

Effect of House Dust Mite-Free Pillow on Clinical Course of Asthma and IgE Level—A Randomized, Double-Blind, Controlled Study

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Subjects comprised 20 children with bronchial asthma who displayed positive levels of house dust (HD)-IgE. These children were randomly divided into two groups: active group ($n = 10$), who used HD mite (HDM)-free pillows for 1 year; and placebo group ($n = 10$), who used new common pillows with HDM-permeable fabrics. No difference was seen between groups in regard to detection of fungi on surfaces of pillows and bedding. Fungi were detected inside one pillow in the active group and six pillows in the placebo group, representing a significant difference ($p = 0.029$). Significant differences were also seen in detection of HDM allergen Der1 between groups. Asthma symptoms did not differ between active and placebo groups. In addition, no significant differences were seen in changes to HD-IgE or *Dermatophagoides pteronyssinus*-IgE levels between groups. However, among children with high HD-IgE levels (≥ 50 U_A/mL) before the study, HD-IgE levels had decreased after the 12-month study in all six subjects in the active group ($p = 0.030$; paired t -test) and in four of seven subjects in the placebo group ($p = 0.481$; paired t -test). Few subjects displayed detectable levels of IgE specific for a combination of fungi. These results show that HDM-free pillows affect HD-IgE levels but not the clinical course of asthma.

Introduction

THE HOME ENVIRONMENT IS a key factor in the health of allergic children. House dust mites (HDMs), fungi, pet dandruff, and pollens are all known as allergens. HDMs are a major source of allergens in children,^{1,2} and exposure to high levels of HDM allergens among patients with asthma who are allergic to HDMs is reportedly associated with greater severity of disease.^{3,4} HDMs seek humid, warm conditions and live in bedding. Special attention should be paid to HDMs in humid countries.

Several studies of environmental interventions for allergic patients have recently been reported. While effects on allergen levels are confirmable, the clinical implications remain controversial.^{5–8} One study found that encasing mattresses and pillows resulted in significantly reduced the need for inhaled steroids in children with asthma.⁷ Another study showed that comprehensive environmental intervention resulted in reduced asthma-associated morbidity for inner-city children with asthma.⁸ Conversely, two studies in

which the intervention simply involved use of impermeable bed covers, mainly for adult patients with asthma or allergic rhinitis, showed that the covers were ineffective against allergic symptoms, although levels of mite allergens were indeed decreased.^{5,6}

Fungi are also important for allergic diseases,^{9–15} although detection of fungi-specific IgE in allergic patients is much less frequent than that of HDM-IgE. Fungi may penetrate through mite-impermeable bed covers, but few studies have investigated fungi contamination in bedding.

Pillows are one of the items that should receive attention when dealing with allergic children and adults, as they are likely to be in very close proximity to pillows for several hours each day during sleep, and thus inhale particles derived from pillows, including HDM and fungi allergens. We therefore investigated HDM and fungi contamination of HDM-free pillows and the effects of these pillows on clinical courses of asthmatic children with house dust (HD) allergy.

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Materials and Methods

Subjects

Subjects comprised 20 children with bronchial asthma who were receiving medical follow-up at Tenri Hospital (Nara prefecture, Japan) and displayed positive levels of IgE specific for HD. These children were randomly divided into two groups: active group ($n = 10$), using HDM-free pillows (Yamasei, Tokyo, Japan); and placebo group ($n = 10$), using new common pillows with HDM-permeable fabrics. Yamasei pillows are free of HDMs during the production process and prevent HDMs from penetrating inside by a special sewing technique and HDM-impermeable fabrics. The two kinds of pillows were indistinguishable by children and their parents, and Tenri Hospital staff were not informed as to which group the children were assigned to. No marked differences in background characteristics were seen between groups (Table 1).

