

Der p I concentrations in mattress surface and floor dust collected from infants' bedrooms

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Summary

Background Allergen exposure in early childhood is thought to be important for sensitization and subsequent development of asthma. Not much is known, however, about exposure of young children to allergens in the home.

Objectives This study was designed to document dust mite allergen exposure in young children, and to determine whether infants from atopic mothers (= 'high-risk' infants) are exposed to lower concentrations of house dust mite allergen than infants from non-atopic parents (= 'low-risk' infants).

Methods Dust samples were taken in the homes of 104 infants (48 'high-risk' and 56 'low-risk' infants, selected by questionnaire) aged 3–15 months, from floors in different rooms and from the child's mattress surface.

Results The majority of the infants were found to be exposed to *Der p* I concentrations of more than 2000 ng/g in dust collected from the surface of their mattresses. Lower *Der p* I concentrations were found in mattress surface dust from the beds of infants from atopic mothers than of infants from non-atopic parents. Also, lower *Der p* I concentrations were found in floor dust from the homes of infants from atopic mothers. Infant beds equipped with new mattresses, new blankets and top plastic sheeting had significantly lower *Der p* I concentrations than beds equipped with used mattresses and blankets, without top plastic sheeting.

Conclusions Young children in the Netherlands are exposed to significant concentrations of *Der p* I in mattress surface dust. Allergic parents appear to provide their children with environments somewhat less rich in mite allergen than non-allergic parents.

Keywords: infants, mite allergen exposure

Clinical and Experimental Allergy, Vol. 25, pp. 1184–1189. Submitted 30 December 1994; revised 20 April 1995; accepted 26 May 1995.

Introduction

Exposure to allergens early in life is suspected to be an important risk factor for the subsequent development of allergy in genetically predisposed children [1,2]. In some studies a 'month-of-birth' effect was seen for allergic disease suggesting the existence of a period early in life in which infants are more vulnerable to sensitization.

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This effect seems to be stronger for seasonal allergens, e.g. grass pollen, than it is for perennial allergens, e.g. cat and mite allergens [3,4].

Few investigators have measured allergen concentrations in the homes of very young children. Most studies focused on *Der p* I, the major allergen of *Dermaphagoides pteronyssinus*, as this house dust mite seems to be the most important producer of indoor allergens in many areas of the world. It has been postulated that the primary cause of asthma in many areas in the world is exposure to house dust mite allergens, especially in

children [5]. In an early study, Carswell *et al.* estimated that the respiratory intake of mite allergens in a group of 10 infants of about 4 weeks old was low [6]. Cots and children's beds were reported to contain less mite allergen than adult beds, but no quantitative data were given. Sporik *et al.* (1990) reported relatively high *Der p* I concentrations in mattress and bedroom floor dust in the homes of 59 children, aged 1–2 years. The geometric mean concentrations were 4300 and 18 400 ng *Der p* I/g of fine dust respectively [1]. Arshad *et al.* (1992) found high geometric mean *Der p* I concentrations (> 10 000 ng/g) in both bedroom floor dust and living room floor dust in the homes of 120 genetically predisposed children that were born one week previous to the home visit [7]. All three studies [1,6,7] were conducted in the south of England. In a recent study, conducted in central Sweden, low *Der p* I concentrations were found, ranging from 15 to 1944 ng *Der p* I/g, in fine dust collected from floors in the homes of 40 3-months-old infants of atopic parents [8]. A provisional threshold for *Der p* I concentrations of 2000 ng/g for sensitization and 10 000 ng/g for an increased risk of asthma attacks in sensitized persons has been proposed [9].

The present study was conducted to gain more insight into mite allergen exposure of infants, especially focusing on mattresses. In an earlier study, we have found that parents of children with allergic asthma report to have taken allergen avoidance measures frequently [10,11]. As children who develop allergy are more likely to have parents who are also allergic and/or asthmatic, we wondered whether parents, who are aware of their own allergy would be more likely than non-allergic parents to take allergen avoidance measures even before their children show any signs or symptoms of allergies. Therefore, we have investigated exposure to *Der p* I of infants born to mothers, aware of a respiratory allergy diagnosed by a doctor, and of infants born to parents not reporting respiratory allergy or symptoms.

Materials and methods

Subjects

A screening questionnaire was distributed among parents visiting a number of Infant Welfare Centres in the Netherlands. The questionnaire enquired about allergy to house dust, pets and pollen, and about cough, phlegm, wheeze, asthma attacks, and shortness of breath in the biological parents of the infants.

