

Fungal propagules in house dust. II.

Relation with residential characteristics and respiratory symptoms

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As part of a case-control study on the relation between home dampness and respiratory symptoms of children, house-dust samples were collected from bedroom floors and mattresses in 60 homes in The Netherlands. The house-dust samples were analyzed for the presence of fungal propagules by plating 30 mg of dust directly onto DG18 agar. A checklist and questionnaire were used to obtain information on the home characteristics and occupant behavior that may have an effect on the presence of fungal propagules in house dust. The geometric mean (GM) number of colony-forming units (CFU)/g dust collected from the floors was 8990. The number of CFU/g dust was significantly higher in dust from carpeted floors than in dust from smooth floors (GM, respectively, 12880 CFU/g dust and 3530 CFU/g dust). The GM number of CFU/g dust collected from mattresses was 6760. Overall, the mean numbers of CFU/g dust collected from floors and mattresses were higher in bedrooms where damp spots mold growth, or both were observed. However, these differences were not statistically significant. The relation between home characteristics and the number of CFU/g dust of the most frequently isolated mold species ($n = 17$), including *Alternaria alternata*, *Cladosporium cladosporioides*, *Penicillium brevicompactum*, and *Scopulariopsis brevicaulis*, was also investigated. Only the type of flooring had a significant and consistent effect on the number of CFU/g floor dust of the different mold species. For *P. brevicompactum*, the number of CFU/g floor dust was significantly higher in bedrooms where damp spots were observed. The number of CFU/g mattress dust of *S. brevicaulis* was also significantly higher for bedrooms where damp spots were observed. However, in view of the large number of statistical comparisons made, these two significant relationships might have been caused by chance alone. The total numbers of CFU/g mattress and floor dust were not related to the average relative indoor humidity measured over 6 weeks. Furthermore, there was no association between the presence of fungi in house dust and respiratory symptoms. We conclude that there was only a very weak relationship between the home characteristics and occupant behavior, as determined by checklist and questionnaire, and the presence of fungal propagules in floor dust and mattress dust. Only the type of flooring had a substantial and statistically significant effect on the presence of fungal propagules in floor dust. Therefore, the presence of fungal propagules in house dust cannot be predicted reliably by home characteristics.

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House dust is recognized as a major source of allergens in nonindustrial indoor environments. Over the last 25 years, it has been shown that pyroglyphid mites are a major source of allergens in house dust in many areas of the world (13, 14). It is also clear that house dust is a complex mixture that may con-

tain various other potent allergens such as animal danders (10, 21) and molds (1, 7, 20, 21).

A number of recent epidemiologic studies have indicated a relation between home dampness and respiratory symptoms (e.g., 2, 3, 5, 12, 15, 19). House-dust mites and fungi, which both encounter

favorable conditions in damp houses, are thought to be a major cause of respiratory symptoms in damp houses. Several authors have suggested that molds are primarily harmful through production of allergens, toxins, and volatile compounds (6, 16). Evidence of an association between asthma and indoor exposure to fungi comes from a case-control study among 72 adults with asthma and 72 age- and sex-matched controls (4). Nineteen patients and nine controls reported mold spots in their homes. Furthermore, there was a significantly higher prevalence of positive radioallergosorbent test (RAST) responses to *Penicillium* among patients reporting mold in their homes.

The prevalence of house-dust mites and the potential exposure to house-dust mite allergens is generally assessed by sampling settled house dust (13, 14). The presence of fungi in indoor environments is generally assessed by air sampling or surface sampling. However, air sampling of viable fungal particles does not provide reliable data for an estimation of the exposure to fungi in nonindustrial indoor environments (17). Assessment of viable fungal particles (fungal propagules) in settled house dust might be a useful measure of potential exposure to fungi. Several studies report on the presence of fungal propagules in house dust (7, 9, 11, 20–22). However, little is known about the presence of fungal propagules in house dust in relation to home characteristics, e.g., signs of dampness, type of flooring, cleaning methods, and indoor humidity. There is no information about the predictive value of these home characteristics regarding the presence of fungal propagules in house dust. Furthermore, the relation between fungal propagules in dust and respiratory symptoms in occupants is (largely) unknown. Therefore, as part of a case-control study on respiratory symptoms in children and home dampness, the presence of viable fungal particles in house dust was assessed, together with indoor relative humidity and other home characteristics that might influence the presence of fungal propagules in house dust.

