

House dust mite allergen (Der p 1) accumulation on new synthetic and feather pillows

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Summary

Background We have previously demonstrated that synthetic pillows contain significantly more Der p 1 than feather pillows. The aim of this study was to compare the accumulation of Der p 1 allergen on new synthetic and new feather pillows.

Methods Der p 1 was measured in dust samples from pairs of synthetic and feather pillows placed together on 12 beds over a 12-month period.

Results After 12 months synthetic pillows contained higher concentrations of Der p 1 (19.28 µg/g; 95% confidence interval: 9.76–38.07) than feather pillows (6.45 µg/g; 2.96–14.05). There was a significant correlation between Der p 1 concentrations of pillows at 12 months and Der p 1 concentrations of the mattresses at the beginning of the study ($r = 0.72$; $P = 0.008$ for both types of pillows).

Conclusions Synthetic pillows accumulate Der p 1 more rapidly than feather pillows and the accumulation rate of Der p 1 on pillows is governed by the Der p 1 concentration in the immediate environment they are placed in.

Keywords: house dust mites, allergen, Der p 1, asthma, pillows

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Introduction

Exposure to high levels of Der p 1 is a risk factor for exacerbation of asthma in house dust mite-sensitive asthmatics [1]. Der p 1 is present throughout domestic dwellings, including the bedroom. Within the bedroom, carpets, mattresses, bedding and pillows are the main sources of exposure [2]. Occlusive covers for mattresses, duvets and pillows are important allergen avoidance measures for house dust mite-sensitive asthmatics but their long-term effectiveness is not known [3].

Although true feather allergy is very rare [4], pillows with feather filling have traditionally been discouraged among allergy sufferers because of the risk of allergy to feathers [5,6], and thus synthetic material-filled pillows have been recommended for use by atopic patients. There is, however, little published evidence to support the use of synthetic pillows.

In 1995 Strachan and Carey made the unexpected observation that nonfeather pillows were associated with an increased risk of severe childhood asthma [7]. They

hypothesized that synthetic material-filled pillows could release volatile organic compounds which could increase mucosal permeability to inhaled allergens. In another study, they found that increased use of nonfeather pillows was the main indoor exposure that was predominantly associated with a 20% increase in the population prevalence odds of wheeze in children in London over a 13-year period [8]. It remains a possibility that exposure to higher Der p 1-containing synthetic pillows could explain these findings [9] as we have previously observed significantly greater amounts of recoverable Der p 1 from synthetic pillows than from feather pillows [10].

As it is not known at present how rapidly pillows accumulate Der p 1, nor what determines this accumulation rate, we studied the rate of accumulation of Der p 1 on new synthetic and new feather pillows over a 12-month period. Such information is of potential interest for instance in determining the frequency of pillow cleaning to keep pillow Der p 1 concentrations at low levels.

Materials and methods

A pair of new synthetic (polyester) and feather (95%

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feathers, 5% down) pillows (Cloud 9™, NZ Merchants Ltd, Auckland, New Zealand) were placed on 12 beds of 12 Wellington residents. Three of the residents slept with the feather pillow on top, four with the synthetic pillow on top, and five had no preference. Dust samples were collected before placement and after 3, 6, 9 and 12 months by vacuuming each pillow for 3 min on each side. In addition, a 1 m² area of the top of the mattress and carpeted floor beside the bed, respectively, were sampled at the initiation of the study. Dust samples were collected with a Hitachi CV-2500 vacuum cleaner (1100 W) with a nylon mesh sleeve attached to the vacuum head.

All collected dust samples were stored at -20 °C before fine-sifting through a 425 µm steel mesh sieve. The resulting fine dust was then extracted (100 mg dust in 1.0 mL of phosphate-buffered saline for 30 min at room temperature) and Der p 1 content estimated by double monoclonal antibody enzyme-linked immunosorbent assay methodology [11]. Between-batch coefficients of variation of around 10% are constantly achieved in our laboratory, which also participates in an external Der p 1 quality control program [12].

Because of the non-Gaussian distribution of the Der p 1 data, results were log-transformed. Statistical analysis was by two-tail paired Student's *t*-test and least square linear regression analysis. A *P*-value of <0.05 was deemed statistically significant.

