmark) was modified by an oblique cutting of the inlet part. This was done to ensure better contact to the surface, thereby facilitating a standardization of the sampling procedure [9]. This device was connected to the end of the suction tube of a household vacuum cleaner (Nilfisk GS, Fisker & Nielsen, Copenhagen, Denmark). The maximum vacuum

produced at the sampling site was 7 kPa, and the maximum flow was 6 l/sec. Without nozzle, the similar values were 17 kPa and 32 l/sec. The same equipment was used for all samplings. Dust samples were kept at –18°C until analysis.

Dust analysis

The allergens were extracted from the sample dust plus filter paper, and ELISA, previously described [10], was applied in order to determine concentration and amounts of the major allergens, *Der p I*, *Der f I*, and *Der m I* from the corresponding house dust mite species *Dermatophagoides pteronyssinus*, *D. farinae*, and *D. microceras*.

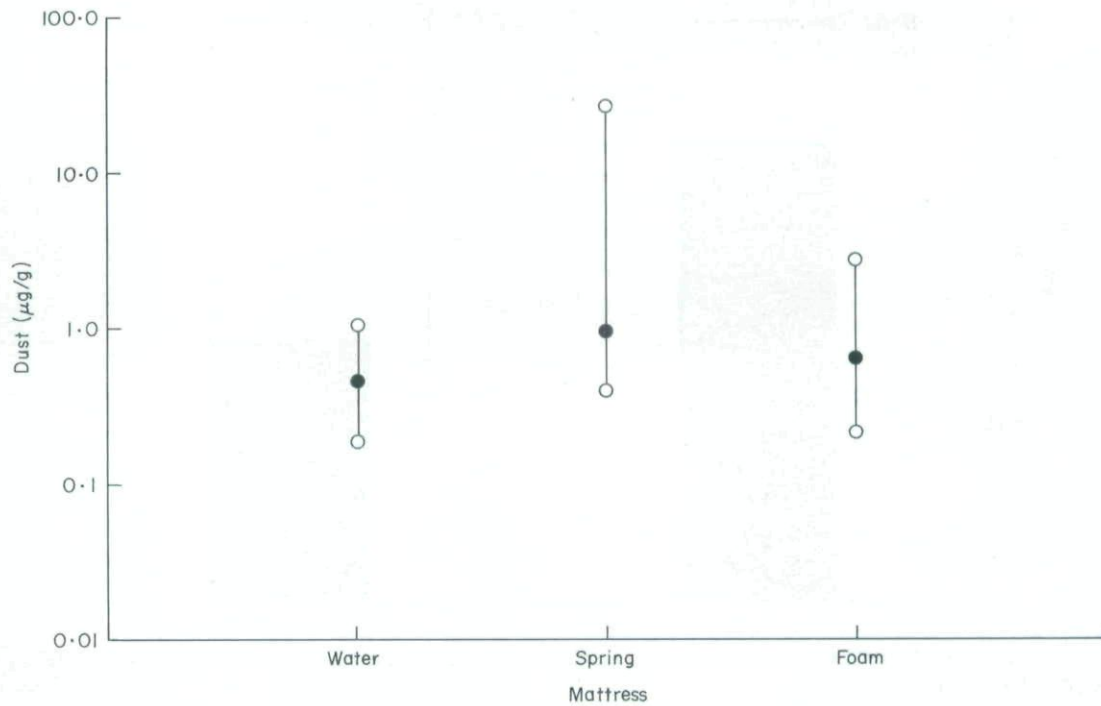


Fig. 1. Major allergen concentration (sum of *Der f I*, *Der m I*, and *Der p I*) for water, spring and foam mattresses. Medians and quartiles.