Material and methods

Study population

Samples of settled house dust were obtained in October and November 1990 from 60 homes in The Netherlands. The homes were selected from a group of 281 homes in the province of Noord Holland that was included in a case-control study on home dampness and respiratory symptoms of children aged 6–12 years. Selection criteria were the presence of signs of dampness anywhere in the home observed by the investigators, and reported respiratory symptoms of the children. Four different groups of 15 homes each were selected: 1) homes of children

without reported respiratory symptoms (controls) and without observed dampness; 2) homes of children without respiratory symptoms but with observed dampness anywhere inside; 3) homes of children with reported respiratory symptoms (chronic wheeze, chronic cough, attacks of shortness of breath with wheezing, or doctor-diagnosed asthma) denoted as cases, without observed dampness; and 4) homes of children with respiratory symptoms and with observed signs of dampness. These groups were chosen to increase the possibility of rejecting the hypotheses of the study: there is no difference in the presence of fungal propagules (quantitatively and qualitatively measured) in bedroom floor dust and mattress dust 1) in bedrooms with or without observed dampness, or 2) in bedrooms of children with reported respiratory symptoms and controls.

Finally, 31 cases and 29 controls were included in the study. Some characteristics of the study population are described in Table 1.

House-dust samples

Dust from the bedroom floor and the mattress of each child was collected with a vacuum cleaner (Philips Topomatic T 518) equipped with a special attachment (the ALK allergen mouthpiece, ALK, Horsholm, Denmark) to retain dust on a cellulose filter (Schleicher & Schuell, 589¹ 70-mm black ribbon). The power of the vacuum cleaner was set at 1000 W. In each bedroom, a floor area of 2 m² was sampled. Each square meter was sampled for 2 min. The entire upper mattress surface (an area of approximately 2 m²) was vacuum-cleaned for 2 min after the bedding had been removed. Between each sampling, the mouthpiece was thoroughly cleaned with 70% ethanol. After sampling, the filters were

Table 1. Characteristics of the study population

	Cases (n=31)	Controls (n=29)
Age (mean, years)	8.7	8.4
Sex (% boys)	54.8	27.6
Total IgE (mean, IU/ml)	310.4	126.1
Increased total IgE levels (%) (adjusted for age)	63.1	55.2
Mold allergy (RAST > 0, %)*	6.6	3.6
House-dust mite allergy (RAST > 0, %)	36.7	10.7
Difference of pulmonary function (%) (cases compared with controls)		
Forced vital capacity	-3.2	
Forced expiratory volume in 1 s	-3.9	
Peak expiratory flow	-4.4	
Maximum midexpiratory flow	-4.5	
Visible signs of dampness in home (%)	51.6	48.3
Textile floor covering in bedroom (%)	71.0	79.3

* Mold mixture used in RAST panel included *Penicillium*, *Alternaria*, *Aspergillus*, and *Cladosporium*.

placed in plastic Petri dishes and stored with silica-gel in the dark for a maximum of 2 weeks at room temperature until analysis.

Fungal propagules in house dust

For investigation of the fungal propagules in house dust, 30 mg representative dust (unsieved) was plated directly onto DG18 agar (8) with a sterile glass spreader, needle, and forceps. The analyses were done in duplicate. At present, there is no standardized method for the analysis of house-dust samples for the presence of fungal propagules. In a comparative study on 10 different analytic methods, direct plating of 30 mg dust onto DG18 agar was shown to be one of the better methods (18). The plates were incubated in darkness for 5 d at 25°C, and then the number of colony-forming units (CFU) was counted with the naked eye with a colony counter (Gallenkamp, Loughborough, UK) and expressed as CFU/g dust. After counting, the colonies were transferred onto appropriate media for identification by species according to standard mycologic procedures.

