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PREVAILING INDOOR CLIMATE CLASSIFICATION TO PREDICT HOUSE DUST MITE ABUNDANCE IN DUTCH HOMES

by

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SUMMARY

In Europe 10-15 % of the human population is sensitized to allergens of house dust mites (Pyroglyphidae). Population development of house dust mites is primarily influenced by water activity (a_w) of the mite habitat. The availability of H_2O (water-activity and relative humidity) in the niches of mites may correlate with the absolute humidity of the room air. Absolute humidity also plays a role in technical indoor climate classifications of Dutch and Belgian buildings. To investigate the effects of dry and humid room conditions on mite abundance, dust samples were taken in 14 living-rooms and bedrooms in the Netherlands. Mite numbers in floor and furniture dust from dry rooms (class II) did not exceed allergologically relevant no-sensitization thresholds of 10 mites/g of floor dust and 100 mites/g of dust from furniture. Climate classes might be different in the various spaces of a dwelling. Assessment of the indoor climate class should be done in the bedrooms as well as in the living-rooms. Results suggest that the technical classification of indoor climate is useful for future building design or when managing home sanitation.

Key words : indoor climate classification, mite abundance, living-room, bedroom, building design, home sanitation.

INTRODUCTION

In Europe 10-15 % of the human population is sensitized to allergens of house dust mites (KORT, 1994). These allergens can provok clinical symptoms such as asthma, rhinitis, bronchitis or atopic dermatitis. Significant correlations between house dust mite exposition or allergen content of dust and clinical symptoms have been demonstrated. Provisional no-sensitization thresholds for house dust mites or allergen exposure have been formulated (VAN BRONSWIJK, 1988 ; PLATTS-MILLS *et al.*, 1985 ; KORSGAARD, 1983). Exposure levels above these values (*e.g.* 10 mites/g of floor dust or 100 mites/g of furniture/mattress dust) significantly increase the disease risk for developing mite asthma.

Development of house dust mites is primarily influenced by water-activity (a_w) of the mite habitat. By measuring the relative air humidity adjacent to a substrate the water-activity (a_w) of a substrate may be assessed. The availability of water (water-activity and relative humidity) in the micro-niches of mites may correlate with the absolute humidity of the room air.

Absolute humidity also plays a role in technical indoor climate classifications of Dutch and Belgian buildings (TAMMES and VOS, 1984 ; VAN HEES, 1986 ; PONCELET and HENS, 1985 ; SCHOBER, 1989), consisting of 4 classes, representing very dry spaces (class I) to very humid spaces (class IV). This classification is based upon water vapour pressure differences between indoor and outdoor environment in relation to outdoor temperature.

In this study, indoor climate classification has been investigated in relation to mite abundance in house dust samples.

MATERIAL AND METHODS

Preliminary field trials were performed in the Netherlands in the surroundings of the cities of Eindhoven, Enkhuizen, Utrecht and Zeist. Dust samples from floors and furniture of living-rooms as well as from floors of bedrooms were collected by a household vacuumcleaner (Hoover S 2222, power : 700 W, with a small nozzle type A). The carpeting and furniture of the rooms were sampled twice (with a time interval of 1 month) for 1 min/m^2. Mite analysis of the dust samples occurred in the laboratory using a flotation method (VAN BRONSWIJK, 1981). In the living-rooms indoor climate was registrated by thermohygrographs (type 252 Ua and type 253 W. Lambrecht, Göttingen, Germany). No climate registrations were performed in the bedrooms since in the tradition of building technology the climate class of the living-room is valid for the entire house. Outdoor climatic measurements at the nearest weather station were obtained from the Royal Dutch Meteorologic Institute (KNMI, De Bilt, The Netherlands). The readings of a 4-5 week period were used to calculate mean absolute air humidity values (in g water/m^3 air) and the partial water vapour pressure (Pa). From these values technical indoor climate classes of each of 14 living-rooms were calculated from the 4-5 week average of differences in vapour pressure indoor and outdoor, in relation to outdoor temperatures. Both « Dutch calculations » (VAN HEES, 1986) and « Belgian calculations » (PONCELET and HENS, 1985) were performed. The classification systems for Dutch and Belgian buildings evolved independently. When comparing both systems they show the same classification for the outdoor air temperature range from 0 to 20 degrees C (representative outdoor air temperatures for both countries).

RESULTS

The results of mite abundance and climate registrations are presented in Tables 1 and 2.

