

Results of a field study on the influence of HygienicWood mattress toppers on the number of mites in bed dust and the state of health of people with house dust mite allergies

Abstract

Objectives: So far, there has been no practical or toxicologically non-hazardous way to decimate mites – without interrupting use of beds – in their main reservoir on bed mattresses to such an extent that the allergic condition of people suffering from house dust mite allergies is reduced or even remedied. As so-called HygienicWood was effective against mites under simulated conditions, the influence of a mattress topper filled with HygienicWood chips on the content of mite antigen Der p1 was to be investigated and the influence on the state of health of the persons concerned analysed at the same time.

Procedure: 32 test persons suffering from dust mite allergy were randomly selected.

During the course of 5 months, the influence of a HygienicWood mattress topper on the content of the mite antigen Der p1 as well as the number of bacteria, dermatophytes and yeasts in the bed dust were determined and compared with the values obtained during the 5 weeks prior to the application of HygienicWood mattress toppers. The samples were taken from between the HygienicWood mattress topper and the sheet below. At the same time, changes in well-being, state of health, typical allergy symptoms and frequency of taking antihistamines and glucocorticoids were recorded as self-assessments in the form of questionnaires.

Findings: The most striking finding was the significant decrease ($p=0.000$) of the house dust mite antigen Der p1 during usage of the HygienicWood mattress toppers. The effect started immediately after applying the toppers and continued with little fluctuation until the end of the observation period without lessening. At the end of the study, 43% of the test persons stated a slight improvement in their well-being, 13% of the test persons felt no change, and 6% of the test persons stated a slight deterioration. The situation was similar with regard to allergy symptoms: 43% reported a significant reduction, 38% a slight reduction, and 19% did not notice any change. The improvement in symptomatology could not be ascribed to an increased intake of antihistamines or glucocorticoids.

The dermatophytes, too, showed a slight, albeit statistically not significant decrease after application of HygienicWood mattress toppers. In contrast, the pollution of bed dust with yeasts rose significantly ($p=0.002$), whereas there was only a tendency towards an increase in the number of bacteria, which, if one considers the slight increase, is without hygienic relevance.

Conclusion: HygienicWood mattress toppers are able to reduce the house dust mite allergen load. This leads to a distinct reduction in the allergy symptomatology, and the well-being of the persons concerned increased significantly.

Keywords: HygienicWood mattress toppers, bed dust, house dust mite antigen Der p1, well being, allergic symptomatology, taking medications

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Introduction

Particles of house dust mite faeces trigger allergic respiratory diseases and contact eczema in approximately 4 million people in Germany, with 16.7 of all children and adolescents suffering from allergic diseases. For 40.8 of the children and adolescents concerned, the blood analysis showed a sensitization to at least one allergen. 37.2% reacted to inhaled allergens (pollen, animal hair, house dust mites) [1]. House dust mites are the second most common trigger (38.3%) after pollen (85.9%) for allergic respiratory diseases [2]. Apart from the considerable impairment of the quality of life, allergies create high costs in the healthcare sector.

House dust mites are natural housemates, in particular in beds, on mattresses and in carpets. They subsist on desquamated skin flakes, after they have been pre-digested by mildews. Every human being loses up to 2 g of skin flakes every day. That is enough to feed 1.5 m house dust mites. Especially in spring and summer, the mite impact is very strong. Each female lays up to 40 eggs, and every three weeks a new generation is created. Due to the mite life expectancy, a bed may carry a load of up to 10 m mites [3]. This may not seem to be a problem for the non-allergic subject; but together with the increasing diversity of further allergens, the "normal" exposition to mites can trigger allergic symptoms in people who are already sensitized.

