

Analysis to Evaluate Efficacy of the Simmons "BackCare Kids" Mattress¹

Prepared by:
Anna Kosheleva
Gary Adamkiewicz
Jose Vallarino
Junenette Peters
Douglas Brugge*
John Spengler (PI)

**Harvard School of Public Health
Exposure, Epidemiology & Risk Program
Department of Environmental Health
P.O. Box 15677
Landmark Center 406 West
Boston, MA 02215**

***Tufts University, School of Medicine
Dept. of Family & Community Health**

Prepared for:

Thomas Oakhill
**The Simmons Bedding Company
One Concourse Parkway, Suite 800
Atlanta, GA 30328**

April 20, 2005

¹ Component of the Healthy Public Housing Initiative, <http://www.hsph.harvard.edu/hphi/>

Introduction

To begin with, we wish to thank the Simmons Bedding Company for the generous gift of 86 new mattresses to the asthmatic children participating in the Healthy Public Housing Initiative. Without your generous donation our overall research effort would have been less successful. The mattresses added both an interesting dimension to our intervention and a strong incentive for families to participate. Below, we briefly review the key findings from our study that were tied primarily to the use of the mattresses that you donated.

As you are likely aware, the Healthy Public Housing Initiative (HPHI) is a Boston-based, community-centered project designed to engage public housing residents in a collaborative process to improve the health and quality of life of residents, as well as building conditions. The HPHI conducted interventions designed to reduce environmental health hazards - especially asthma triggers - and measured the changes in health status of children with asthma after completion of the interventions.

It is our hope that better understanding of the links between improvements in building and apartment conditions and resident health will lead to changes in maintenance practices and in funding for public housing that will make healthy environments for public housing residents a priority. Specifically, the mattresses allowed us to assess how well they reduced dust mite antigen over time after they had been installed.

Methods

Eighty-six (86) Simmons "BackCare Kids" mattresses were installed in homes of asthmatic children living in three Boston public housing developments: Franklin Hill, Washington Beach, and West Broadway. The mattresses were provided to each asthmatic child participating in the study and for the people sleeping in the same room (siblings or other relatives). Allergen dust samples were collected from old mattresses and bed linens (HPHI sampling session 1, "Baseline"). Then the apartment-specific interventions were undertaken, including integrated pest management, industrial cleaning, installation of air-filtration systems, and replacement of the old mattresses with the new Simmons "BackCare Kids" After the intervention, allergen dust samples were collected again up to 3 times from the new beds (HPHI sampling sessions 2 - 4).

Bed samples were analyzed for cockroach (*Bla g 1* and *Bla g 2*), dust mite (*Der p 1* and *Der f 1*), Cat (*Fel d 1*), Dog (*Can f 1*), *Alternaria* allergens, and mouse urinary protein (MUP). Primary analysis was concentrated on the evaluation and comparison of the dust mite (*Der p 1* and *Der f 1*) levels in the bed samples before and after the intervention because the mattresses were designed to reduce dust mite infestation. Analysis of other antigens will be presented elsewhere as part of the full report of the study and we would be happy to forward those analyses to you once they are ready for public presentation.

Dust samples were collected using a Eureka Mighty-Mite II (Eureka Co., IL) or a Dirt Devil Breeze (Royal Appliance Mfg. Co., OH) canister vacuum cleaner. Samples were collected in a 19-mm x 90-mm Whatman cellulose extraction thimble placed in a retrofitted wand extension and capped with a crevice tool. The protocol for sample collection is based on the standard method for collecting dust outlined in the Inner-City Asthma Study (ICAS) Environmental Intervention Manual of Operations Version 1.0 (March 17, 1998). For bed samples, all layers of the bedding, including the mattress and pillows, were vacuumed for a total of five minutes.

For the detection and quantification of *Der p 1*, *Der f 1*, *Bla g 1*, *Bla g 2*, *Fel d 1* and *Can f 1* a sandwich enzyme link immunosorbent assay (ELISA) was used. For MUP and *Alternaria*, a competitive inhibition ELISA was used.

Results

While 86 new Simmons beds were installed in the houses of the participants of the study, 32 mattresses were not followed up due to drop out. The remaining 53 beds in 42 households were analyzed (Figure 1). We compared the baseline measurements of *Der p 1* and *Der f 1* with measurement at the farthest time point from the intervention for each household. Data used in the primary analysis of the Simmons mattress efficacy are shown in Table 1. Time distance between the installation of a new mattress and the sampling session varied from 1 month to 14 months with the average value of 7 months. This means that basically we were comparing allergen levels in the old mattresses with the allergen levels in the new Simmons mattresses up to 14 months of their use.

The concentrations of *Der p 1* and *Der f 1* allergens were not normally distributed. Distribution was skewed to the right for the both allergens. Skewedness to the right means that the shape of the distribution is not symmetric. Most of the observations are bunched below the mean, although there are few observations, which are much higher than the rest. Therefore, nonparametric statistical methods were used. Spearman rank correlation was used as a measure of association between baseline and post-intervention measurements of *Der p 1* and *Der f 1* allergens. To test the difference in dust mite levels in the old and new mattresses we used Wilcoxon matched-pairs signed rank test.