Sampling for fungi and HDM

Use of the pillows provided was started in Spring. Samples for the detection of fungi were obtained using 10×12 cm pieces of sticky tape (Tegaderm®; 3M, Minnesota, USA) on the surface of the pillows and on the surfaces of the bedding. Samples were collected on three occasions, at 4 (T4, Summer), 7 (T7, Autumn), and 12 months (T12, Spring) after starting use of the pillows. At 12 months after initiation of the study, pillows were returned and the cotton inside the pillows was removed to measure levels of fungi and HDM allergen Der 1.

Analysis of fungi

The procedure used to detect fungi was the same as described previously.¹⁶ Briefly, Tegaderm® samples were

directly attached and cultured on potato-dextrose agar (PDA) and malt yeast 40% sucrose agar (M40YA) media. Cotton samples were immersed in distilled water and cultured in both these media. The largest number of colonies that grew in PDA or M40YA medium was recorded as the colony count for each fungus.

Measurement of Der 1

The procedure to detect Der 1 (Der p 1 + Der f 1) has also been described previously.¹⁷ Briefly, cotton samples were immersed in phosphate-buffered saline and 0.05% Tween-20 for 2 h at room temperature, and Der p 1 and Der f 1 allergens were quantified by sandwich ELISA.

Asthma symptoms

Asthma symptoms were checked three times per day. Asthma attacks were scored as follows: 0, no attack; 1, mild attack; 2, moderate attack; and 3, severe attack. The severity of asthma exacerbations was defined following the Japanese Pediatric Guideline for the Treatment and Management of Asthma. The asthma score was original at Department of Pediatrics, Tenri Hospital. Asthma scores were calculated monthly. Maximum score is 9 per day and 279 per month. Average monthly asthma scores at T1, T2, and T3 were compared with those at T10, T11, and T12.

Specific and total IgE in patients

Serum samples from subjects were collected twice: before using the new pillows and at the end of the study. Total serum IgE levels and serum IgE levels specific for HD, *Dermatophagoides pteronyssinus* (Dp), and a combination of fungi (*Aspergillus*, *Alternaria*, *Cladosporium*, *Penicillium*,

TABLE 1. DETAILS OF THE SUBJECT

	Active group	Placebo group
Median age, years (range)	7 (5–11)	6 (4–8)
Gender ratio; male/female (n^a)	9/1	7/3
Allergic condition (n)		
Bronchial asthma (BA)	6	7
BA + Atopic dermatitis	2	2
BA + Allergic rhinitis	2	1
Controller therapy; DSCG/LTRA/ICS ^b (n)	6/1/1	7/0/0
Total serum IgE, IU/mL, median (range)	502 (130–8890)	1128 (75.2–6578)
Specific IgE, U _A /mL		
HD, median (range)	117 (4.89–755)	240 (7.99–524)
Dp, median (range)	83 (0.94–624)	247 (10.7–696)
Fungi combination; ≥ 0.70 U _A /mL (n)	2	2
House structure (n)		
Wood detached	7	6
Wood attached	1	1
Steel attached	2	3

^a n , number.

^bDSCG, disodium cromoglycate; LTRA, leukotriene receptor antagonist; ICS, inhaled corticosteroid.

Helminthosporium, and *Candida*) were measured using UniCAP (Pharmacia Diagnostics AB, Uppsala, Sweden).

Ethics

All study protocols were approved by the ethics committee of Tenri Hospital.

Statistical analyses

Fisher's exact test was used for comparison of contaminated pillows with fungi and Der 1 between groups and Mann-Whitney's U test to compare colony numbers of fungi and Der 1 levels between groups. Wilcoxon's signed-ranks test was used for comparing changes in asthma scores between groups. Changes to IgE levels in each group were compared by the paired *t*-test and repeated-measures ANOVA was used for comparing changes in asthma scores and IgE levels between groups.

Results

Detection of fungi on the surface of pillows and bedding

The number of pillows (Fig. 1) and bedding (Fig. 2) contaminated with each fungus is shown separately for the active and placebo groups at the three time points. No significant differences between groups were seen at any point in time.