Currently, there are three strategies to reduce exposition to mites in the sleeping area and so improve the quality of life for persons suffering from house dust mite allergies:

- application of acaricidal agents, which has to be classified as toxicologically critical (sensitizing and allergy potential, toxic exposition);
- frequent cleaning of all bed linen including mattress, which has not proved sufficiently effective – because of the numbers of mites and their reproduction rates, it would make sense to clean all bed linen daily, which is, however, not feasible;
- usage of mite and allergen-tight encasings together with mite-tight bed linen, which prevents mites from entering into the interior of bed and mattress. This, however, leads to a concentration of the remaining mites and skin flakes on the bed linen surface, which means that contact with the allergen cannot be completely stopped. Furthermore, usage of mite-tight bed linen does not offer the same cosiness.

So, for house dust mite allergies, the standard elimination and contact prevention strategy is hardly possible, as is indicated by the high number of patients, which is tending to increase.

Therefore, a field study was to investigate, if it is possible to control mites by applying the so-called HygienicWood without acaricidal agents and mite-tight bed linen (Gustav Wilms oHG). Two indicators speak for the potential effectiveness of HygienicWood: the antimicrobial effect including the efficacy against dermatophytes [4], [5], and the mite re-

pellent effect, experimentally verified through incubation of HygienicWood mats with mites under simulated conditions. A reduction of 97% was reached in comparison to the control [6]. For HygienicWood a sustainable reduction of bacteria and fungi on the surface was also verifiable in comparison with plastics, glass, stainless steel, non-treated pine and beech wood [7], [8], [9]. In the food sector, transport pallets made of HygienicWood showed a distinctly lower microbial contamination than standard pallets [10].

The antimicrobial effect of HygienicWood in comparison with silver fir and deciduous trees such as copper beech, oak and robinia is based on its high content of tannins, pinosylvins and further ingredients [11], [12], [13], [14], [15], [16], [17], as well as the moisture-scavenging properties of the wood [18]. HygienicWood consists of pine heartwood, which was treated in a patented washing process [5]. The process makes the wood's microbiocidal potential, which is evolutionarily necessary for the plant, more readily available. For this, no additional chemical substances are introduced into the wood.

Gustav Wilms oHG developed a mattress topper, the so-called HygienicWood mat (Figure 1, Figure 2) as a prerequisite for the field test. The mats consist of HygienicWood chips, which are pressed together to shape large-pored mats. Four such mats are kept together in an encasing as HygienicWood mattress toppers.

Procedure

Study design

The study was carried out as a field study under real practical conditions with 50 people suffering from house dust mite allergies. The test persons were found through an appeal in the local newspaper. With the help of a questionnaire, the test persons assessed their home situation and state of health at the beginning of the study (Attachment 1). They were specifically asked to assess the allergy load in the sleeping area.

In an introductory event about the study, the test persons were given detailed information on composition and handling of the HygienicWood mattress topper and as to how to take and treat samples and fill in the questionnaires.

During the course of the study, each test person received a HygienicWood mattress topper, adapted to the size of their bed. The interviews as to the development of their state of health were carried out at the end of week 8 after the start of the test, and were repeated at the end of the sampling period, i.e. at the end of week 20. At the same time, the load of mites, fungi and bacteria in the bed dust, taken from between the HygienicWood mattress topper and the sheet below, was determined. The course of the study is summarised in Table 1. The study began on 1 March 2008.



Figure 1: Four-piece mattress topper filled with HygienicWood chips



Figure 2: Structure of the mattress topper's inner core of compressed HygienicWood chips

Table 1: Course of the field study

Measure	Period
Sample taking before handing over HygienicWood toppers 2x/week	5 weeks
Handing over questionnaires and HygienicWood toppers	end of week 5
Sample taking 2x/week	up to end of week 9
Sample taking 1x/week	week 10
Handing over questionnaires once again	end of week
Sample taking in intervals of 3 weeks	up to end of week 25
Handing over questionnaires once again	end of week 25

Determination of mite, fungus and bacteria load

Each test person was familiarized with taking samples in their household on the basis of the following guidelines:

