

House dust mite allergen levels in German day-care centers

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Abstract

We investigated the levels of the major house dust mite allergens, Der p 1 and Der f 1, in dust collected from various locations in 41 day-care centers from two German cities (Düsseldorf and Bonn). One hundred and thirty-seven (96%) of 143 samples yielded detectable amounts of house dust mite allergen (range, <15–85,000 ng/g; interquartile range, 210–1,480 ng group I allergen [sum of Der p 1 and Der f 1]/g dust), and 24 (17%) of the samples (8/34 mattresses; 11/46 cushions/soft toys; 5/43 carpeted floors, 0/20 smooth floors) exceeded the proposed “threshold” level of 2,000 ng/g dust in 18 (44%) of 41 day-care centers. Der p 1 and Der f 1 could be detected in nearly an equal number of samples. The highest concentrations of house dust mite allergens were found in dust from mattresses (geometric mean, 1,103 ng/g dust) and cushions/soft toys (geometric mean, 1,004 ng/g dust). The allergen load per unit area from carpeted floors exceeded that from smooth floors by more than two orders of magnitude. In comparison with dust samples from private homes within the same geographical area, the mite allergen levels in mattress dust (RR, 0.34; CI₉₅, 0.18–0.64) and floor dust (RR, 0.21; CI₉₅, 0.09–0.49) from day-care centers were significantly lower ($p < 0.001$). We conclude that day-care centers should be included as potential places of additional exposure to house dust mite allergens if avoidance measures are taken.

Key words: day-care center – dust mite – allergen – Germany

Introduction

Mite allergens sensitize and induce perennial rhinitis, asthma, or atopic dermatitis in a large portion of patients with allergic disease (Platts-Mills et al., 1992; 1997). It is well established that reducing exposure can effectively reduce allergic symptoms and may offer a realistic chance for primary prevention of sensitization and asthma (Custovic et al., 2000; Tan et al., 1996). However, avoidance measures should be introduced at the earliest

possible stage, if possible during infancy, as early exposure to dust mite allergens may be critical for primary sensitization (Wahn et al., 1997; Ricci et al., 2000). Thus, it is important to include all sites of relevant exposure. Beside the domestic environment, children may spend a considerable amount of their time in day-care centers, and there are sporadic reports on the occurrence of house dust mite allergen levels in day-care centers from Sweden (Munir et al., 1995), France (Dornelas de Andrade et al., 1995), Florida (Fernandez-Caldas et al.,

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2001), Singapore (Zhang et al., 1997), Taiwan (Li et al., 1997), New Zealand (Wickens et al., 1997), and Australia (Green et al., 1992). The purpose of this study was to firstly measure house dust mite allergen levels in a representative number of German day-care centers.

Materials and methods

Characteristics of day-care centers

During 1993-1995, dust samples were collected in 41 randomly selected day-care centers in the cities of Düsseldorf (n=20; sampling period, May to August 1993) and Bonn (n=21; sampling period, December 1994 to March 1995). Overall, the 41 day-care centers harboured a total of 2,760 persons (children and adults), which were scaled as follows: ≤ 50 persons per day-care center, 9 centers; $> 50-70$, 15 centers; $> 70-90$, 14 centers; and > 90 , 3 centers, respectively. The median year of construction of the day-care centers was 1975 (range, 1876-1993; interquartile range, 1958-1988). There were no visible signs of mold, humidity, or (present or past) water infiltration in 92%, 84%, and 78% of the day-care centers, respectively. Further details of the housing characteristics (i.e., insulation, type of roof, flooring, heating, ventilation, construction materials, furniture, plants, pets, cleaning habits) were collected using a checklist. The indoor climatic conditions (single measurements with a portable thermohygrometer) during the time of sampling were as follows: temperature (median), 21.0°C (interquartile range, 19.7-22.7°C); relative humidity, 43% (interquartile range, 38-61%).

Reference data from private homes

As reference data, dust samples from mattresses (n=55), as well as from carpeted floors in living rooms (n=53), and bedrooms (n=55) from private homes of persons with (n=21) and without (n=34) house dust mite sensitization were employed. The samples were collected in the city of Düsseldorf during 1993-1994 (Engelhart et al., 1996). There were no visible signs of mold, humidity, or water infiltration in 93%, 91%, and 98% of the private homes, respectively. As we found no differences between dust mite levels in private homes of persons with or without mite sensitization, both are summarized in the following.

Environmental sampling and laboratory analysis

For dust collection, we used a hand held vacuum cleaner (1000 W) equipped with a new dust bag for each sampling site. Dust samples were collected in each day-care center from three different sites: (i) mattresses, (ii) cushions (sofas, pillows) and soft toys, (iii) and carpeted floors. In addition, smooth floors were sampled in the day-care centers from the city of Bonn. Dust sampling was performed as recommended by Wanner et al. (1993), i.e., by vacuuming at 2 min/m² (floors), and 1 min/m²

(mattresses, soft toys, pillows) respectively. Dust extraction and ELISA were performed as described by Lau et al. (1989). Precoated polystyrene microtiter trays and reagents for sandwich ELISA were obtained from ALK, Copenhagen, Denmark. Results were expressed as nanograms per gram of dust. Assay sensitivity was 15 ng/g dust.