In total, 1650 questionnaires were given to the Infant Welfare Centres for distribution. By mail 648 were returned before the first of October, the deadline for inclusion in the study. The questionnaire was completed

by the parents of 543 infants that were between 3 and 15 months old in October 1993, were living with both natural parents and had full questionnaire data. These infants were divided into three groups, according to the answers of their parents to the questionnaire, only two groups of infants were used in the study:

1. infants with both parents reporting neither respiratory allergy nor respiratory symptoms in themselves ($n = 228$).
2. infants with at least the mother reporting doctor-diagnosed and doctor-treated allergy for 'house dust' and/or pets in herself ($n = 67$).

The average age of the infants in each group was approximately 8.5 month. In the first group 50.4% of the infants were girls, in the second group only 37.3% were girls. In the second group 51 of the 67 parents were asked, at random, by telephone, to participate in the study, and all of them agreed. In the first group, 58 of the 228 parents were asked, at random, to participate of whom 56 agreed. The numbers of infants in both groups were matched according to month of birth, making it possible to compare age groups. Eventually, complete data were obtained for 48 infants in the group of infants of atopic mothers and for 56 infants in the group of infants of parents not reporting respiratory allergy or symptoms. The homes of all infants were visited in October 1993 by one employee.

Dust sampling and assay for *Der p* I

Dust samples were taken from the living room floor, the floor of the parental bedroom, the floor of the child's bedroom and the child's mattress surface. Details of the sampling procedure have been published before [10]. From floors consisting of a smooth floor with a rug two samples were taken, one of the smooth floor and one of the rug. The mattress surface was sampled removing the blankets, but leaving undersheets and, when present, plastic sheeting in place. All dust and the filter, which was cut into pieces, was extracted by shaking for 2 h in 0.125 M ammonium hydrogen carbonate with 0.1% sodium azide. The amount of extraction buffer added was determined by the amount of dust in a sample: < 200 mg of dust was extracted in 2.5 mL, 200–500 mg in 5 mL, 500–1000 mg in 10 mL and > 1000 mg in 20 mL. The amount of *Der p* I in the extracts was determined using a sandwich ELISA manufactured by ALK, Hørsholm, Denmark, according to procedures previously described [10].

Questionnaire

A questionnaire was administered to one of the parents.

The interview dealt with a variety of items, including use and characteristics of the house, allergen avoidance measures and respiratory symptoms, allergic disorders and other diseases of the infant. The questionnaire also included information on all possibly dust mite infested materials around the house, i.e. mattresses, floor coverings and upholstery. Also changes in floor coverings, mattresses, cushions and couches which could possibly lead to a reduction in allergen exposure were asked for.

Statistical analyses

Der *p* I concentrations were found to be right skewed and became approximately normally distributed after $\ln$ -transformation. Geometric means (GM) and geometric standard deviations (GSD) were calculated. Differences in mite allergen levels between groups of infants were

evaluated by *t*-test. Mite allergen levels were expressed in ng/g of dust. Statistical analysis was carried out using SAS v6.07 on an ALPHA main frame computer.

Results

In Table 1, a number of characteristics of the study houses and parents is shown. Non-atopic parents rarely reported having taken allergen avoidance measures whereas atopic mothers reported having taken several different measures to reduce the amount of allergens in their homes. Homes of infants of atopic mothers more often had smooth floor coverings in the living room, the parental bedroom and the child's bedroom. In homes of atopic mothers all floors were more often void of carpets or rugs than in homes of non-atopic parents. More than half of the infants in this study slept on a used mattress,

Table 1. Characteristics of the selected groups

		Infants of non-atopic parents (<i>n</i> = 56)	Infants of atopic mothers (<i>n</i> = 48)
Age	(mean (days)/range)	263/117-460	270/113-476
Gender	(% girls)	58.9	39.6
Both parents without secondary education	(%)	21.4	12.5
Firstborn child	(%)	32.1	31.3
Reported changes because of allergies	(%)		
	Living room floor covering	3.6	50.0
	Other floor coverings	1.8	43.8
	Beds	7.1	56.3
	Furniture	0.0	14.6
	Other measures	1.8	27.1
Floor covering in the living room	(%)		
	smooth	30.4	50.0
	smooth with rug	32.1	27.1
	wall-to-wall carpet	37.5	22.9
Floor covering in child's bedroom	(%)		
	smooth	30.4	43.8
	smooth with rug	3.6	2.1
	wall-to-wall carpet	66.1	54.2
Floor covering in parental bedroom	(%)		
	smooth	14.3	29.2
	smooth with rug	0.0	2.1
	wall-to-wall carpet	85.7	68.8
Smooth floorcovering in living room, child's bedroom and parental bedroom	(%)	1.8	22.9
Child sleeps:			
	alone in bedroom (%)	85.7	87.5
	in parental bedroom regularly (%)	30.4	27.1
	on a used mattress (%)	60.7	60.4
	with used blankets (%)	67.9	56.3
	on a mattress with top plastic sheeting (%)	73.2	81.3

