

Allergens, Der p 1, Der f 1, Fel d 1 and Can f 1, in newly bought mattresses for infants

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Summary

Background To avoid allergen exposure of newborn babies, the use of a new mattress for the baby bed may be recommended. However, it is not certain that new mattresses are always free of allergens.

Objective In the present study the allergen content of new infant mattresses was investigated.

Methods Dust samples were vacuumed from 90 new mattresses for infant beds bought in 50 different Dutch shops, and the concentrations of Der p 1, Der f 1, Fel d 1 and Can f 1 were determined by radioimmunoassays.

Results Most mattresses contained some allergen and often the allergen concentrations were surprisingly high. Only 15 of the 90 mattresses contained no detectable amounts of any of the four allergens. The highest concentration found for each allergen was 3.1, 46.5, 20.2 and 95.7 µg/g of dust, respectively. However, the total amount of allergen in a mattress was still rather low because the new mattresses contained only modest amounts of dust. Baby mattresses more often contained an increased allergen load than the larger, standard-sized, infant mattresses. This may be caused by differences in manufacturing procedure. Also, mattresses that were sold without a plastic encasement more often contained an increased allergen load.

Conclusions It is advisable to buy a mattress that is wrapped in plastic, but it may still contain a substantial amount of allergen. Thorough vacuuming of a newly bought mattress before it is installed on a child's bed, is also advisable. After instalment, regular vacuuming of the mattress and washing of the bed linen as well as measures to eliminate allergen reservoirs in other parts of the house are important, because our observations indicate that mattresses easily pick up allergens from the environment.

Keywords house dust allergen, mattress

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Introduction

Indications have been found that early onset of asthma is correlated with high concentrations of mite allergens in the mattress [1], an issue which brings mattresses for babies and infants into focus. The Netherlands Asthma Foundation, for instance, recommends buying a new mattress for newborn babies. These recommendations rely on the assumption that new mattresses are free of allergen. But are they always free of allergen? In the present investigation we checked whether newly bought mattresses for babies and infants contained detectable amounts of the allergens Der p 1, Der f 1, Can f 1 and Fel d 1.

Methods

Sample of mattresses

Mattresses for baby cots (B-mattresses, dimensions 40 × 85 × 6–10 cm, $n = 44$) and for infant beds (K-mattresses, dimensions

60 × 120 × 10 cm, $n = 46$) were bought in 50 different shops (one baby and one infant mattress per shop) in 28 different cities and towns, spread over seven of the 12 provinces of the Netherlands. One was an inner-spring mattress (06K) and one had the core partly made of latex (07K). All other mattresses had a polyurethane core. The shopkeepers were not informed about the purpose of the purchase until the mattresses were chosen. Then some more information was acquired about the origin, history and composition of the mattress.

Dust sample

One dust sample was taken from each mattress, using a Miele 'Cat and Dog' vacuum cleaner (Miele & Cie. GmbH, Gütersloh, Germany), operated at 1000 Watts and supplied with an ALK nozzle (Allergologisk Laboratory, Horsholm, Denmark) with Whatman filter paper (no. 54, diameter 70 mm) for dust collection. The mattress was vacuumed for a total of 8 min (with three interruptions to avoid overheating the vacuum cleaner) in a standardized way so that the whole surface was covered evenly. The amount of fibrous material released differed greatly among mattresses. After the sample was weighed, most of the fibrous material was taken off and weighed separately. All material, fine dust and fibres was used to make an extract for allergen

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Table 1. Quantities of dust and allergen recovered from new mattresses, arranged by increasing total amounts (Sum) of allergen