Contamination inside the pillows

Fungi were detected inside one pillow in the active group and six pillows in the placebo group, representing a significant difference (Fisher's exact test, $p = 0.029$). Colony count tend to differ between groups (Mann-Whitney's U test, $p = 0.051$) (Fig. 3). Numbers of pillows contaminated inside with each fungus are shown in Figure 4. Several kinds of fungi were found inside one pillow in the active group, with the main fungus being 56 colony-forming unit (CFU) of *Aspergillus restrictus* per gram of cotton, which was also found mainly on the pillow surface in Autumn (T7) and at the end of the study (T12).

Der 1 was not detected inside any pillow from the active group and was detected in four pillows from the placebo group, representing a significant difference (Fisher's exact test, $p = 0.043$) (Fig. 5).

Clinical course of asthma and IgE levels

Changes in asthma scores from T1–T3 to T10–T12 did not differ between active and placebo groups (Fig. 6). One boy in the active group required inhaled corticosteroids (ICS) instead of disodium cromoglycate (DSCG) to control asthma symptoms. Changes to HD-IgE levels in each group are shown in Figure 7. No significant difference was seen between groups. However, among children with high levels of HD-IgE (≥ 50 U_A/mL; U_A means unit allergen) before the study, HD-IgE levels had decreased after the 12-month

study in all six subjects in the active group (paired *t*-test, $p = 0.030$) and in four of seven subjects in the placebo group (paired *t*-test, $p = 0.481$). No significant differences were seen in changes to Dp-IgE levels (data not shown). Since few subjects displayed detectable levels of IgE to a combination of fungi, changes in IgE levels in relation to fungi were not evaluated. Changes to IgE levels specific for HD, Dp, and a combination of fungi in each subject were unrelated to the contamination of pillows with fungi and HDMs.

Discussion

Fungi were detected in the cotton inside one pillow in the active group and inside six pillows in the placebo group. This difference was significant, and contamination with fungi was less frequent in HDM-free pillows than in common pillows. As the spores of some fungi are smaller than the mesh size of the HDM-free pillow fabrics, detection of fungi inside one such pillow is unsurprising. In fact, HDM-free pillows displayed contamination with many fungi on the surface. The pillow surface should be cleaned even when HDM-impermeable fabrics are used, as fungi and/or spores attached to the surface invade inside. Fungi, including *Alternaria*, are reportedly relevant to allergic diseases.^{9–15} The present study could not show any clinical importance of fungi for asthmatic children, as few subjects displayed detectable levels of IgE specific for a combination of fungi, but fungi levels should be measured for intervention studies in future.

This study showed that after pillows had been used for 1 year, none in the active group and four pillows in the placebo group were contaminated with HDM allergen Der 1. This difference was significant, and HDM-free pillows were free of HDMs. This indicates that HDM-free pillows are useful for HDM-sensitized asthmatics, since pillow areas in close proximity to the mouth and nose might play an important role as a source of HDM allergen. However, contamination of common pillows with HDMs was also not remarkably frequent after 1 year of use. Although we did a 1-year study following previous studies,^{5,6} follow-up of several years might be necessary to clarify the effects of this kind of intervention.

In this study, HDM-free pillows had no effects on asthmatic symptoms. No differences in fungi contamination on the surfaces of pillows were seen between groups. Although contamination inside HDM-free pillows with HDMs and fungi was less frequent than seen with standard pillows, improvements to the environment for allergic patients achievable using pillows were limited. Two previous studies also did not show any clinical effects of impermeable bed covers on allergic symptoms,^{5,6} although one study found that encasing mattresses and pillows resulted in significant reductions in the need for inhaled steroids in children.⁷ Since bedding represents only one fact of the environment, interventions targeting bedding may not be sufficient to provide clinical influences for allergic children. Comprehensive environmental interventions may be necessary to obtain clinically meaningful effects on allergic diseases.