Table 2. Geometric mean *Der p I* concentration (ng *Der p I*/g) for the child's mattress surface dust, the child's bedroom floor dust, and for dust collected from the parental bedroom and from the living room floor

	Infants of non-atopic parents			Infants of atopic mothers			<i>t</i> (<i>t</i> -test)
	<i>n</i>	GM	GSD	<i>n</i>	GM	GSD	
Mattress surface dust	55	3331	5.1	48	1610	6.2	2.1*
Child's bedroom, smooth	19	788	5.8	21	235	3.9	2.5*
Child's bedroom, textile	36	3626	5.8	27	2556	5.5	0.8
Parental bedroom, smooth	8	1143	4.7	14	640	3.8	0.9
Parental bedroom, textile	45	7927	6.1	32	4510	8.0	1.3
Living room, smooth	33	542	3.7	37	252	4.0	2.4*
Living room, textile	38	5843	5.7	23	3790	9.3	0.9

$P < 0.05$.

which did not differ between infants of atopic mothers and infants of non-atopic parents. Also more than half of the infants slept with used blankets, the percentage of infants of non-atopic parents appearing somewhat higher ($\chi^2 = 1.5$, NS). It should be noted that mattresses were equipped with top plastic sheeting regularly. This top plastic sheeting is used against bed wetting. None of the mattresses were equipped with mite impermeable covers. There were less girls among the infants of atopic mothers ($\chi^2 = 3.9$, $P < 0.05$) than among the infants of non-atopic parents.

Table 2 shows the geometric mean *Der p I* concentration (ng/g) for mattress surface dust of the child's bed, and for dust sampled from the infant's bedroom floor, the parental bedroom floor and the living room floor. Mattress surface dust of infants of atopic mothers contained less *Der p I* than mattress surface dust of infants of non-atopic parents ($P < 0.05$). In total 56% of the infants slept on beds with *Der p I* concentrations of 2000 ng/g of mattress surface dust and 23% of the infants slept on beds with concentrations higher than 10 000 ng/g of mattress surface dust. *Der p I* concentrations for floor dust were stratified according to type of floor covering. Within strata, lower *Der p I* concentrations were found in homes of infants of atopic mothers, only reaching statistical significance for the *Der p I* concentrations on smooth floors. There was a significant correlation ($P < 0.01$) between the mite allergen concentration in mattress surface dust and the mite allergen concentration in floor dust from the infants' bedroom, the parental bedroom and the living room, irrespective of the type of floor covering (Pearson correlation coefficients were 0.53, 0.53 and 0.30, respectively). The age of the infant had a slightly positive relationship with the *Der p I* concentration in mattress surface dust. Mattress dust

of infants aged 6–15 months had roughly two times higher *Der p I* concentrations than mattress dust of infants younger than 6 months. This difference was not statistically significant, however, and seemed to be somewhat more pronounced for infants of atopic mothers than for infants of non-atopic parents.

In Table 3, mattress surface dust *Der p I* concentrations, are shown for new and used mattresses, new and used blankets and for beds with and without top plastic sheeting. Used mattresses, used blankets and the absence of top plastic sheeting were associated with higher *Der p I* concentration in mattress surface dust. Furthermore in Fig. 1 the group with new mattresses, new blankets and top plastic sheeting was compared with the group with a used mattress, used blankets and without top plastic sheeting. Beds with new mattresses, new

Table 3. Mattress surface *Der p I* concentrations in relation to the age of mattress and blankets and the presence of top plastic sheeting

	<i>Der p I</i> concentration		
	<i>n</i>	GM	GSD
All	103	2373	5.8
New mattress	41	1792	6.3
Used mattress	62	2858	5.4
New blankets	33	1346	4.8
Used blankets	70	3100*	5.9
Top plastic sheeting	79	2182	5.7
No top plastic sheeting	24	3134	6.0

Differences tested with Student *t*-test: * $P < 0.05$.

blankets and with top plastic sheeting had three to five-fold lower geometric mean *Der p* I concentrations ($t=2.42$; $P<0.05$). The Pearson correlation between allergen levels expressed in ng/g and ng/m² was high: it ranged from 0.69 to 0.87 for dust collected from smooth floors, and from 0.90 to 0.97 for dust collected from mattresses and carpeted floors.

Discussion

The results of this study show that relatively high *Der p* I concentrations can be found on the mattress surface of beds of infants in the age of 3–15 months, suggesting a swift infestation of these mattresses with house dust mites. The concentrations were somewhat lower for infants of atopic mothers than for infants of parents not reporting respiratory allergy or symptoms. The results also show that the *Der p* I concentration in mattress surface dust is lower when beds are fitted with new mattresses, new blankets and top plastic sheeting.