Home characteristics

For characterization of those variables of the home environment and the occupant behavior that might affect the presence of fungal propagules in house dust, a checklist and a questionnaire were used. The checklist, completed by the investigators, consisted of 59 items, including type of home, ventilation facilities, heating facilities, building materials, home insulation, home design, type of flooring, type of mattress, and visible signs of dampness (damp patches and fungal growth on outer and inner walls, ceilings, and floors). The questionnaire, completed by a principal occupant, consisted of 90 items, including the number of occupants, the presence of pets, cleaning methods, age of flooring and mattress, and visible signs of dampness over the past 2 years.

Relative humidity

Relative humidity and temperature were measured with thermohygrometers continuously for 6 weeks in the bedrooms of 11 children with respiratory symptoms and of eight children without respiratory symptoms. The thermohygrometers were calibrated at the beginning of the measuring period and then every 2 weeks.

Statistical analysis

Statistical analysis of the data was performed with SPSS-PC version 4.01. Pearson correlation coeffi-

cients were calculated to assess associations among continuous variables. For testing differences between means, *t*-tests were performed. Bivariate and multivariate linear regression analyses were conducted to investigate the association between the numbers of CFU/g dust and home characteristics. For that purpose, all variables regarding home characteristics were dichotomized with regard to their possible effect on the presence of fungal propagules in house dust. A variable was given the value "0" if it was considered not to favor the development of fungi in house dust, and the value "1", if it was considered to favor development.

Results

Number of CFU/g dust

The total number of CFU/g dust in both floor and mattress dust varied widely (Table 2). The values were right-skewed, but normally distributed after ln-transformation. For approximately 9% of the samples, the count could not be made because of the high density of colonies on the agar plates. This loss of samples was equal for floor dust and mattress dust, but it was somewhat higher for controls than for cases (14% and 5%).

The total number of CFU/g dust from textile floorings (Table 2) was significantly higher than that for smooth floorings (*t*-test; $P < 0.001$). The number in mattress dust was significantly lower than that in dust from carpeted floors, but significantly higher than that in dust from smooth floors. However, the total number of CFU/g in mattress dust correlated significantly with the number in dust from smooth floors ($r = 0.58$, $P < 0.05$), but not with that in dust from textile floorings.

In total, 64 different fungal species belonging to 26 genera were isolated by the analytic method described. The following species were isolated from more than 50% of the floor and mattress dust samples: *Alternaria alternata*, *Aspergillus versicolor*, *Aureobasidium pullulans*, *Cladosporium cladosporioides*, *C. herbarum*, *Eurotium herbariorum*, *Mucor* spp.,

Table 2. Frequencies (geometric mean (GM), geometric standard deviation (GSD)) of numbers of CFU/g dust from bedroom floors and mattresses for total population and cases and controls separately

Location	Total population			Cases			Controls		
	<i>n</i>	GM	GSD	<i>n</i>	GM	GSD	<i>n</i>	GM	GSD
Bedroom floor	54	8990	2.30	30	8300	2.6	24	9940	2.0
Smooth	15	3530	1.93	9	2760	1.8	6	5050	1.8
Textile	39	12880	1.79	21	13250	1.8	18	12460	1.8
Mattress	55	6760	2.11	29	6810	2.0	26	6690	2.3