1. Insert the dust collecting filter in the vacuum-cleaner attachment and fasten the vacuum-cleaner attachment to the vacuum-cleaner tube.
2. If the vacuum-cleaner attachment does not match your vacuum-cleaner tube, use the adapter to fasten the vacuum-cleaner attachment to the vacuum-cleaner tube.
3. The adapter has two different ends, which can be put on the tube end according to size.
4. Switch on your vacuum-cleaner and vacuum 4 separate fields on your sheet according to the attached sketch for 30 seconds each (overall time 2 minutes). For doing this, please use the template (30x30 cm).
5. Remove the dust collecting filter from the vacuum-cleaner attachment and put it in the attached plastic bag.
6. Close the sample together with the plastic bag and attach the filled in sample label.
7. Send the sample in an envelope to the laboratory. Please use the attached envelopes, address labels and stamps.
8. Rinse the vacuum-cleaner attachment under running water, so that it is ready for being used again.

For sample taking every test person was given a dust collector (vacuum-cleaner attachment Dustream™ Collector, Indoor Biotechnologies, Inc., Charlottesville, VA) with the required amount of dust-collecting filters as well as the materials required for returning or sending them back.

Furthermore, the test persons were asked to stick to their normal cleaning behaviour (change of bed linen). For double beds, the partner in life was also given a mattress topper, even if they did not take part in the study. This was done in order to make sure that there was no area in the immediate proximity of the test person, which was not exposed to the influence of the HygienicWood mattress topper. No samples, however, were taken from this side of the bed. During the study, no test person was given an insight into the results of the analytics of the biological parameters.

After receiving the dust samples in the laboratory, they were weighed, prepared in the proportion of 50 mg dust/ml extraction buffer (PBS Tween) and analysed. The quantitative determination of the house mite content was carried out via the detection of the house dust mite antigen Der p1 with the ELISA Kit 5H8/aC1 (Indoor Biotechnologies). In each case 100 µl of the standard or sample solution were transferred as double values into the cavities. After the microtitre plates had been washed three times and subjected to antibody, enzyme and substrate response, the antigen-antibody response was stopped by adding the reagent SDS. The preceding substrate re-

sponse brings about a colour development depending on the allergen content, which was quantitatively evaluated by means of the Benchmark EIA-Reader (BioRad) against the standard range of diverse concentration, using the respective software. For each testing positive and negative controls were used to validate the process.

At the same time, the dermatophyte, yeast and bacteria content of the dust sample was examined. For this purpose, 100 µl of the dust sample solution were plated on malt extract agar or casein-soy flour-peptone agar and incubated for 1–7 d at 25 °C or 30 °C respectively.

Findings

The most striking finding is the 5.6 fold reduced content of the house dust mite antigen Der p1 after applying the HygienicWood mattress toppers (Table 2). The difference between the values before and after was statistically highly significant ($p=0.000$, Independent Samples Test). The effect could be seen immediately after applying the toppers (Figure 3) and continued unabated with minor fluctuations.

The dermatophytes showed a slight, statistically however not significant drop (Table 2). In contrast, the load of yeasts in the bed dust increased significantly ($p=0.002$), the load of bacteria only as a tendency (Table 2). The findings for bacteria and yeasts, however, are limited in as much as the measured values were often in the area within or above the upper detection limit, so that the values, so that the values cannot be seen, in principle, as reliable values in each and every case.

At the end of the study, 43% of the test persons declared a slight improvement and 38% declared a significant improvement with regard to their well-being. 13% of the test persons felt no change and 6% of the test persons stated a slight deterioration. With respect to the influence on the allergy symptoms, 43% stated a significant decrease and 38% a slight decrease. The remaining 19% of the test persons felt no effect. A deterioration was not stated. The improvement of well-being as well as of allergic symptoms was significant (Wilcoxon test $p<0.01$). To establish the sustainability of the influence of the HygienicWood mattress topper, the question was asked, if the symptoms had been reduced within the course of the past two months. 34% of the test persons answered this question with significantly, 31% with a little, 22% with hardly and 13% with not at all (Figure 4). No symptom increase was indicated.