Mattress	In plastic	Dust (mg)	Allergen (ng/mattress)				
			Der p 1	Der f 1	Fel d 1	Can f 1	Sum
04B	Y	80	<3	<3	<4	<10	0
19B	Y	9	<3	<3	<4	<10	0
20B	Y	9	<3	<3	<4	<10	0
35B	Y	18	<3	<3	<4	<10	0
02K	Y	25	<3	<3	<4	<10	0
09K	Y	18	<3	<3	<4	<10	0
24K	Y	12	<3	<3	<4	<10	0
26K	Y	6	<3	<3	<4	<10	0
27K	Y	16	<3	<3	<4	<10	0
29K	Y	15	<3	<3	<4	<10	0
32K	Y	15	<3	<3	<4	<10	0
34K	Y	20	<3	<3	<4	<10	0
42K	Y	104	<3	<3	<4	<10	0
45K	Y	15	<3	<3	<4	<10	0
46K	Y	13	<3	<3	<4	<10	0
04K	Y	18	<3	3	<4	<10	3
15K	Y	49	<3	3	<4	<10	3
30K	Y	11	<3	3	<4	<10	3
41K	Y	22	<3	<3	4	<10	4
17B	Y	291	<3	<3	4	<10	4
05B	Y	17	<3	<3	5	<10	5
33B	Y	20	<3	<3	5	<10	5
28K	Y	91	<3	6	<4	<10	6
05K	Y	76	<3	6	<4	<10	6
36K	Y	26	7	<3	<4	<10	7
29B	Y	30	9	<3	<4	<10	9
11K	Y	50	<3	<3	9	<10	9
19K	Y	30	<3	<3	10	<10	10
03K	Y	8	<3	<3	11	<10	11
39B	Y	6	6	<3	7	<10	13
10B	Y	16	<3	<3	<4	13	13
34B	Y	82	<3	<3	<4	15	15
17K	Y	319	<3	<3	4	14	19
10K	Y	67	<3	6	13	<10	19
20K	Y	42	<3	7	<4	15	22
23B	Y	35	3	<3	8	13	24
49K	Y	14	<3	<3	12	13	25
02B	Y	12	<3	<3	12	13	25
22B	Y	36	3	<3	6	17	26
23K	Y	83	<3	<3	26	<10	26
37K	Y	64	<3	<3	8	18	26
11B	Y	14	<3	<3	7	22	28
47B	Y	20	<3	<3	<4	31	31
28B-2	N	29	<3	<3	36	<10	36
40B	Y	66	7	19	13	<10	39
16K	Y	131	5	17	5	14	40
07K	Y	17	<3	6	23	13	42
25K	Y	389	<3	4	<4	40	44
03B	Y	11	<3	<3	11	33	44
22K	Y	56	<3	7	5	33	46
01K-1	Y	160	17	11	18	<10	46
21K	Y	32	5	4	40	<10	49
09B	Y	15	<3	<3	34	15	49
30B	Y	20	3	<3	30	18	52
42B	Y	25	<3	<3	31	21	52
48K	Y	83	<3	30	9	16	54
06K	Y	91	5	8	11	31	55
14K	Y	18	8	<3	34	15	58

Table 1. (contd.)

Mattress	In plastic	Dust (mg)	Allergen (ng/mattress)				
			Der p 1	Der f 1	Fel d 1	Can f 1	Sum
33K	Y	88	25	37	<4	<10	62
01K-2	N	74	<3	5	29	30	64
07B	Y	27	5	5	<4	57	66
12B	Y	182	13	<3	10	49	72
16B	Y	180	15	8	31	19	73
06B	Y	64	17	44	22	<10	83
31K	Y	17	<3	56	19	13	88
26B	Y	20	<3	4	47	38	89
38B	Y	101	22	14	20	40	94
35K	Y	577	<3	<3	65	32	97
44K	Y	26	7	3	92	<10	102
25B	N	23	5	7	40	54	105
01B	Y	166	<3	<3	26	103	129
28B-1	Y	16	<3	134	<4	<10	134
37B	N	22	6	10	26	94	135
21B	Y	62	3	<3	96	36	135
24B	Y	194	12	13	53	74	153
18K	Y	26	11	6	<4	144	161
15B	Y	74	8	6	67	145	225
08B	Y	9	15	2	33	208	257
32B	Y	276	5	<3	79	205	288
43B	N	20	6	213	42	30	291
31B	Y	14	5	14	283	27	328
12K	N	200	54	14	116	199	383
13B	Y	18	6	4	<4	483	492
27B	Y	21	66	225	192	23	505
08K	N	212	28	21	105	421	575
41B	N	23	13	<3	28	700	740
14B	Y	25	22	1163	20	<10	1204
50K	N	37	46	227	57	2324	2653
01K-3	N	285	6	27	1680	951	2664
18B	Y	47	114	26	36	4497	4673