Penicillium aurantiogriseum, *P. brevicompactum*, *Ulocladium chartarum*, and yeasts. *Scopulariopsis* spp. were isolated mainly from mattress-dust samples, whereas the xerophilic mold *Wallemia sebi* was isolated from approximately 30% of both mattress and floor dust samples. The following yeasts were predominant: *Rhodoturula glutinis*, *R. minuta*, *R. mucilaginosa*, *Cryptococcus albidus*, and *C. laurentii*. Table 3 presents the geometric mean numbers for the most frequently isolated mold species and genera, and the yeasts, in floor and mattress dust. Table 3 shows that the colonies from approximately 40% of the samples could not be isolated and identified because of the high density of the colonies on the plates. This loss of samples was comparable for floor dust and mattress dust, as well as for cases and controls. The mean numbers of CFU/g of the various species in mattress dust were generally higher than those in the dust of smooth floors. This difference was significant ($P < 0.05$) for *U. chartarum* only. The mean numbers in dust from textile floorings were generally higher than those in mattress dust. These differences were significant for *C. cladosporioides*, *Cladosporium* spp., and *Penicillium* spp.

Relation with home characteristics

The relation between home characteristics and the total number of CFU/g dust was studied by performing bivariate linear regression analyses with 46 explanatory variables. As indicated above, all variables were dichotomized with regard to their possible effect on the presence of fungal propagules in house dust. For floor dust, only five variables showed a (marginally) significant ($P < 0.10$) influence on the number of CFU/g dust. For mattress dust, four variables were found to have (marginally) significant influence. Multivariate linear regression analyses

Table 4. Relation between total number of CFU/g dust from floors and mattresses and home characteristics (multivariate regression analyses)

Characteristic (not favoring/favoring fungal growth)	Coefficient	Standard error	Factor*	P
Floor dust ($R^2=0.76$)				
Occupants at home most of time (yes/no)	-0.40	0.19	0.67	0.04
Presence of pets (no/yes)	-0.47	0.17	0.63	0.01
Type of floor (smooth/textile covering)	1.33	0.17	3.78	<0.01
Mattress dust ($R^2=0.57$)				
Furniture against outer wall (no/yes)	-0.74	0.27	0.48	0.01
Mold patches on inner wall (no/yes)	1.47	0.64	4.35	0.03
Damp patches on outer wall (no/yes)	0.70	0.22	2.04	<0.01

* Factor: regression coefficient to the power of e.

were performed, including only those explanatory variables that showed at least a marginally significant effect on the number of CFU/g dust according to the bivariate linear regression analyses. Table 4 presents the results of the multivariate linear regression analyses for floor dust and mattress dust. Table 4 indicates, for each variable, when it is considered to favor, or not to favor, the presence of fungal propagules in house dust. Furthermore, the regression coefficient and the coefficient to the power of e ("factor") are presented. The latter indicates to what extent the number of CFU/g will increase if the variable in question is expected to favor development of molds. Also R^2 is presented, as it indicates the proportion of the variance of the number of CFU/g dust explained by the regression analysis.

For floor dust, 76% of the variance was explained by the type of flooring, the presence of pets, and whether or not the occupants were at home most of the time. For mattress dust, 57% of the variance was explained by the presence of furniture against the outer wall, fungal growth on the inner wall, and damp spots on the outer wall. However, it should be mentioned that the distribution of each of these explanatory variables was right-skewed. For example, fungal growth on the inner wall was present in only one of the bedrooms. The results obtained with the regression analysis might therefore have been determined mainly by outliers.

Bivariate linear regression analyses were also performed on the number of CFU/g of each of the most frequently isolated mold species ($n = 17$) and genera ($n = 13$) in floor dust and mattress dust. As mentioned before, the colonies could not be isolated from about 40% of the samples. Therefore, the number of homes included in the regression analyses was reduced, as was the number of explanatory variables ($n = 29$). In total, 1740 bivariate linear regression analyses were made. For each species or genus, approximately three varying explanatory variables had a marginally significant influence ($P < 0.10$) on the

Table 3. Frequencies (GM and GSD) of numbers of CFU/g dust from bedroom floors and mattresses for eight different mold species and yeasts