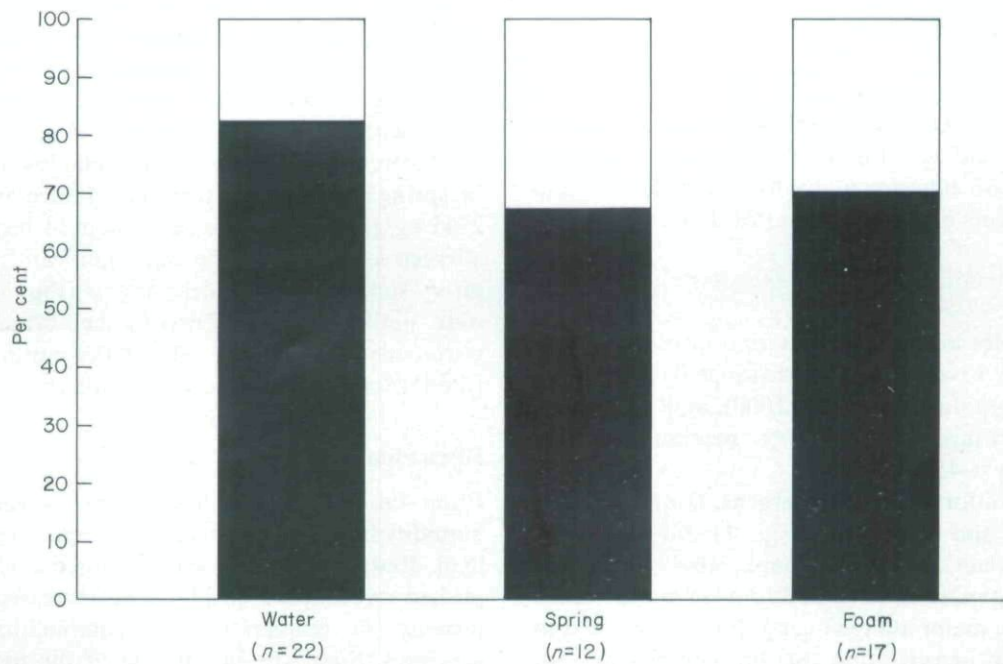


Fig. 2. Percentage of mattresses with major allergen concentration at or above ($\square$) and below ($\blacksquare$) risk level of 2 $\mu\text{g/g}$ dust.

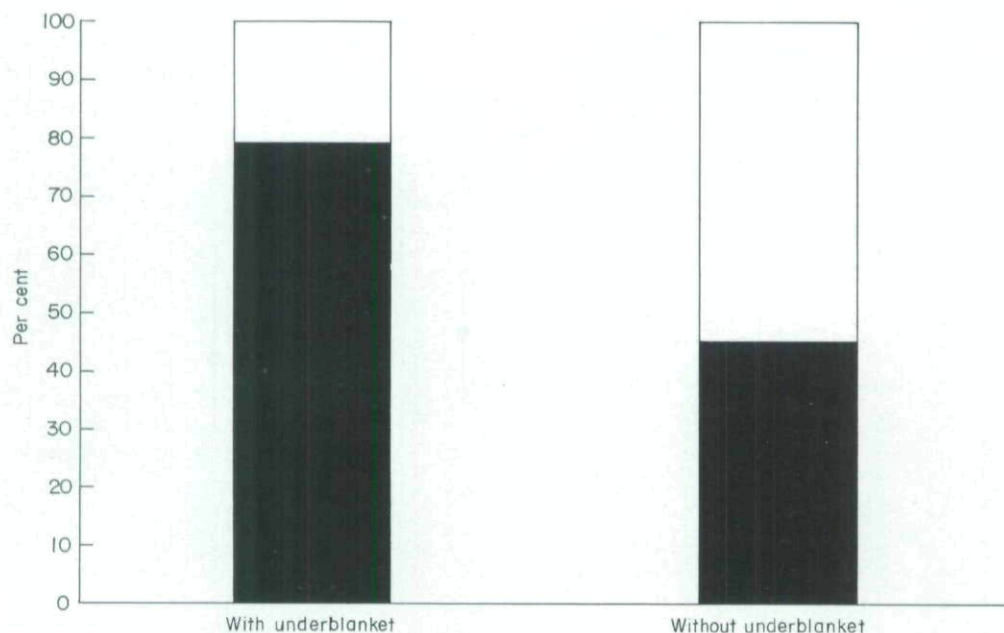


Fig. 3. Percentage of mattresses with major allergen concentration $\geq 2 \mu\text{g/g}$ (□) and $< 2 \mu\text{g/g}$ dust (■). Groups with ($n=112$) and without ($n=9$) underblankets.

