HOUSE DUST MITES, HUMIDITY OF ROOM AIR AND FLOORING MATERIALS

*L Gunnarsen¹, K Sidenius² and TE Hallas²

¹Danish Building and Urban Research
²Allergy unit, Copenhagen University Hospital

ABSTRACT
House dust mites are known to cause airway allergy. Humidity in the immediate environment of the mites is believed to be decisive for their prevalence. The purpose of the present study was to analyze the impact of microenvironment on the prevalence of mites based data from a cross sectional study in Danish apartments. The room parameters air change rate, temperature and relative humidity was measured in apartments when outside temperatures were in the range –5 to 10 °C. Mites were counted under microscope in surface dust sampled from beds and from bedroom floors. In average more mites were found on the floors than in the beds. Far more mites were found on carpeted floors. No relation between prevalence on floor and room air parameters was found. The prevalence in beds correlated with absolute humidity in room air. Temperature and humidity profiles of typical beds and floors can in part explain these results.

INDEX TERMS
House dust mites, Relative humidity, Absolute humidity, Bed, Flooring material

INTRODUCTION
High humidity in homes has been associated with increased prevalence of symptoms and serious diseases like asthma among occupants - in particular among children. The increased proliferation of house dust mites in moist rooms may partly explain this. Increased moisture levels has been shown to increase the prevalence of both fungi and house dust mites.

The prevalence of sensitization to house dust mites are generally believed to be between 9 and 16%. (Linneberg et al., 2000) have demonstrated an increase in sensitization using specific IgE measurements to house dust mites (dermatophagoides pteronyssinus). They found 5.9% sensitized in 1990 and 11.8% in 1998 in a cross-sectional study in the Copenhagen area (P<0.07 for increase). House dust mites are considered to be the most important source of inhalation allergens in homes.

House dust mites require certain temperatures and high humidity in their microenvironment (Cunningham, 1999). They feed on the human skin scales found abundantly in most homes and thrive from elevated moisture contents. It is difficult to remove mites from protected environments such as mattresses, wall-to-wall carpets or textured upholstered furniture. Normal cleaning procedures are more likely to remove mites from smooth surfaces. The mites move around and in infested rooms they are found on most surfaces (Korsgaard, 1983).

House dust mites generally have the temperature of their surroundings and absorb vital moisture from the air around them. This process is essential for the survival of the mites. The

---

*Contact author email: LBG@byogbyg.dk
difficulty in absorbing moisture for a cold-blooded animal depends on the relative humidity of the surrounding air. Absolute moisture only becomes relevant for moisture absorption among animals warmer than their surroundings.

Past investigations have often focused on the prevalence of house dust mites in beds. Mites on floors and other surfaces have received less attention. The fact that these little animals with a length around 0.1 mm live in many beds is not a pleasing thought. The focus on beds may also be justified by the intimate contact between bed and occupant and the resulting direct route for transport of mite allergens from bed to the airways of sleeping persons. It is nevertheless of interest to identify other microenvironments where mites thrive.

The purpose of this study was to identify mite-favoring microenvironments and to discuss possible ways to reduce their numbers.

METHODS
87 apartments representing the typical range for rented apartments in Denmark were investigated using non-destructive methods. Occupants of a random sample of approximately 600 rented apartments drawn from the government register of houses were invited to participate. Approximately one out of six accepted to participate. Two trained assistants made a pre-announced visit to the apartments in the winter months January to March 1999. They set up small data loggers that monitored temperature and humidity, they placed small sources of tracer gas and passive samplers for air change measurements and they registered surface materials and other information about the apartments. The area and density of growing moulds on surfaces was measured. Dust samples were taken for mite counting under microscope using a normal vacuum cleaner connected to a special sampling head with filter. One sample was taken from 2 m² of the bed during a sampling period of 2 minutes on the layer immediately below the sheets. The other sample was taken from 2 m² of the bedroom floor also sampling 2 minutes. A questionnaire concerning annoyance and symptoms was introduced and returned by occupants by mail after one week together with the monitoring equipment. More information about the study may be found in (Gunnarsen and Hansen, 2002)

RESULTS
House dust mites were found in 57 % of the bedrooms. It is however generally believed that some mites may be found in most homes. The many bedrooms where no mites at all were found are probably caused by the rather small amounts of dust that was used for counting mites. The study was designed to focus on rooms with high mite concentration and in order to reduce the job of counting the sample size was reduced. Obviously many samples without mites would be expected based on the normal scatter of observations when expected number of mites were close to zero.