In the first column mattresses are designated by a number, indicating the shop where it was bought, followed by either a B, for a baby mattress (85 × 40 cm) or a K for an infant mattress (120 × 60 cm).

quantification. Exactly the same sampling procedure was applied to either a 0.85-m² or a 1.8-m² surface area of four old, adult mattresses to obtain some indication about the normal dust load of used mattresses.

Allergen quantification

To determine the allergen content of the dust extracts, radioimmunoassays were done at the Central Laboratory of the Blood Transfusion Service (CLB) in Amsterdam. The protocol followed by this laboratory is totally equivalent to that described in detail by van Ree et al. [2] for grass pollen allergen, whereas we replaced anti-grass pollen rabbit serum with anti-Der p 1, Can f 1 and Fel d 1 serum, and replaced labelled grass pollen allergen with labelled Der p 1, Can f 1 and Fel d 1. Der p 1 was purified using specific monoclonal antibodies as described previously [3]. Purified Fel d 1 was obtained by affinity-purification [4], as was purified Can f 1 [5]. Purified allergens were radiolabelled using the Chloramine T method. Anti-Der p 1 was obtained after multiple immunizations of New Zealand White rabbits with 100 µg of purified Der p 1. Anti-Can f 1 was

ALK 522182 and anti-Fel d 1 was ALK 120482/1. Der f 1 was measured using a commercially available enzyme-linked immunosorbent assay (ELISA) kit (Indoor Biotechnologies, Cardiff, UK).

Statistical evaluation

Non-parametric statistical tests were applied to the total amount of allergen in the mattresses, Der p 1 + Der f 1 + Fel d 1 + Can f 1 (last column in Table 1).

Results

The results are summarized in Table 1, in which the mattresses are arranged by increasing total amount of allergen recovered per mattress (Der p 1 + Der f 1 + Fel d 1 + Can f 1). The concentrations of allergen per gram of dust can be calculated easily. Rather high concentrations per gram of dust were found in several mattresses. The concentration of Der p 1 was more than 2 µg/g in two cases, the suggested threshold level for risk of sensitization [6]. The dust from mattress 27B had the highest concentration (3.1 µg/g) but, with regard to the total amount of Der p 1, it was in second place after 18B (2.4 µg/g). Mattress 14B had the highest concentration of Der f 1 (as much as 46.5 µg/g) and also the highest total amount of this allergen. Mattress 31B had the highest concentration of Fel d 1 (20.2 µg/g) but, with regard to the total amount, it was in second place after 01K-3, with 5.9 µg/g. Mattress 18B had the highest concentration of Can f 1 (as much as 95.7 µg/g) and also contained the highest total amount. To obtain some comparable data about the total amount of allergen in old, used mattresses, a 0.85-m² area (the surface area of a B-mattress) of two adult mattresses was vacuumed with the same intensity as the new mattresses under study. This yielded 405 and 1171 mg of dust, respectively. Similarly, a 1.80-m² area (the surface area of a K-mattress) of two other adult mattresses was vacuumed, yielding 1152 and 818 mg of dust, respectively. The average amount of dust recovered from the 44 new baby B-mattresses was 56 mg, while the 46 K-mattresses yielded on average 81 mg of dust (Table 1). Mattresses 35K, 25K, 17K and 17B yielded much dust, but this dust contained less allergen. There is no clear correlation between the amount of dust recovered and the total amount of allergen, but the 15 mattresses that yielded no detectable allergen of any kind also contained little dust on average (median-test: $P < 0.01$). Eight mattresses (01K-1, 12B, 24B, 12K, 08K, 32B, 17B and 25K) had the ticking made of stretch, which releases much fibre when it is vacuumed, resulting in a heavy dust sample. When these eight mattresses are left out, the average weight of the dust is 66 and 38 mg for K- and B-mattresses, respectively. The mattresses originated from at least 18 different manufacturers in the Netherlands and Belgium. Three manufacturers dominated the market, namely ABZ (Overpelt, Belgium), Faas (Arnhem, the Netherlands) and Cools (Haarlem, the Netherlands) and were accordingly well represented in the sample (B: seven, 11 and four mattresses; K: seven, seven and three mattresses, from ABZ, Faas and Cools, respectively). Statistically significant differences concerning the total amount of allergen among these three and the pooled remaining