Species	Floor dust			Mattress dust		
	n	GM	GSD	n	GM	GSD
<i>Alternaria alternata</i>	33	145	6.2	35	160	6.0
<i>Alternaria</i> spp.	36	168	6.2	37	244	2.5
<i>Aspergillus versicolor</i>	36	33	13.8	37	38	9.2
<i>Aspergillus</i> spp.	36	44	13.0	37	58	8.7
<i>Aureobasidium pullulans</i>	36	493	6.4	37	275	6.8
<i>Cladosporium cladosporioides</i>	31	453	3.9	34	181	8.5
<i>Cladosporium</i> spp.	36	1461	2.8	37	617	5.2
<i>Eurotium herbariorum</i>	36	20	14.3	37	37	9.1
<i>Penicillium brevicompactum</i>	32	215	6.8	37	134	6.0
<i>Penicillium</i> spp.	36	994	2.8	37	451	2.9
<i>Ulocladium chartarum</i>	35	33	14.4	36	79	8.1
<i>Wallemia sebi</i>	36	6	14.9	37	4	9.2
Yeasts	36	498	5.8	37	457	9.3

number of CFU/g floor or mattress dust. Only the type of flooring had a consistent and substantial influence on the numbers of CFU of the different species and genera in floor dust: the numbers were higher in dust from textile floorings than in dust from smooth floorings. All other explanatory variables had no consistent influence on the numbers of CFU/g for the various species or genera in dust. This finding, together with the large number of regression analyses made, suggests that the significant relations found might have been caused by chance alone. Therefore, no multivariate linear regression analyses were done for the number of CFU/g dust of the various mold species and genera.

Relation with reported and observed dampness

A comparison was made (*t*-test) between the total CFU/g in floor and mattress dust, and the reported and observed dampness of the bedroom (Table 5). For floor dust, the geometric mean number of CFU/g was lower in bedrooms where the presence of fungal growth or damp spots was reported by the occupants. However, these differences were not statistically significant. In contrast, the geometric mean in mattress dust was higher in bedrooms with reported fungal growth or damp spots. Only for reported damp spots was the difference statistically significant. Overall, the mean numbers of CFU/g in floor and mattress dust were higher in bedrooms where fungal growth or damp spots were observed by the investigators, but the differences were not statistically significant.

The same comparisons made for the different fungal species and genera revealed that the counts for

Mucor spp. and *U. chartarum* in floor dust were significantly lower in bedrooms with reported signs of dampness. The number of CFU/g dust belonging to *P. brevicompactum* in floor dust was significantly higher in bedrooms where dampness was observed by the investigators. The number of CFU/g dust of *S. brevicaulis* in mattress dust was also significantly higher in bedrooms where dampness was observed. However, in view of the large number of comparisons made ($n = 240$), these significant differences might have been caused by chance alone.

Fungi in dust of bedrooms of cases and controls

A comparison was made between the total number of CFU/g in dust gathered in bedrooms of cases and controls (Table 1). The numbers of CFU/g in mattress dust and in dust from textile floorings were slightly higher for cases than for controls, but these differences were not statistically significant. For smooth floorings, the mean numbers were lower for cases than for controls.

The same comparisons were made with the numbers of CFU of the different fungal species and genera. For textile floorings, there were only minor differences between cases and controls. In dust from smooth floors, the counts of *Aureobasidium pullulans* were significantly higher for controls than for cases. The number of yeasts in mattress dust of controls was significantly higher than that of cases, whereas the counts of *W. sebi* were significantly higher in mattress dust of cases than that of controls. However, in view of the number of comparisons made, these significant differences might have been caused by chance alone.

Relation with relative humidity

The average relative humidities over the entire measuring period in the different bedrooms ranged from 52.3% (SD 5.5) to 79.0% (SD 7.1). Pearson correlation coefficients were calculated between the average relative humidities and the numbers of CFU/g mattress and floor dust. This was done separately for textile and smooth floorings. The calculated correlation coefficients were all negative, but not statistically significant. Furthermore, there was no association between reported or observed dampness and the average relative humidity. However, the average relative humidity in the bedrooms of cases (68.4%; SD 7.8) was significantly higher (*t*-test; $P = 0.025$) than the average relative humidity in the bedrooms of controls (60.7%; SD 4.9%). Comparable results were obtained with the average absolute humidity over the entire measuring period, because the relative and absolute humidities were strongly associated.