Statistical analysis

Analysis was carried out using the program Epi Info (version 6; CDC, Atlanta, GA). For presentations and statistical evaluation, the sum of Der p 1 and Der f 1 (referred to as "group I allergens" in the following) was used. Mite allergen levels were log₁₀-transformed, and univariate analysis was used to compare levels of two quantitative variables. The incidence of positive samples and allergen levels above the proposed threshold was analyzed using the chi-square test. All *P* values are two-sided.

Results

A total of 143 dust samples were analyzed from 41 day-care centers, of which 137 (96%) yielded detectable amounts of house dust mite allergen (median, 620; interquartile range, 210-1,480 ng group I allergen/g dust), and 24 (17%) of the samples exceeded the proposed "threshold" level of 2,000 ng group I allergen/g dust in 18 (44%) of 41 day-care centers (Table 1). Der p 1 and Der f 1 could be detected in an equally high proportion of samples (i.e., 94% and 96%, respectively), however, we found no significant correlation between both allergens, the concentrations being somewhat higher for Der f 1 (median, 260.0 ng/g, 90th percentile, 1,100.0 ng/g dust) as compared to Der p 1 (median, 200.0 ng/g, 90th percentile, 3,600.0 ng/g dust). The highest concentrations of house dust mite allergens were found in dust from mattresses (geometric mean, 1,103 ng/g dust) and cushions/soft toys (geometric mean, 1,004 ng/g dust; Figure 1). Smooth floors showed the lowest levels of house dust mite allergens (geometric mean, 81 ng/g dust). Table 2 demonstrates mite allergen load (per unit area) from carpeted floors exceeding that from smooth floors by more than two orders of magnitude ($p < 0.001$), and Figure 2 shows that there was a moderate correlation (Pearson's $r = 0.69$) between the mite allergen load from carpeted and smooth floors. Except for the type of flooring, the total mite allergen levels did not show significant associations with any of the housing characteristics, signs of indoor dampness/mold, relative humidities, culturable fungi in dust samples, cleaning habits, or with the season (data not shown). In private homes, house dust mite allergen levels were generally higher as

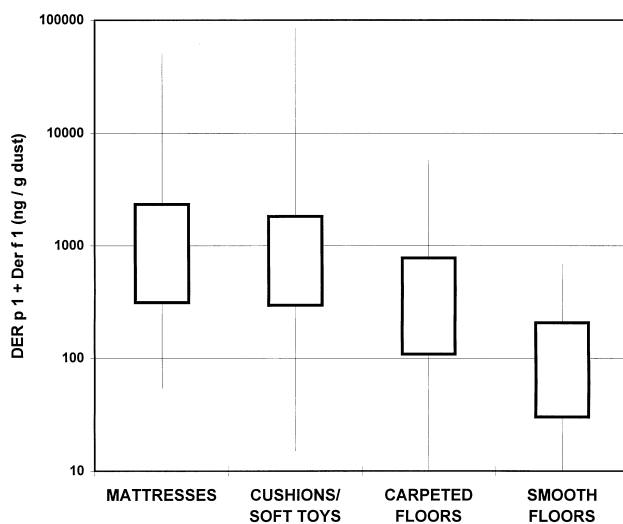
Table 1. Number of dust samples from day-care centers exceeding the proposed "threshold" level of 2,000 ng group I allergen (sum of Der p 1 and Der f 1)/g dust, and relative risk of exposure as compared to private homes (Engelhart et al., 1996).

	No. of samples > 2,000 ng/g dust (%)		Relative Risk (CI ₉₅)	P
	Day-care centers	Private homes		
Mattresses	8/34 (23.5)	38/55 (69.1)	0.34 (0.18–0.64)	< 0.001
Cushions/soft toys	11/46 (23.9)	/	/	/
Carpeted floors	5/43 (11.6)			
Living room		21/53 (39.6)	0.29 (0.12–0.71)	0.002
Bedroom		31/55 (56.4)	0.21 (0.09–0.49)	< 0.001
Smooth floors	0/20	/	/	/

Table 2. Mean values of floor dust (gram per unit area), house dust mite allergen concentration (per unit mass), and house dust mite allergen load (per unit area) in carpeted and smooth floors (n = 20) from day-care centers in Bonn, and corresponding ratios.