Statistical analysis

Categorical data were analysed by the chi-square test. Between-group differences of other data were evaluated by Kruskal-Wallis test. A 5% significance limit was applied.

Results

Basic parameters

The three groups were comparable with regard to age of mattresses, use and age of underblankets, size of carpets, type and age of eiderdown, heating, ventilation, and occurrence of pets in the bedroom (Table 1).

Dust samples

For dust samples in the total material, median concentration of *Der f* I was 69 ng/g dust (range 0–19 000), for *Der m* I 129 ng/g dust (range 0–22 000); and for *Der p* I 76 ng/g dust (range 0–45 000); the median sum was 474 ng/g (range 0–45 130).

The concentrations of major allergens, *Der f* I, *Der m* I, and *Der p* I, and their sum (Fig. 1) did not differ significantly when mattress groups were compared, although spring mattresses tended to have higher levels. More than $2 \mu\text{g}$ major allergen per g dust is suggested to imply a risk of sensitization [8], but differences seen between groups with regard to this parameter (Fig. 2) were not significant either.

Neither the dust load nor the total amount of major allergen differed significantly between water, spring and foam mattresses. In these groups the median amounts of dust were 0.7, 0.9, and 0.8 g, respectively. Amounts of major allergen in the same groups were 331, 1449, and 642 ng, respectively.

For all samples, basic parameters mentioned above were compared with concentrations of major allergen. Median concentration of allergen was lower in the group using underblankets (257 ng/g) as compared with the group without such protection (2745 ng/g) ($P=0.03$). A similar trend was observed when analysis was performed on spring and foam mattresses only: medians 243 ng/g vs 2745 ng/g, $P=0.09$. The percentage of beds with major allergen level of $> 2 \mu\text{g/g}$ was significantly lower in the group supplied with underblankets (Fig. 3), and figures were similar (44% vs 79%) in the subsample without waterbeds. None of the other basic parameters investigated seemed to correlate with the allergen concentration.

Discussion

From laboratory and field studies a certain relative humidity has been shown to be necessary for mite growth [5,6]. Reduction in relative humidity could be accomplished by reduced production, increased ventilation, increase in temperature or combinations of these measures. Since the bed is one of the major breeding grounds for house dust mites, differences in occurrence possibly related to differences in the local climate were

looked for in the present study. Previously, the use of electrical heating blankets was shown to produce a certain reduction in house dust mite concentration on old mattresses [7]. In theory, the constant heating of water beds necessary in the Danish climate was expected to influence the temperature and humidity on mattress surfaces in a similar way, thereby reducing mite growth. The washable surface of waterbeds might add to this effect. Surprisingly, no differences in mite concentrations were registered between the three mattress types in the present study. Additional analysis of environmental factors of possible influence did not disclose any difference between groups, and the lack of effect of waterbeds could therefore not be explained simply by environmental bias. The temperature on the upper surface of waterbeds was probably too low to influence the mite growth.

The use of mainly synthetic underblankets seemed to reduce the risk of massive mite exposure. The explanation might be that human dander, a major food component for the mites, is deposited on this layer, from where it is removed together with mite allergen by washing. Underblankets could therefore be recommended.

The *D. pteronyssinus* allergen was not as dominant on mattress surfaces as previously reported on older mattresses [11]. However, *D. pteronyssinus* may overgrow *D. microceras* and *D. farinae* over time.

About 25% of the present selected mattresses contained allergen concentrations above risk level [8]. However, the mattresses were rather new, and a further increase is likely over time. Mite allergen concentrations seem to reach significant levels rapidly in accordance with similar measurements of mite counts on new mattresses [12]. It is important to realize that keeping the concentration of allergen below risk level in many cases would not be feasible by simply changing mattresses every 12 or 18 months; additional measures would be necessary, and the use of impermeable textile mattress covers might be one such measure [13].

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