Table 5. Relation between total numbers of CFU/g in floor dust and mattress dust, and reported or observed dampness in bedroom (*t*-test)

	No signs of dampness		Signs of dampness		
	<i>n</i>	GM	<i>n</i>	GM	<i>P</i>
Reported dampness					
Floor dust					
Fungal growth	50	9090	3	8 130	0.83
Damp spots	45	9170	7	7 120	0.47
Mattress dust					
Fungal growth	51	6540	3	10870	0.26
Damp spots	46	6010	7	11870	0.02
Observed dampness					
Floor dust					
Fungal growth	50	9010	1	5 100	—
Damp spots	42	8370	9	10710	0.44
Mattress dust					
Fungal growth	51	6400	2	8400	0.61
Damp spots	42	6370	11	8210	0.32

Discussion

The numbers of CFU/g dust found in the present study were higher than those reported in two other studies in which the presence of fungal propagules in house dust was investigated by plating 30 mg dust directly onto an agar plate. Wood et al. (21) sampled house dust in 106 houses in the Baltimore area, MD, USA. The numbers ranged from 133 to 25 341 CFU/g dust (median 2398). However, Wood et al. (21) used a mixed-dust sample from the bedroom floor, mattress, and the floors of the television area and the basement. The dust was analyzed by direct plating of 30 mg dust onto V8-agar. A valid comparison could not be made because of the different sampling and analytic methods. Wickman et al. (20) investigated the presence of fungal propagules in 175 homes in Sweden by taking dust samples from the floor of the living room and plating 30-mg portions directly onto V8-agar. The mean count was 1349 CFU/g dust (median 999). We have compared the results obtained with 10 different analytic methods (18). This comparison indicated that the yield depends on the medium used. Higher numbers of CFU were obtained with DG18 than with V8-agar. In the study of Gravesen (7), no estimation of the numbers of CFU was made.

The type of flooring had a significant influence on the counts, which were approximately four times higher in dust from textile floorings than from smooth floorings. Wood et al. (21) and Gravesen (7) did not provide information on the type of flooring. Wickman et al. (20) reported only slightly higher numbers of CFU in dust from wall-to-wall carpets. The presence of fungal propagules in floor dust was not associated with reported or observed signs of dampness in the bedroom. Wickman et al. (20) did not find a relation between the number of CFU/g of floor dust (living room) and reported damp patches or mold growth in the home either. However, in their study, higher counts were associated with shower bathing (>0.5 h/d) and reported windowpane condensation in winter. Lower counts of CFU/g floor dust in the present study were associated with the presence of pets in the home and the absence of the occupants during most of the day.

In our study, higher numbers in mattress dust were associated with observed mold growth and damp patches in the bedroom, whereas lower numbers were associated with the presence of furniture placed directly against the outer wall. However, these findings lack meaning because the distributions of these explanatory variables were right-skewed. The results obtained might therefore have been determined mainly by outliers. Wood et al. (21) reported a positive association between reported mold growth in the home and the number of CFU/g dust. As

mentioned above, they used a mixed-dust sample, including mattress and floor dust from four different locations in the home. They also found an association between the number of propagules in house dust and the age of the home. The highest numbers were found in homes less than 10 years and more than 30 years old. In our study, no relation was found with the age of the home.

As far as comparable, the fungal flora found in the present study is similar to that reported by Gravesen (7), Wood et al. (21), and Wickman et al. (20). However, the xerophilic fungi *Eurotium* spp. and *W. sebi* were not found by these investigators because these species do not develop on V8-agar. van Lustgraaf (11) also frequently isolated xerophilic fungi from mattress dust, using three different media with relatively low water activities ranging from 0.82 to 0.94.