Our study showed the effect of HDM-free pillows on HD-IgE levels. Decreases to HD-IgE levels in children with high HD-IgE levels may be due to the absence of

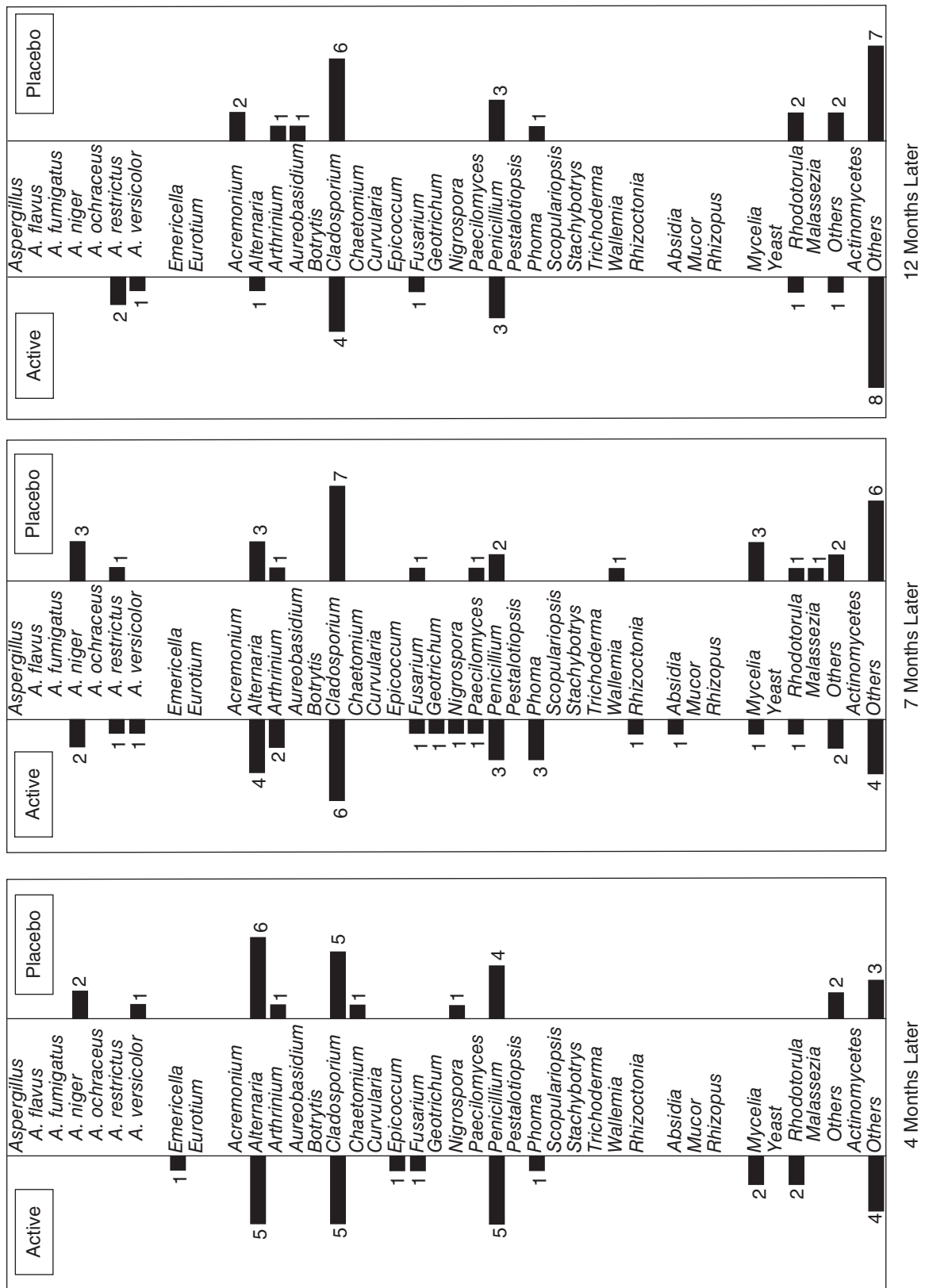


FIG. 1. Fungi detected on the pillow surface. The number of pillows with detection of each fungus on the surface is shown.