Parameter	Unit	Carpeted floor	Smooth floor	Ratio
Floor dust	g/m ²	8.6×10^0	7.0×10^{-1}	1.2×10^1
House dust mite allergen* concentration	ng/g dust	8.1×10^2	8.1×10^1	1.0×10^1
House dust mite allergen* load	ng/m ²	7.0×10^3	5.7×10^1	1.2×10^2

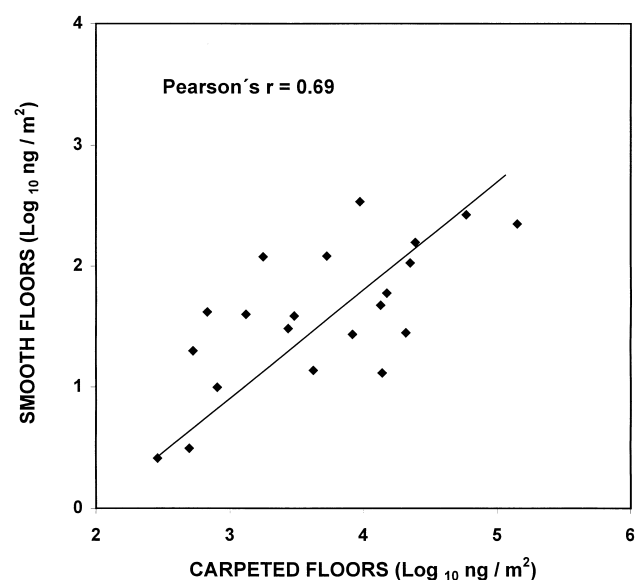
* geometric mean

**Fig. 1.** Mite allergen concentration in dust of mattresses (n = 34), cushions/soft toys (n = 46), carpeted (n = 43), and smooth floors (n = 20) from day-care centers in Düsseldorf and Bonn (n = 41).

compared to day-care centers. The highest concentrations were found in dust samples from mattresses (geometric mean, 5,504.4 ng/g dust), followed by bedroom floors (geometric mean, 2,489.9 ng/g dust), and living room floors (geometric mean, 1,051.2 ng/g dust) (see also Table 1).

Discussion

Our study shows that allergens from house dust mites are common contaminants in German day-

**Fig. 2.** Correlation (Pearson's r) of group I mite allergen levels ($\log_{10}$ ng of allergen load per m²) in carpeted and smooth floors (n = 20) from day-care centers in Bonn.

care centers, and that a considerable proportion (44%) of the day-care centers exceeded the proposed "threshold" level for sensitization in atopic children (Platts-Mills et al, 1992; 1997) in at least one sample, most (79%) of the positive samples referring to mattresses, cushions (sofas, pillows) and soft toys. The clinical appraisal of these data raises the question for the significance of risk levels for mite allergens. Data from several ongoing prospective studies of children suggest that mite sensitization

also may occur below the suggested threshold level, however, it seems that high mite-allergen exposure increases the risk of early sensitization, whereas low exposure levels probably take a longer time to induce sensitization (Custovic and Chapman, 1998; Dreborg, 1998; Munir, 1998). Irrespective of the question of sensitization, there is a significant association between the level of indoor exposure to mite allergens and the provocation of symptoms in sensitized persons (Custovic et al., 1996, Platts-Mills et al., 1997; Tunnicliffe et al., 1999), and only recently, Green et al. (2002) suggested that allergens and viruses may act together to exacerbate asthma, increasing the risk of hospital admission. However, a more detailed presentation of this ongoing discussion is beyond the scope of this paper.

To our knowledge, this is the largest published study on mite allergens in day-care centers. Fernandez-Caldas et al. (2001) reported that mite allergen levels exceeded the proposed "threshold" level in 40% of day-care centers ($n = 20$) in Florida, whereas in the study of Dornelas de Andrade et al. (1995) from France ($n = 28$), concentration of mite allergens was lower on 94% of mattresses and soft toys and on 100% of floors and pillows. Investigations in Swedish day-care centers ($n = 7$) found very low (maximum, 106 ng/g) mite allergen levels in various sites (except floor dust samples) from 9 of 22 sections (Munir et al., 1995). House dust mite allergens have also been isolated from day-care centers in Singapore ($n = 10$; Zhang et al., 1997), Taiwan ($n = 28$; Li et al., 1997), New Zealand ($n = 5$; Wickens et al., 1997), and Australia (Green et al., 1992). However, there is broad consensus that indoor allergen levels are much lower in public places than in most houses and that the domestic dwelling constitutes the most important site of exposure to house dust mite allergens; this is also supported by our studies (Engelhart et al., 1996; 1999; 2000).

The finding of much higher mite allergen levels in carpeted versus smooth floors is consistent with findings in other environments (van Strien et al., 1994; Wickens et al., 1997; Zock and Brunekreef, 1995). Except for the type of flooring, the total mite allergen levels in our study did not show significant associations with any of the housing characteristics which is in accordance with the findings of Wickens et al. (1997). We assume that this is due to different conditions of the microenvironments in mattresses, soft toys, etc., and the macroenvironment as indicated by the housing characteristics. There are many variables influencing this microenvironment (time of use, kind of use, practice of uncovering and ventilating, and so on) which can hardly be recorded

in total by a questionnaire. The limitations of a home characteristics questionnaire as a predictor of indoor allergen levels have also been outlined by Chew et al. (1998). The fact that there was no clear cut predominance of either of the allergens underlines the recommendation to measure both allergens (Gross et al., 2000) which has not been done in all of the studies from day-care centers (Li et al., 1997; Wickens et al., 1997).

In conclusion, this study underlines that day-care centers should be included as potential places of additional exposure to house dust mite allergens if avoidance measures are taken.

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