manufacturers were not found (Kruskal–Wallis test, $n_1 = 14$, $n_2 = 18$, $n_3 = 7$, $n_4 = 51$, $P < 0.28$).

Most of the mattresses were tightly wrapped in plastic when they were bought, but 10 were not (Table 1). These 10 contained on average much more allergen, namely 765 µg instead of 132 µg (Mann–Whitney *U*-test, $n_1 = 10$, $n_2 = 80$, $P < 0.001$, two-sided). Three of these (01K-2, 08K and 01K-3) had been used as show-models in the shop where they were bought. When these three K-mattresses are left out, the difference in allergen levels is still significant (621 vs. 132 µg; Mann–Whitney *U*-test, $n_1 = 7$, $n_2 = 80$, $P < 0.001$, two-sided). When only B-mattresses are considered, the difference between wrapped and unwrapped mattresses is not so great (261 vs. 242 µg; Mann–Whitney *U*-test, $n_1 = 5$, $n_2 = 39$, $0.05 < P < 0.10$, two-sided).

Although B-mattresses are much smaller than K-mattresses, the former contain on average more allergen (B: 244 µg; K: 163 µg; Mann–Whitney *U*-test, $n_1 = 44$, $n_2 = 46$, $P < 0.01$, two-sided). When the 10 mattresses that were not wrapped in plastic are left out, the difference is even more striking (B: 242 µg; K: 28 µg; Mann–Whitney *U*-test, $n_1 = 39$, $n_2 = 41$, $P < 0.01$, two-sided). It is also remarkable that the mattresses with the highest concentrations of specific allergens were all B-mattresses ($P = 0.06$).

Discussion

The allergen concentrations per gram of dust are at first sight appallingly high. Nevertheless, the allergen exposure that it will lead to may be quite modest because new mattresses contain little dust. For an effective avoidance strategy it is important to be aware of the sources and movements of allergen-containing dust. To explain the difference in allergen content between B- and K-mattresses, the following speculative but plausible explanation can be offered: Infant beds have a standard size and consequently K-mattresses originate from a bulk of 120 × 60 cm mattresses, made in factories using installed machinery. In contrast, baby cots have all different sizes (the dimensions 85 × 40 cm do not represent a standard size.). Thus the B-mattresses were all specially made by order. It is conceivable that this involves much more handling by people, some of whom may have allergen-containing dust on their clothes.

There is much evidence in the literature indicating that the allergens of cats and dogs can be efficiently transported on the clothes of people [6–12]. For mite allergens this is not so easy to establish because live mites may be present almost everywhere. Dust mites often live in the core of mattresses [13–15], but in new mattresses food for them must be very scarce and without food they cannot produce allergens. Thus, the likeliest explanation for the presence of mite allergens, as well as allergens from cats and dogs, is contamination through the clothes of people who were handling them. This also explains why mattresses that were not wrapped in plastic contained relatively more allergen. In line with this interpretation is the finding that mattresses that contained exceptionally high amounts of one allergen, usually had increased amounts of other allergens as well (01K-3, 08K, 12K, 14B, 18B, 27B, 31B, 43B, 50K).

Thus it is advisable to buy mattresses that are wrapped in plastic. However, wrapped mattresses may also contain allergen. Vacuuming the mattress before instalment will remove part of the dust. Also, after instalment, regular vacuuming is advisable because our findings indicate that contamination from other sources frequently occurs.

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