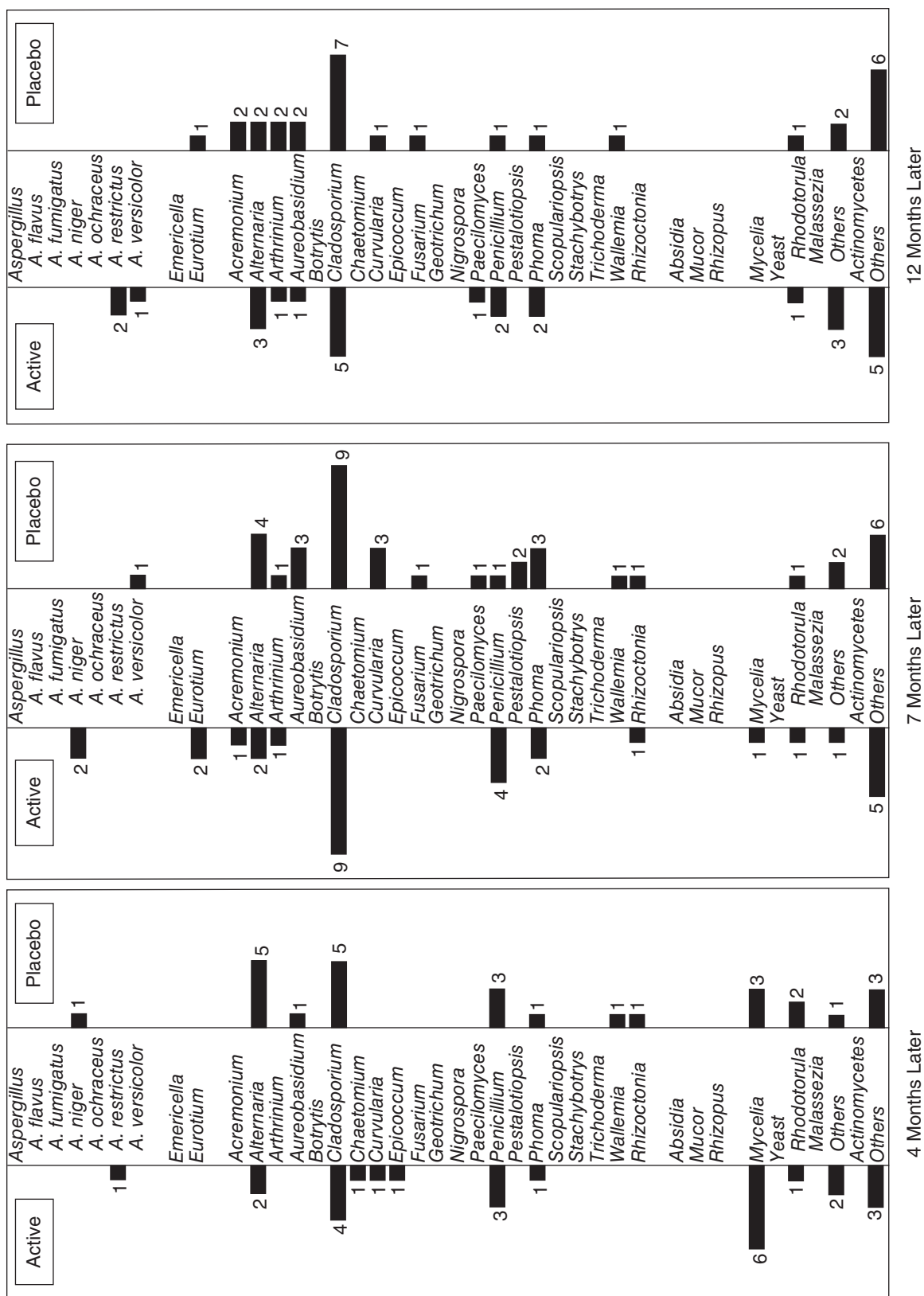


FIG. 2. Fungi detected on the surface of the bedding. The number of the bedding with detection of each fungus on the surface is shown.