Figure 1 shows a cumulative chart of mite concentrations on both floor and mattress of different fractions of apartments. The average concentration of mites was higher on floors than on mattresses. Only some percent of the floors and mattresses had mite concentration above 100 m⁻² that is generally believed to contribute significantly to the development of mite allergy.

Mite concentrations on floor only had a weak correlation to the concentration in mattresses.
Figure 1. Cumulative chart of house dust mite concentrations on bedroom floors and on mattresses.

Figure 2 show the lack of correlation between outside air change and relative humidity in the bedrooms. Similarly it was not possible find an impact of air change in the whole apartment on neither relative nor absolute humidity in the bedrooms.

Figure 2. Relation between outside air change in bedroom and relative humidity.

The mite concentrations on bedroom floors were tested for correlation to air change, absolute humidity and relative humidity. No significant correlation was found.

Similarly the mite concentration in beds were tested for the same correlations. Only mite concentration in beds and absolute humidity was found to correlate significantly. At a first glance this finding opposes the fact that moisture absorption among mites depends on relative humidity and not absolute humidity. Previous researchers have found a similar correlation (Korsgaard 1983).

Figure 3 show the found relation between mite concentration in mattresses and absolute humidity in bedroom.
Figure 3. Relation between absolute humidity in bedroom and mite concentration on mattresses.

The average mite concentration on different floor types of the investigated bedrooms is shown in Figure 4. Near four times as many mites were found on floors with wall to wall carpet than on any other floor types. This finding is clearly significant.

Figure 4. Average house dust mite concentrations on different floor types

It would increase the impact of wall to wall carpets on mite allergen exposure if an impact of floor type on mite concentrations in mattresses could be demonstrated. Figure 5 shows the mite concentration in mattresses in relation to floor types.
Differences between mite concentrations in mattresses between the different floor types are not significant.

**DISCUSSION**

When moisture sources in the home are small, increased ventilation may reduce indoor humidity and hereby eliminate mites. However, the strength of the moisture sources is crucial for the ability of ventilation to control the moisture content of indoor air. Problems caused by high relative humidity at cold surfaces are only in some cases controllable by ventilation. Problems caused by direct wetting of materials can not be handled by ventilation. Furthermore it is important to consider the behavior of occupants of apartments when they try to control moisture sources and ventilation.

Mite concentrations depend on moisture and temperature properties of their immediate environment. Mite concentrations does however also depend on mite removing activities such as cleaning and washing. The high concentration of mites in wall to wall carpets may be caused by the poor mite removal during normal cleaning procedures such as vacuum cleaning. Another likely mechanism is related to the fact that carpets often lie on cold floors. An analysis of temperature and relative humidity profiles of a typical carpet on a cold floor reveals that the temperature is reduced at the bottom of the carpet. At the same time the relative humidity is elevated. Therefore it is likely that the part of a carpet with elevated relative humidity may act as a moisture filling station for mites challenged by dry air. This may improve their survival.

A similar analysis of the micro climate of a typical Danish bed with a down comforter reveals that relative humidities often are reduced when people lie in them in thermal comfort. This assumption has even been validated by a few tests with loggers of temperature and relative humidity in beds with sleeping persons. It may be assumed that the relative humidity may drop to levels critical for mite survival in cold bedrooms with low absolute humidity. This may be the explanation for the lack of correlation between mite concentrations and relative humidity and the found correlation to absolute humidity.
CONCLUSIONS AND IMPLICATIONS

- Mite concentrations were in average higher on floors than in mattresses.

- Relative humidity in beds with sleeping persons may most often be lower than relative humidity in the surrounding air.

- Mite concentrations were four times higher in wall to wall carpets than on any other floor type.

- Correlation between mite concentrations in mattresses and on floors was insignificant.

ACKNOWLEDGEMENT
The Energy Research Program of the Danish Ministry of Environment and Energy supported this study together with the Danish National Board of Health.

REFERENCES