The type of flooring had a significant and consistent influence on the numbers of CFU in floor dust of the various species and genera. Overall, for each species or genus, each time approximately three varying home characteristics had a marginally statistically significant influence ($P < 0.10$) on the number of CFU/g floor or mattress dust. In view of the large number of statistical comparisons made, we believe that these associations might have been caused by chance alone. Therefore, they are not reported here. Wickman et al. (20) reported that some construction characteristics of buildings were associated with the occurrence of certain mold species and genera. For example, *A. alternata* was more prevalent in dust samples from homes with mineral-wool thermal insulation than in homes without this insulation. Although Wickman et al. (20) reported four statistically significant associations, they did not report on the total number of comparisons made and the distributions of the explanatory variables.

In our study, no clear differences were found between the presence of fungi in mattress and floor dust (textile and smooth floorings separately) gathered in the homes of cases and controls. The loss of samples caused by the high density of colonies on the agar plates was somewhat higher for controls than for cases. Therefore, the actual difference between the numbers of CFU/g in mattress dust and in dust from textile floorings for cases and controls might even be smaller. Yoshida et al. (22) investigated the presence of fungi in house dust of patients with summer-type hypersensitivity pneumonitis and controls. The total numbers of fungi and yeasts were not significantly different between the homes of the two groups. However, some yeasts (*Trichosporon* spp.) were isolated significantly more frequently from dust obtained in the homes of patients. Ishii et al. (9) investigated the presence of fungi in house dust of asthmatic children with positive and negative skin

tests to molds and in house dust of nonasthmatic controls in Japan. The average number of fungal colonies did not differ significantly among the three groups. Also, the mycoflora in the dust of the three different groups was comparable. Only *W. sebi* was isolated more frequently from the dust in homes of asthmatic children than controls. In our study, the counts of *W. sebi* were also significantly higher in mattress dust of cases than controls. *W. sebi* is known to have allergenic properties (1). In the study of Wood et al. (21) among 106 allergic patients, no association was found among total colony counts in house dust and skin test results, a history of asthma, or a history of exacerbation of symptoms on mold exposure. Wickman et al. (20) reported significantly lower numbers of CFU in dust obtained in homes of atopic children than in that of control children. They suggested that the fact that sanitation measures are taken more often in the homes of asthmatic children explains this difference. Textile floorings were present in 45% of the living rooms of the control group, as compared with 31% for the atopic group. However, as mentioned earlier, the type of flooring only marginally affected their counts. Furthermore, they found no differences between the two groups in reported cleaning habits.

No correlations were found between the average relative humidity in the bedroom over the entire measuring period and the total number of CFU in mattress and floor dust. However, statistically significant correlations were found between the average relative humidity in the bedroom and the concentrations of *Der p* I (the major allergen of the mite *Dermatophagoides pteronyssinus*) in mattress and floor dust (results will be presented elsewhere). Wickman et al. (20) did not find an association between total CFU count and absolute indoor humidity. In our study, the average relative humidity in the bedrooms over the entire measuring period of cases, was significantly higher than that in the bedrooms of controls. Wickman et al. (20) found a higher average absolute indoor humidity in the houses of house-dust-mite-sensitized children than of other atopic children, but not of the control group.

We conclude that only a weak relation was found between the home characteristics as compiled by a checklist and questionnaire, and the number of fungal propagules in floor and mattress dust. Only the type of flooring had a significant and substantial effect on the number of fungal propagules in floor dust. Therefore, the presence of fungal propagules in house dust cannot be reliably predicted by the home characteristics as registered in the checklist and the questionnaire. Furthermore, the presence of fungal propagules in house dust was not related to the average relative indoor humidity measured over 6 weeks. No clear differences were found between the

presence of fungal propagules in house dust of children with reported respiratory symptoms and in that of controls.

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