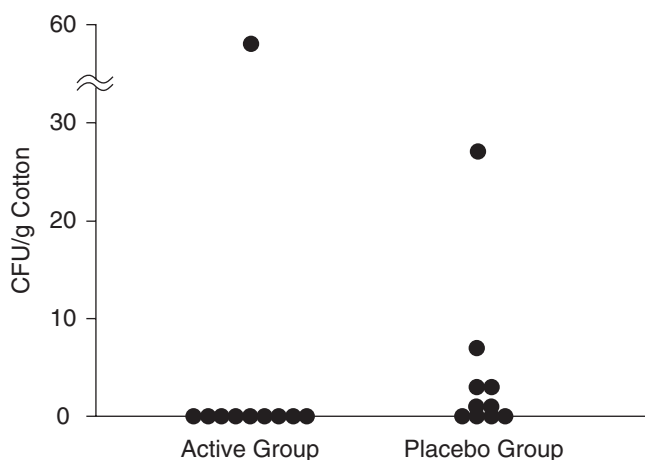


FIG. 3. Colony numbers of fungi detected inside pillows. The plots show CFU of fungi per gram of cotton inside of each pillow.

Active		Placebo
	<i>Aspergillus</i>	
	<i>A. flavus</i>	
	<i>A. fumigatus</i>	
	<i>A. niger</i>	
	<i>A. ochraceus</i>	
1	<i>A. restrictus</i>	1
	<i>A. versicolor</i>	
	<i>Emmericella</i>	
	<i>Eurotium</i>	
	<i>Acremonium</i>	
	<i>Alternaria</i>	
	<i>Arthrinium</i>	
	<i>Aureobasidium</i>	
	<i>Botrytis</i>	
1	<i>Cladosporium</i>	6
	<i>Chaetomium</i>	
	<i>Curvularia</i>	
	<i>Epicoccum</i>	
	<i>Fusarium</i>	
	<i>Geotrichum</i>	
	<i>Nigrospora</i>	
	<i>Paecilomyces</i>	
	<i>Penicillium</i>	
	<i>Pestalotiopsis</i>	
	<i>Phoma</i>	
	<i>Scopulariopsis</i>	
	<i>Stachybotrys</i>	
	<i>Trichoderma</i>	
	<i>Wallemia</i>	
	<i>Rhizoctonia</i>	
	<i>Absidia</i>	
	<i>Mucor</i>	
	<i>Rhizopus</i>	
	<i>Mycelia</i>	
	<i>Yeast</i>	
1	<i>Rhodotorula</i>	2
	<i>Malassezia</i>	2
1	Others	6
	<i>Actinomycetes</i>	1
1	Others	3

FIG. 4. Fungi detected inside pillows. The number of pillows with detection of each fungus inside is shown.

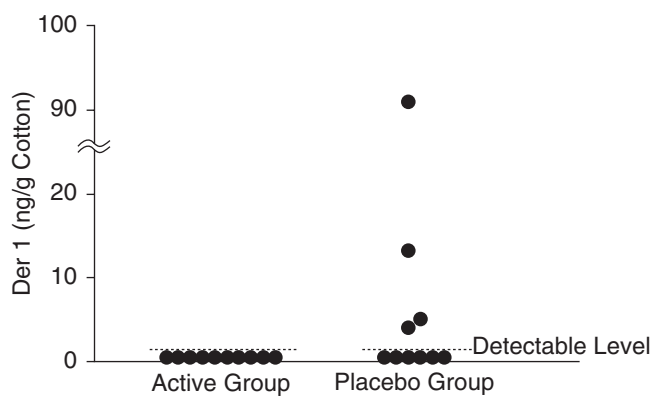


FIG. 5. Amount of Der 1 detected inside pillows. The plots show Der 1 level (ng) per gram of cotton inside of each pillow.