The improvement was obviously not ascribable to an increased intake of antihistamines and glucocorticoids. At least a trend to even reduce the intake of medications (albeit not significant) was noticeable during the weeks immediately after application of the toppers.

At the same time, the filled-in questionnaires allow for an analysis of the change in typical allergic symptoms; the significance was tested by the Wilcoxon test. On average the intensity of the frequently or strongly occurring symptoms such as blocked nose ($p=0.001$), running nose

Table 2: Mean values and standard deviation of averaged measurement values (ng/50 µg dust) for the test persons with regard to mite antigen, bacteria, yeasts and dermatophytes

Study		Mean value of all test persons			
week	phase	Der p1	Bacteria	Yeasts	Dermatophytes
1	Pre-values (without HygienicWood mattress toppers)	39.9	2646	921	112
1.5		26.4	2692	804	115
2		31.1	2439	675	154
2.5		18.1	2516	892	114
3		19.9	2413	1176	227
3.5		33.5	2583	1308	115
4		27.4	2519	741	156
4.5		17.1	2461	1092	155
5		23.9	2514	989	182
5.5		12.9	2620	887	131
Mean value		25.02	2540	949	146
Standard deviation		8.32	92.4	197.1	37
6	Post-values (Start of HygienicWood mattress toppers)	7.0	2739	1484	87
6.5		5.5	2781	1262	161
7		4.9	2697	1131	198
7.5		3.6	2946	1579	134
8		5.5	2587	1506	142
8.5		3.8	2780	1613	140
9		4.0	2831	1509	100
9.5		47	2955	2149	106
10		3.9	2666	2241	71
13		9.0	2985	1964	85
16		2.6	3000	2253	355
19		2.3	2963	2652	86
22		1.6	2828	2120	54
25		4.1	>3000	2714	74
Mean value		4.48	2840	1870	128
Standard deviation		1.91	137	499	77

* without drop outs

($p=0.014$) and urge to sneeze ($p=0.145$) decreased during the course of the week (Figure 5). Equally, a decrease was noticeable for the symptoms, which were less pronounced during the course of the test such as “red eyes, streaming eyes, swollen eyes, itching and coughing” (Figure 6). Apart from the parameter “blocked nose”, however, the difference between the pre and post values was not rated as significant. The parameters “burning, red skin, shortness of breath and asthmatic attack” occurred too rarely as to deduce an influence. The direct connection between the observed improvement of well-being and allergy situation and the HygienicWood

mattress topper becomes clear, when the occurrence of the symptoms is looked at throughout the day, as the test persons perceived a reduction of the medical condition rather when and after getting up as well as when making the beds but did not feel any change during the normal course of the day. This was particularly so in the last two months of the period under study.

Due to the small sample, no valid statements can be deduced with regard to the influence on well-being and allergy symptomatology from the other answers.

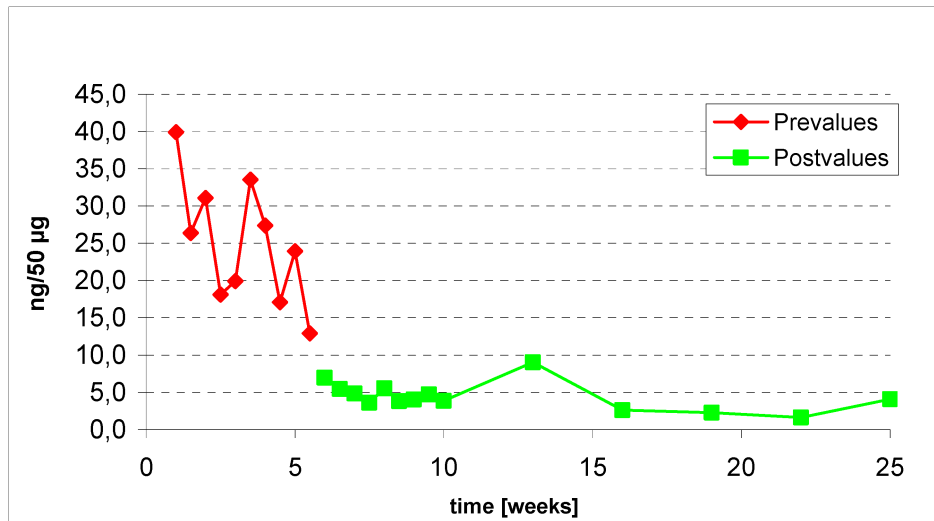


Figure 3: Chronological sequence of concentration of mite allergen Der p1 in bed dust