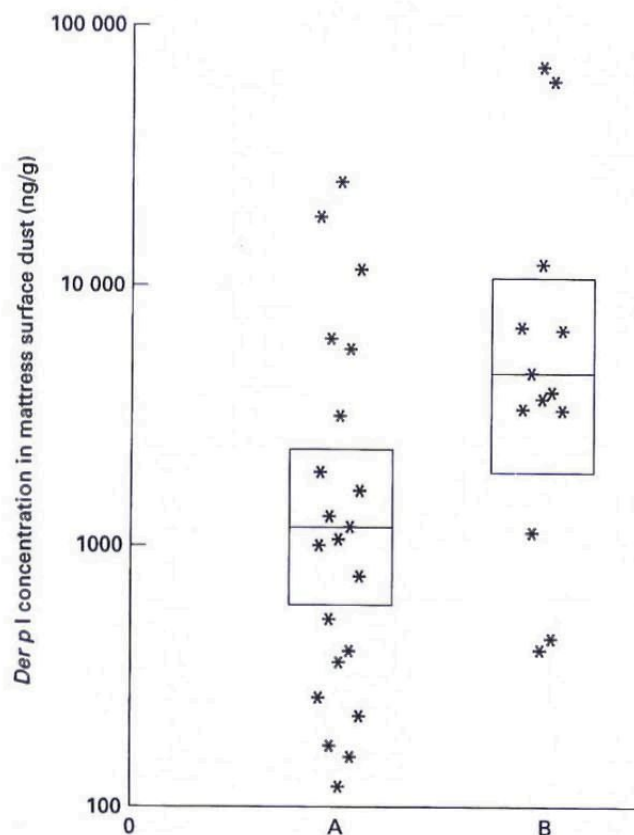


Fig. 1. The influence of age of materials and presence of top plastic sheeting on the *Der p* I concentration (ng/g) in mattress surface dust. Boxes denote geometric mean and 95% confidence limits. A. New mattress, new blankets, plastic sheeting ($n=21$). B. Used mattress, used blankets, no plastic sheeting ($n=13$).

Der p I concentrations found in mattress surface dust in this study were relatively high (geometric mean 2373 ng/g). About 40% of the beds were provided with a new mattress and 38% with newly bought blankets. The mattress surface area was sampled with all the bedding remaining in place, so the influence of the presence of top plastic sheeting was taken into account. Mattress surface *Der p* I concentrations were only slightly lower than in our previous study of the *Der p* I concentrations in dust (geometric mean 5075 ng/g from 512 mattresses (blankets etc. removed) of children aged 6–12 years [10]. Mattress dust *Der p* I concentrations reported by Sporik *et al.* in beds of 59 1–2-year-old children with at least one atopic parent, were much higher (geometric mean 18 400 ng/g). The fact that samples were actually taken from the mattress itself, could account for the higher concentrations encountered in these two studies. Also the age of the infants in this study was lower, and the materials in their surroundings possibly less infested with house dust mite.

Mattress surface dust *Der p* I concentrations were two to three times lower for infants of atopic mothers than for infants of non-atopic parents. Allergen avoidance measures were more frequently reported for the homes of infants of atopic mothers than for the homes of infants of non-atopic parents. This suggests that reported allergen avoidance measures have had their intended effect at least to some extent. The lower *Der p* I concentrations in dust from mattresses of infants of atopic mothers could not be explained in full by the use of new mattresses, new blankets and top plastic sheeting. Differences between infants of atopic mothers and infants of non-atopic parents with regard to the use of new materials on the bed were not very pronounced (Table 1), while still the mattress surface dust *Der p* I concentrations were lower for infants of atopic mothers. Floor dust *Der p* I concentrations were also lower in the atopic group. Differences in cleaning regime could be the cause of these differences, especially on floors with smooth floor covering, but no information on this factor was obtained.

The influence of a used mattress, used blankets and top plastic sheeting on the *Der p* I concentration in mattress surface dust was quite clear. When these three factors were combined and beds with a used mattress, used blankets and without top plastic sheeting were compared to beds provided with new blankets, a new mattress and top plastic sheeting, the difference in the *Der p* I concentrations was statistically significant, notwithstanding the small numbers of infants involved (Fig. 1).

We conclude that *Der p* I concentrations in dust collected from mattress surfaces of infant beds were quite high, and often exceeded 2000 ng/g dust, which is

regarded as representing a risk for genetically predisposed children. For newborn infants, it is possible to lower exposure to Der p I by providing new mattresses, blankets and top plastic sheeting, or by applying a mite impermeable mattress cover which has been shown to be effective by other investigators [12].

Acknowledgements

We thank the parents of the infants who participated in the study. The study was supported by a grant of the Dutch Asthma Foundation.

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