Results

Der p 1 levels in the dust collected from the synthetic and feather pillows at baseline and at 3, 6, 9 and 12 months are listed in Table 1 (µg/g fine dust) and Table 2 (total µg/pillow). Der p 1 accumulation was more rapid on synthetic pillows than on feather pillows throughout the 12-month study period. At 12 months, synthetic pillows contained on average five times more total Der p 1 than feather pillows. This was not due to differences in the weights of dust collected by the vacuuming technique as the mean total

weights (95% confidence interval) of dust collected were 0.0472 g (0.0298–0.0646) and 0.0311 g (0.0190–0.0432), respectively, for synthetic and feather pillows at 12 months (*P* = 0.11).

The geometric mean (95% confidence interval) Der p 1 levels in mattresses and carpeted floors at commencement of the study were 61.9 µg/g (36.9–103.6), and 59.1 µg/g (28.1–124.5), respectively. There was a significant correlation between initial mattress Der p 1 levels (µg/g) and the 12-month pillow Der p 1 levels (µg/g) for both types of pillow (*r* = 0.72; *P* = 0.008). No correlation between carpeted floor Der p 1 levels and 12-month pillow Der p 1 levels could be found (*r* = 0.003 and 0.25, respectively, for synthetic or feather pillows, *P* > 0.05).

Discussion

This study has demonstrated that synthetic pillows accumulate Der p 1 more rapidly than feather pillows, and that pillow Der p 1 accumulation is governed by the Der p 1 concentration at the site they are placed in. The study has also reconfirmed our previous findings of a greater Der p 1 content of synthetic pillows when compared with feather pillows [10], which has recently been confirmed in the UK [13].

The reason for the greater Der p 1 accumulation on synthetic pillows is uncertain. Synthetic pillows either preferentially retain allergen or support greater house dust mite infestation. In regard to the latter, electron microscopy showed that the weave of the encasement on synthetic pillows is considerably more open than that of the feather pillow encasement material (unpublished observations). Further studies are required to determine whether the more tightly woven encasements used on feather pillows (to keep the feathers inside the pillow) act as a barrier against house dust mites, while the more loosely woven encasements of synthetic pillows may allow freer movement of house dust mites into the pillow.

Table 1. Relative geometric mean Der p 1 concentrations in 12 synthetic and 12 feather pillows over a 12-month period

Time period (months)	Pillow Der p 1 µg/g		<i>P</i> (<i>t</i> -test)	Mean ratio Synthetic : Feather (95% confidence interval)
	Synthetic	Feather		
0	1.83	0.67	0.0019	2.76 (0.72–10.49)
3	4.91	0.60	0.0001	8.15 (3.48–19.11)
6	6.20	0.77	0.0021	8.09 (1.01–65.00)
9	9.11	1.99	0.0143	4.57 (1.05–19.81)
12	19.28	6.45	0.0039	2.99 (1.45–6.15)

Table 2. Total geometric mean Der p 1 content of 12 synthetic and 12 feather pillows over a 12-month period

Time period (months)	Pillow Der p 1 $\mu\text{g/g}$		P (<i>t</i> -test)	Mean ratio Synthetic : Feather (95% confidence interval)
	Synthetic	Feather		
0	0.06	0.10	0.0922	0.67 (0.18–2.53)
3	0.13	0.05	0.0001	2.44 (1.14–5.24)
6	0.31	0.04	0.0032	7.65 (0.78–75.16)
9	0.46	0.08	0.0194	5.52 (0.99–30.77)
12	0.76	0.15	0.0001	4.90 (1.90–12.67)

We spend approximately one-third of our lives in our sleeping environment. Bedding and pillows are a potent source of house dust mite allergen exposure. Der p 1 levels in pillows, bedding and clothes, in closer proximity to the airway, may have a much greater impact on lung exposure than levels on floors and furniture. Sakaguchi *et al.* [14], for example, have shown that the airborne levels of house dust mite allergens in the bedroom during sleep is 10-fold higher than during normal daily activities in the living rooms of the same domestic dwellings. A recent study has demonstrated strong correlations between bedding Der p 1 levels and several markers of severity of asthma [15], while previous studies from Papua New Guinea [16,17], Italy [18] and New Zealand [19] have also demonstrated the importance of the domestic environment, and bedding in particular, in sensitizing individuals to environmental allergens.

Current advice to asthmatic and atopic patients sensitized to house dust mite allergens is to use synthetic pillows in preference to feather pillows because they are less 'allergenic' or 'hypo-allergenic'. From the results of this study, and from those in the UK [7,8,13], this advice may be inappropriate given the rapid and greater accumulation of Der p 1 by synthetic pillows compared with modern feather pillows.

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