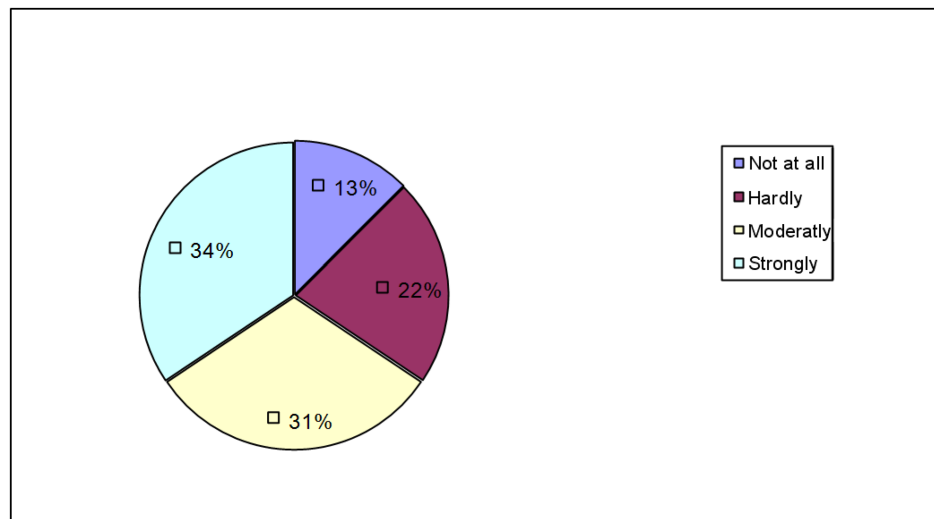


Figure 4: Test persons' assessment of reduction of allergy symptoms during the past two months