Table 1 presents the results of climate classification and geometric means of number of pyroglyphid mites/g of dust from floors and furniture of living-rooms. Mite numbers in floor and furniture dust samples from dry living-rooms do not exceed the generally accepted no-sensitization thresholds of 10 mites/g dust for floors and 100 mites/g dust for furniture. This coincides with the limit between indoor climate class II and III in the Dutch as well as the Belgian classification system with one possible exception. On the other hand living-rooms with a climate class of IV are always mite ridden, while those of class III show noxious concentrations with again one possible exception.

TABLE 1

Technical Dutch and Belgian indoor climate classes and geometric means of numbers of pyroglyphid mites/g of dust in floor dust and furniture dust of 14 living-rooms.

Climate class (*) Dutch	Climate class (*) Belgian	Home number	Mites/g of floor dust	Mites/g of furniture dust	Exceeding no-sensit. threshold
II	II	1	11	71	yes/no
II	II	3	1	30	no
II	II	4	2	8	no
II	II	5	9	58	no
II	II	6	1	39	no
II	I-II	8	5	33	no
II	II	14	— (**)	8	no
III	III	10	146	16	yes/no
III	III	12	83	130	yes
III	III	13	— (**)	— (**)	—
IV	IV	2	63	122	yes
IV	IV	7	41	132	yes
IV	IV	9	25	127	yes
IV	IV	11	42	94	yes

no-sensitization thresholds : floor dust = 10 mites/g dust
furniture dust = 100 mites/g dust

(*) I = very dry rooms
II = dry rooms without water vapour production in the rooms
III = humid rooms with moderate water vapour production
IV = humid rooms with high water vapour production and moisture problems

(**) = no textile floors / no textile covered furniture

TABLE 2

Geometric means of numbers of pyroglyphid mites in floor dust of 14 bedrooms and technical Dutch indoor climate classes.

Mites/g of floor dust	Home number	Climate class living-room Dutch	Climate class living-room Belgian	Expected climate class bedroom (*) Dutch & Belgian
0	6	II	II	II
16	5	II	II	III-IV
20	11	IV	IV	III-IV
25	9	IV	IV	III-IV
32	8	II	I-II	III-IV
40	10	III	III	III-IV
43	13	III	III	III-IV
50	1	II	II	III-IV
63	2	IV	IV	III-IV
79	3	II	II	III-IV
158	4	II	II	III-IV
251	7	IV	IV	III-IV
—	12 (**)	III	III	—
—	14 (**)	II	II	—

no-sensitization threshold = 10 mites/g gust

(*) I = very dry rooms
II = dry rooms without water vapour production in the rooms
III = humid rooms with moderate water vapour production
IV = humid rooms with high water vapour production and moisture problems
(**) = no textile floors covering

Table 2 presents the results of the bedroom samples. Almost all mite numbers exceed the no-sensitization threshold. However, no climate registrations took place in these bedrooms. The table includes climate classifications of the living-rooms. In a separate column expected climate classifications of bedrooms according to mite numbers are included. In general bedrooms proved to be more 'humid' than living-room measurements indicated.

DISCUSSION

To reduce mite exposure in the homes of mite allergic patients thresholds have been formulated as regards survival and population development of house dust mites. For survival in a dry climate *Dermatophagoides* species require a minimum relative humidity of 45 % at 20° C room temperature (VAN BRONSWIJK, 1981). Egg production starts when relative humidity exceeds 60 % (LARSON, 1969). Population growth then initiates an increasing allergen production with maximum levels at 75 to 85 % relative humidity (WHARTON, 1976).

Our results indicate that rooms in Dutch buildings with a low mite exposition for (mite) allergic patients should belong to climate class II of either the Belgian or the Dutch system. These rooms should be considered 'safe' rooms for the allergic patient.

Mite numbers in almost all bedrooms exceeded the no-sensitization threshold. When comparing the mite results of the living-room samples with those of the bedrooms we concluded that most bedrooms are more humid than the living-rooms of the same house. Usually Dutch bedrooms are only poorly heated during winter. Climate classes may be different in the various spaces of a building. For that reason a classification of the indoor climate of a dwelling should include at least measurements in the living-room and in the bedrooms.

From Table 1 it can be concluded that high indoor air humidity (climate class IV) does not necessarily result in highest mite numbers since excessive humidities of the indoor air are not in favour of house dust mites growth. Other aspects, besides humidity, such as the quality of a substrate could become important when interpreting results. Recently the protein content of floor dust has been found to be a relevant parameter for mite development (KOREN and ECKHARDT, personal communication).

In conclusion the results of our preliminary field trials suggest that the technical classification of the indoor climate is useful in future building design, to construct dry buildings, or when managing home sanitation to reduce house dust mite exposition in the homes of allergic patients.

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