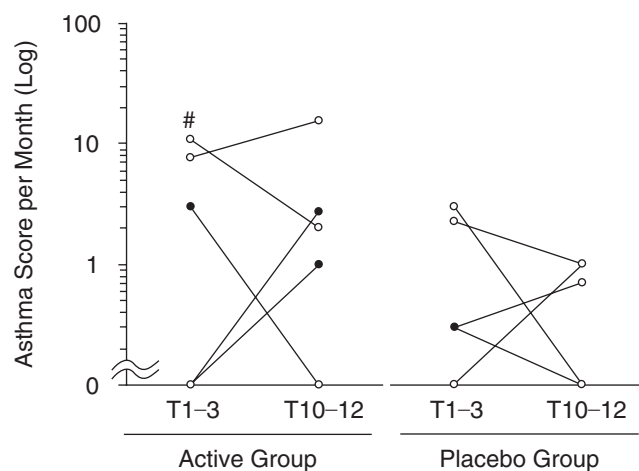


FIG. 6. Changes in asthma scores. The plots show changes of asthma scores per month of each patient. #This patient required introduction of ICS instead of DSCG to control asthma symptoms.

contamination with HDMs and reduced contamination with fungi inside HDM-free pillows. HD-IgE levels might be further lowered in more children using not only HDM-free pillows but also other bedding of HDM-free materials. Since HDM-free pillows were somewhat effective at least for HD-IgE levels, longer use of this kind of pillow might be helpful for asthma control.

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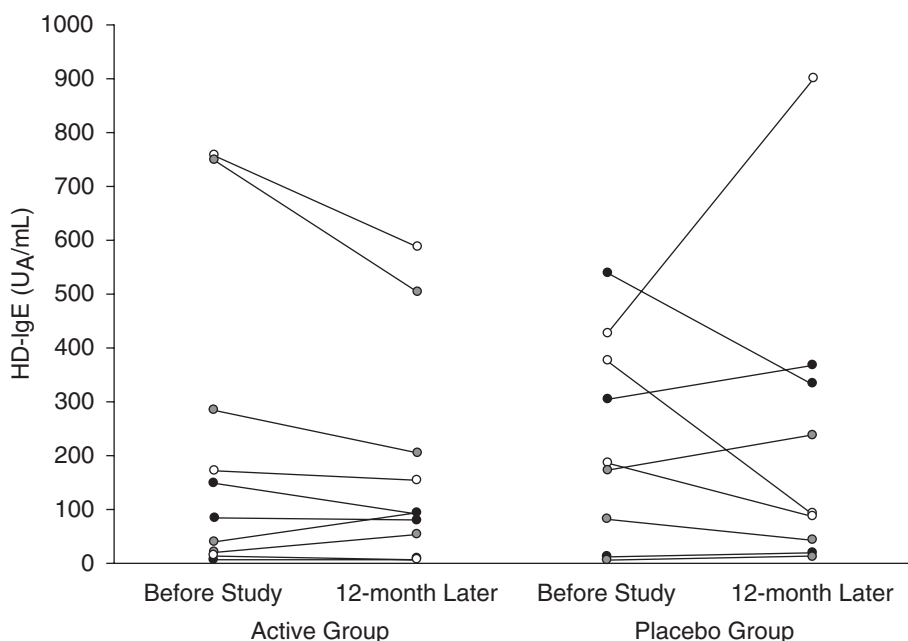


FIG. 7. Changes in HD-IgE levels. The plots mean changes of HD-IgE levels of each patient.

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