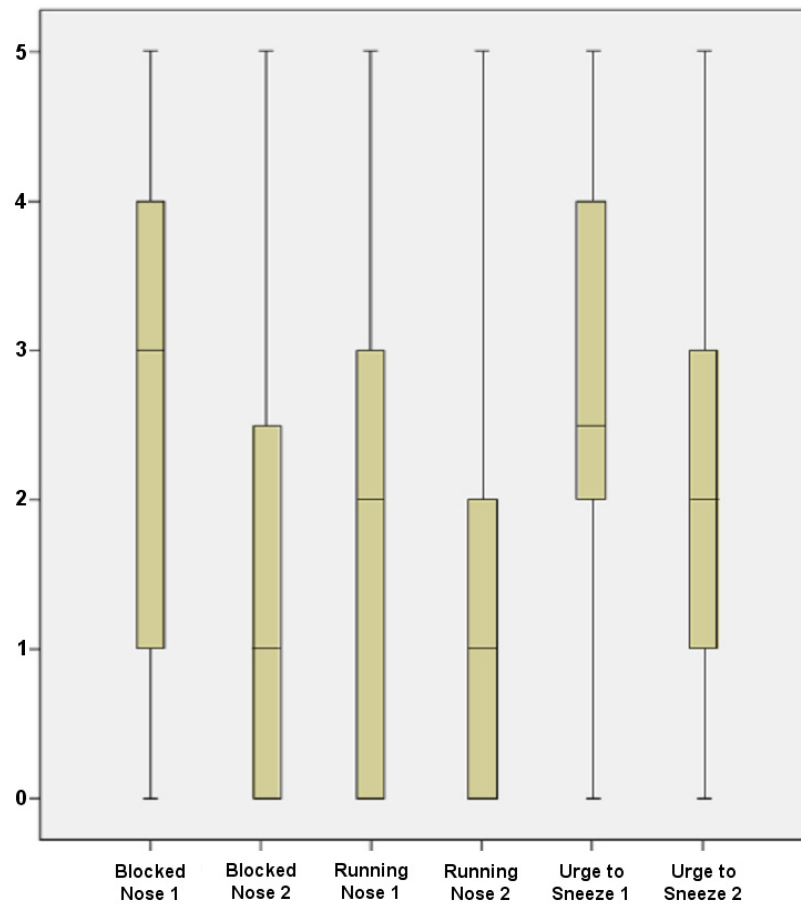


Figure 5: Changes in the irritation symptoms of the nose when comparing the initial situation with the end of the 20 week period under study

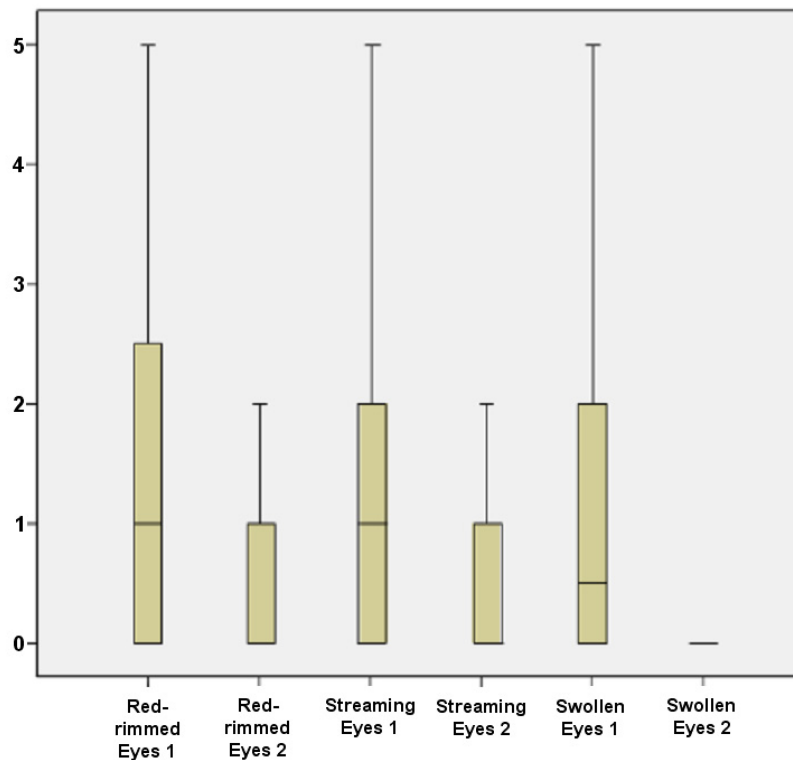


Figure 6: Changes in the irritation symptoms of the eyes when comparing the initial situation with the end of the 20 week period under study

Discussion

Questionnaire

Although it was not possible, due to the insufficient size of the sample, to create a connection between all questions and the change in well-being, the entire questionnaire was reproduced in the section "Procedure", because the questions are interesting in case a more extensive survey is carried out and because they did not cause any difficulty or reluctance on the part of the test persons.

Duration of study

A period of 25 weeks had been planned for the study in order to be able to consider seasonal fluctuations. The first 5 weeks served the purpose to analyse the average pre-values without application of the HygienicWood mattress topper.