The dust from bedding contained detectable levels of *Der p 1* allergen in 29.7% (11 of 37) and of *Der f 1* allergen in 77.7% (28 of 36) of the household samples collected before the intervention. Dust samples collected from the bedding of the Simmons mattresses approximately 7 months after their installation showed substantial reduction in both *Der p 1* and *Der f 1* where detectable levels occur in only 2.7% (1 of 37) and 2.8% (1 of 36) of the samples respectively. Summary statistics for *Der p 1* and *Der f 1* allergens is shown in the Table 2. It shows that maximal, mean and median levels of the both dust mite allergens decreased after the intervention.

Cumulative distributions of *Der p 1* and *Der f 1* are shown on the Figures 2 and 3. *Der f 1* cumulative probability plot (Figure 3) lets visually trace the substantial change in the distribution of this allergen: starting approximately at the 40th percentile *Der f 1* levels at

the baseline are higher than for the post intervention measurement. Several outliers (i.e. unusually high values) were detected for the both *Der p 1* and *Der f 1* allergens. These outliers are marked at the plots. The households, which were found the highest at the baseline, were also the highest at the last session.

Pre and post *Der p 1* and *Der f 1* levels were significantly correlated ($r=0.56$, $p<0.001$, and $r=0.43$, $p<0.01$, respectively). High correlation between pre and post allergen levels along with the pattern seen on the cumulative probability plots suggest that there are some strong factors within the household that explain large part of the allergens' variation.

To test the difference in the mattress dust allergen levels before and after the intervention, we used Wilcoxon matched-pairs signed rank test. The Wilcoxon matched-pairs signed rank test is a non-parametric test that evaluates whether paired data come from the same population. The test confirmed that decrease in the dust mite levels was highly statistically significant for *Der f 1* allergen ($p<0.01$) and marginally significant for *Der p 1* allergen ($p=0.07$). The shift in the distributions after the intervention can be seen from the box-and-whisker plots (Figures 4 and 5).

Levels of cockroach, dog, cat, and alternaria allergens were not targeted in this intervention strategy and will not be reported in detail here. However, we can report that there was some decrease in the levels of all of these allergens. In the case of dog and cat allergens this decrease was statistically significant (Wilcoxon $p<0.001$ and $p=0.03$, respectively).

The findings of the study suggest that the Simmons "BackCare Kids" mattresses were effective at reducing dust mite antigen levels for substantial periods of time. Both *Der p 1* and *Der f 1* allergen levels were found substantially lower on the new Simmons mattresses after up to 14 months of their usage.

There were several limitations of the data analysis. The sample size was relatively small due to the cost constraints and drop out of the participants. At the same time the allergens' distributions were strongly skewed to the right with the very long tails. This can be explained by the diversity of the study population, differences in housekeeping, presence or absence of pets, etc. Small sample size along with such distribution resulted in the non-applicability of some of the statistical methods.

Figure 1. Mattress study summary.

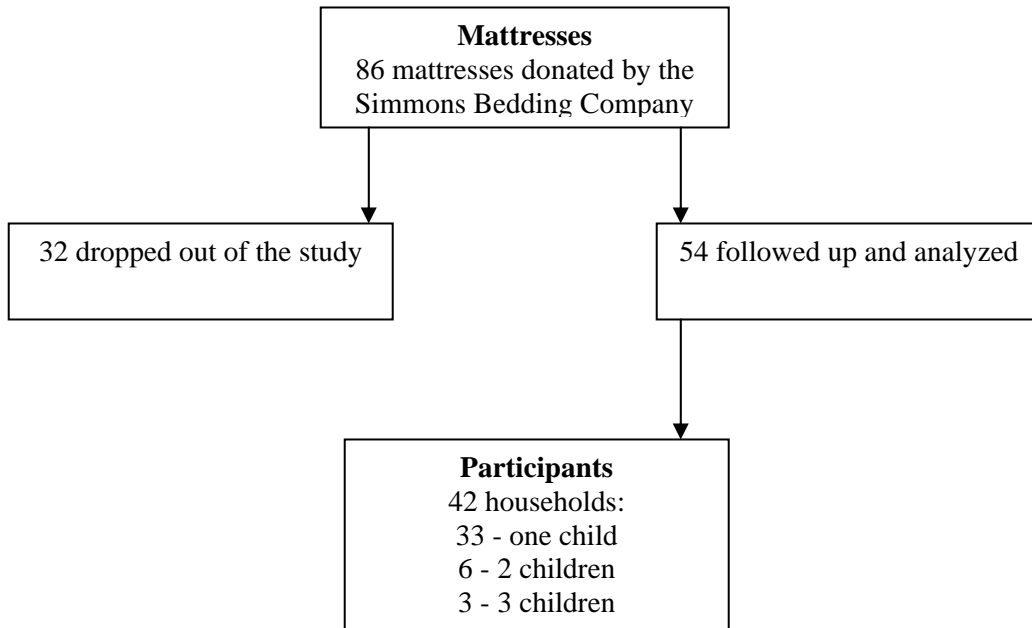


Table 1. Data used in the primary analysis of mattress efficacy: *Der p 1*, *Der f 1* ($\mu\text{g/g}$ dust). (Observations that were actually used in the analysis are in bold.)

