

Synthetic pillows contain higher levels of cat and dog allergen than feather pillows

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The use of non-feather pillows has increased over the last few decades. Recently, we found significantly higher levels of dust mite allergens in synthetic pillows than in feather ones. This study investigated the levels of pet allergens in feather and synthetic pillows. Dust samples were collected from 14 pairs of pillows (consisting of one synthetic fibre-filled and one feather-filled). Each pair of pillows had been on the same bed for at least 2 years. The pillows were vacuumed for 1 min on each side through a 355- μ m diameter mesh onto a 5- μ m vinyl filter, producing a sample of fine dust. Samples were extracted, and cat (Fel d 1) and dog (Can f 1) allergens determined using monoclonal antibody-based enzyme-linked immunosorbent assay (ELISA). Results were expressed both as total amount of allergen recovered and concentration of allergen per unit weight (ng/g). Total levels of pet allergens were significantly higher in the synthetic pillows (Fel d 1: 6.7-fold difference [95% CI 1.5–29.7], $p=0.01$; Can f 1: 8-fold difference [95% CI 1.6–39.5], $p=0.01$). Similarly, when the results were expressed as ng/g, synthetic pillows contained significantly more allergens than feather pillows (Fel d 1: 3.7-fold difference [95% CI 1.3–10.1], $p=0.01$; Can f 1: 4.4-fold difference [95% CI 1.5–13.2], $p=0.01$). We have therefore demonstrated that synthetic pillows contain significantly more pet allergens than feather pillows, supporting the view that tightly woven encasements surrounding feather pillows act as a barrier for allergens.

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In the last 20 years there has been an increasing number of cats and dogs in the home environment, and a trend to keeping them indoors. Several recent studies have highlighted the importance of pet allergens in asthma. Warner et al. studied the prevalence of sensitization to mite, cat, and dog allergen in relation to current exposure in asthmatic children in Sweden (1). Dust mite allergen levels were higher in homes in the south of the country, whilst levels of cat and dog allergens tended to be higher in the north. Mite sensitization was dominant in the south, while sensitivity to cat and dog was more prevalent in the central and northern areas of the country. In the desert environment of Los Alamos (NM, USA), with low levels of mites but high levels of exposure to cats and dogs, childhood asthma is associated with sensitization to dog and cat allergens (2). Similar findings were

reported from southeastern Asia. Pet ownership is rare in the traditional Chinese population, and asthma is not associated with pet allergy (3). Contrary to this, in urban Hong Kong where there is a high level of pet ownership, being sensitized to animal dander represents a significant risk factor for asthma (3).

The use of non-feather pillows has also increased over the last few decades. In two population-based case-control studies carried out 13 years apart, Butland et al. reported an increase in the use of non-feather pillows from 44% in 1978 to 67% in 1991 (4). Recently, both Kemp et al. (5) and the current authors (6) have found significantly higher levels of dust mite allergens in synthetic pillows than in feather ones. The aim of this study was to investigate levels of cat and dog allergens in feather and synthetic pillows.

Table 1. Cat (Fel d 1) and dog (Can f 1) allergens expressed both as the total amount of allergen recovered (total ng) and concentration of allergen per unit weight (ng/g) in feather and synthetic pillows

Allergen	Synthetic pillows	Feather pillows
Fel d 1 (total ng)	9.14 (1.87–44.62)	1.37 (0.28–6.67)
Can f 1 (total ng)	18.48 (4.24–80.59)	2.31 (0.51–10.36)
Fel d 1 (ng/g)	231.60 (62.9–851.9)	62.80 (16.2–242.9)
Can f 1 (ng/g)	468.20 (134.3–1631.9)	105.70 (25.8–432.3)

Values are expressed as geometric mean (95% confidence interval).

Materials and methods

Sampling was performed in 14 homes without pets. In each of the homes, dust samples were collected from a pair of pillows, each pair consisting of one synthetic fibre-filled and one feather-filled pillow. The pairs of pillows had been on the same bed for at least 2 years. Each pillow was vacuumed for 1 min on each side using a dust sampler with an air flow rate of 45 l/s, through a 355- μ m diameter mesh onto a 5- μ m vinyl filter, producing a sample of fine dust. One hundred milligrams of fine dust was extracted with 2 ml of borate-buffered saline containing 0.1% Tween-20, pH 8.0 (BBS-T). For dust samples of less than 50 mg, 1 ml of BBS-T was added. Dust samples of 50–100 mg were extracted in a proportional volume of BBS-T (1:20). The dust was resuspended using a vortex mixer. Samples were then mixed end-over-end on an orbital rotator for 2 h at room temperature before being centrifuged for 20 min at 750 $\times g$ at 4°C. Supernatants were removed and stored at –40°C.