Drop outs

The evaluation of the findings was hampered by the following factors. 21 of the 53 people participating in the study (4 until week 5, a further 9 until the end of week 13 and another 8 until the end of the study) left the groups of test persons prematurely. Nevertheless the number of test persons was still above the statistically calculated minimum value of 30. Due to the reduced number of test persons, the confidence interval for the statistical evaluation was fixed at 99%. The test persons who left did not show particularly high or low pre or post-values in a striking, homogeneous way, so that there was no influence on the overall distribution of the findings. Approximately half of the drop outs gave as the reason a change of their life situation, lack of comfort or quality problems with the toppers. 8–10 weeks after the start of the study. Almost all test persons reported signs of disintegration at the edge of segments of the HygienicWood mats, which were often accompanied by opening seams of the encasings, so that HygienicWood chips spilled out. Hence, the quality of the HygienicWood mats has to be improved.

Findings

As the effect of mite antigen reduction occurred immediately after application of the topper, a pure mechanical barrier effect of the topper had to be assumed initially. If it had been limited to this effect, a re-increase of the Der p1 values would have been to be expected. As there was no increase during the following weeks, it can be assumed that HygienicWood mattress toppers can reduce the propagation of house dust mites in bed.

The study showed a positive correlation between the reduced mite load, indicated by the reduction of the Der p1 antigen, and the subjective allergy status of the test persons with sustainable effect, as 65%–81% of the test persons stated an improvement in well-being as well as

a decrease of symptoms and medical conditions also in the last two months of the study.

On the whole, the generally positive effect of HygienicWood mattress toppers seems to be based to a minor degree on many individual factors and to a special degree on distinct improvements in the parameters blocked and running nose.

There are no standard values for the allergen load in bed dust. For house dust the following standard values apply [19]:

- $\leq 0.3 \mu\text{g Der p1/g dust}$ (slight allergen load): in this range, even for highly sensitive, sensitised people no medical condition is to be expected
- $0.4 - < 2 \mu\text{g Der p1/g dust}$ (substantial allergen I): in this range, medical conditions may occasionally occur for people with a distinct, pre-existing sensitization
- $2 - 10 \mu\text{g Der p1/g dust}$ (high allergen load): risk factor for the development of specific IgE antibodies, bronchial hyperreactivity and asthma symptoms
- $> 10 \mu\text{g Der p1/g dust}$ (very high allergen load): risk factor for acute asthma attacks and occurrence of symptoms for people suffering from mite allergies.

The pre-values determined for bed dust were $25 \text{ ng}/50\mu\text{g}$ and thus approximately a 100 times lower than in house dust. This leads to the conclusion that the standard values for house dust cannot be transferred to bed dust, presumably because the exposure in bed is more intensive and of longer duration. As 19% of all test persons complained about allergic symptoms at the mean value of $4.5 \text{ ng}/50\mu\text{g}$, the noncritical threshold is probably even below this value.

However, the absolute allergen content is not primarily important for the evaluation of the field study. In the first place, the personal well-being in the period with and without the mattress topper is important. In this respect, the distinct improvement in the allergy symptomatology after introduction of HygienicWood toppers represents a step forward in the prevention of house dust mite allergies.

While, over time, there was a decrease in the number of microorganisms under the encasing during the application of bacteria tight mattress encasings [20], the application of HygienicWood mattress toppers showed the opposite development. The reason for the increase of yeasts and bacteria in bed dust remains open, it has, however, no hygienic relevance due to the increase by the factor of 1.1 for bacteria and by the factor of 2 for yeasts.

It concludes that HygienicWood mattress toppers can reduce the house dust mite allergen load and thus noticeably attenuate the allergy symptomatology, whereby the well-being of the persons concerned is distinctly improved. Nothing changed because of the fact that the number of test persons gradually decreased from initially 53 to ultimately 32 persons relevant for the evaluation. As the findings for the remaining test persons are coherent and unambiguous and document an improvement in about 75% of all the allergy situations, a positive effect of the HygienicWood mats on the well-being can doubtlessly be

assumed, the more so as there was no hint as to the discontinuation of the study because of a deterioration in the well-being.

Attachments

Available from

<http://www.egms.de/en/journals/dgkh/2010-5/dgkh000147.shtml>

1. GMS-dgkh147-Questionnaire.pdf (120 KB)
Structure and contents of the questionnaire

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