The cat allergen, Fel d 1, was assayed using a two-site immunometric enzyme-linked immunosorbent assay (ELISA). The UVA 91/01 standard for Fel d 1 contained 2 units/ml of Fel d 1 (relative to CBER [Center for Biological Evaluation and Research] Cat E5 standard containing 9.7 units/ml; 1 unit=4 μ g of protein). The dog allergen, Can f 1, was evaluated by using a monoclonal/polyclonal ELISA using anti-Can f 1 monoclonal antibody 6E9 for allergen capture and polyclonal rabbit anti-Can f 1 for detection. The assay was quantitated using doubling dilutions of dog allergen standard (UVA 94/02) from 500 IU/ml to 1 IU/ml of Can f 1. The UVA 94/02 (10 000 IU/ml of Can f 1) was substandardized against the WHO/IUIS International Reference Preparation of dog hair and dander (NIBSC 84/685), which contains 100 000 IU/ml of Can f 1. One International Unit represents $\approx$ 1 ng of Can f 1 protein, and this value was used to calculate the results. Paired samples were rejected if they

differed by greater than 5% (restricting intra-assay variation to this level).

Data followed a log normal distribution. The results are thus presented as geometric means (GM) and 95% confidence intervals (CI). Differences in allergen levels in synthetic and feather pillows were compared using a paired sample *t*-test. Statistical significance was set at the <5% level.

Results

Results are presented in Table 1 and are expressed both as total amount of allergen recovered and concentration of allergen per unit weight (ng/g).

Total levels of pet allergens were significantly higher in the synthetic pillows: Fel d 1: 6.7-fold difference (95% CI 1.5–29.7), *p*=0.017; Can f 1: 8-fold difference (95% CI 1.6–39.5), *p*=0.014. Similarly, when the results were expressed as ng/g, synthetic pillows contained significantly more allergens than feather pillows: Fel d 1: 3.7-fold difference (95% CI 1.3–10.1), *p*=0.015; Can f 1: 4.4-fold difference (95% CI 1.5–13.2), *p*=0.011.

Discussion

We have demonstrated that synthetic pillows contain significantly higher levels of pet allergens than feather pillows. Rains et al. have recently discussed the possible reasons for the differences in accumulation and content of mite allergen in feather and synthetic pillows (7). It is possible that the encasement, rather than the filling, of pillows may be responsible for the observed phenomenon. Feather pillows are encased in tightly woven fabrics to prevent the feathers protruding, which is not necessary in polyester-filled pillows. Thus, encasements in feather pillows may act as a barrier, both for allergens entering the pillow and contributing to the allergen build-up, and also keeping the allergen inside the pillow. It has recently been suggested that fine-woven fabrics were effective in blocking cat and mite allergen, and that they could be an effective alternative to semi-permeable or impermeable materials as an allergen barrier (8). Our findings support the view that tightly woven encasements surrounding feather pillows act as a barrier not only for dust mite, but also for pet allergens.

Asthma is one of the few common treatable conditions that has increased in prevalence over the last few decades. The reason for this increase is as yet unclear. In a case-control study, a

moderate, but significant, increase of 10% in the ratio of current-wheezers to never-wheezers, and an increase of 16% in the 12-month period prevalence of wheezing attacks between 1978 and 1991, were associated with an increase in the use of synthetic pillows (4). It was estimated that the rise in the use of non-feather pillows was sufficiently large to explain more than half of the total increase in the ratio of current-wheezers to never-wheezers. We speculate that the increase in the use of non-feather pillows has contributed to the increasing exposure to domestic allergens, which could have been partly responsible for the increase in childhood wheezing.

There is little epidemiological data on the risks for asthma symptoms and severity and high-allergen exposure. In a recent case-control study in Birmingham, we have shown that patients with very severe asthma are significantly more commonly both sensitized and exposed to high levels of allergens to which they are allergic, when compared to patients with a mild disease (9). In this study, mild asthmatics were exposed to much lower levels of allergens to which they were sensitized (9). Strachan & Carey have recently conducted a case-control study to investigate the effect of the home environment on the risk of severe asthma in children (10). The most powerful risk factors for severe asthma were identified as pet ownership and non-feather bedding. The authors estimated that if the association between non-feather pillows and severe asthma was causal, it could account for 53% of the severe asthma in the studied population. Pet ownership is a marker for high exposure to pet allergens (homes with pets contain $\approx$ 250-fold higher concentrations of pet allergens than those without pets) (11,12), and we have already outlined that the use of non-feather pillows may be a marker of high exposure to all domestic allergens.

This study suggests that the concentrations of all recoverable allergens from feather pillows are lower. Further studies are needed to define whether it is the content or cover of the pillow that is important and whether an intervention to replace synthetic pillows with those filled with feather, or covering all pillows with tightly woven

fabric, could contribute to a reduction in asthma prevalence and severity.

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