Household ID	Mattress ID	Baseline		Post-intervention session 1			Post-intervention session 2			Post-intervention session 3		
		<i>Der p 1</i>	<i>Der f 1</i>	<i>Der p 1</i>	<i>Der f 1</i>	Time*	<i>Der p 1</i>	<i>Der f 1</i>	Time	<i>Der p 1</i>	<i>Der f 1</i>	Time
A001	A0011	0.015	0.03				0.015	0.015	136	0.015	0.015	286
A002	A0021	0.16	1.52	0.32	0.78	22	0.1	0.05	113	0.015	0.015	292
A004	A004	0.015	0.015	0.3	0.015	5	0.015	0.015	101	0.015	0.03	283
A008	A0081	0.015	0.76	0.015	0.19	20	0.015	0.015	118	0.015	0.015	437
A011	A0111	0.42	11.13	0.18	3.48	31			139			
A012	A0121	0.015	0.09	0.015	0.11	27	0.015	0.015	132			322
A012	A0122	0.015	0.015	0.015	0.015	27	0.015	0.015	132	0.015	0.015	322
A012	A0123	0.015	4.42	0.015	0.015	27	0.015	0.015	132	0.09	0.015	289
A013	A0131	0.015	0.015	0.015	0.13	38	0.015	1.57	136	0.015	0.06	285
A015	A0151	0.21	23.33				0.18		113	0.14		247
A016	A0161	8.31	0.24	15.39	0.55	22	12.26	0.35	106			
A016	A0162	23.57	5.22	19.97	3.64	22	2.52	0.11	106			
A017	A0171	0.015	1.86	0.015	0.015	7	0.015	0.015	104			
A019	A0191	0.08	0.015	0.015	0.015	24	0.015	0.015	140	0.015	0.015	322
A027	A0321	6.71	3.09	49.4	3.16	43	8.34	1.08	203			
A029	A0291	0.015	1.09	0.015	0.015	27	0.015	0.015	112	0.015	0.04	300
A031	A0311	0.015	0.04	0.015	0.03	21	0.015	0.03	94	0.015	0.015	291
A033	A0331	0.015	0.015				0.015	0.015	85	0.015	0.05	262
A034	A034	0.05	2.46				0.015	0.015	101			
A035	A0351	0.015	0.015							0.015	0.08	272
A036	A036	0.015	0.02							0.015	0.015	232
A038	A0381	0.015	1.98				0.015	0.16	106			
A039	A0391	0.93	1.62				0.18	40.01	65	0.05	0.22	239
A039	A0392	0.93	1.62				0.04	0.43	79	0.1	0.57	239
A039	A0393	0.93	1.62				0.05	0.27	79	0.025	0.22	239
A040	A0401	0.015	0.06	0.025	0.025	1	0.015	0.015	112			
A041	A0411	0.015	0.015				0.015	0.03	112	0.015	0.015	244
A043	A0431	0.015	0.38				0.015	0.04	112	0.015	0.04	267
B002	B0021	0.015	1.22				0.015	0.04	91	0.015	0.04	217
B002	B0022	0.015	0.09				0.015	0.09	91	0.015	0.015	238
B003	B0031	0.015	0.015					0.25	82	0.015	0.015	216
B005	B0051	0.11	0.41	0.015	0.04	13	0.015	0.015	93			
B006	B0061	0.015	0.03		0.4	202	0.015	0.015	83			
B007	B0071	0.015	0.13				0.56	0.9	141			243
B008	B0081	0.015	0.68	0.015	0.28	29	0.015	0.26	124	0.015	0.09	223
B010	B0101	0.015	0.56						89	0.015	2.07	215
B011	B0111	14.14	2.77				4.39	1.21	127	5.83	5.38	216
B012	B0121	0.015	0.24	0.05	0.36	8	0.1	0.15	121			
B013	B0131	0.015	0.06	0.015	0.06	8	0.015	0.015	106	0.015	0.03	234
B013	B0132	0.015	0.61	0.015	0.14	8	0.025	0.025	136	0.015	0.015	234
B015	B0151	0.015	1.84	0.015	0.82	6	0.015	3.48	106	0.015	2.16	217
B017	B0171	0.015	0.25				0.015	0.08	99	0.015	0.22	215
B019	B0191	0.025	0.03	0.015	0.06	7	0.015	0.03	82	0.015	0.015	231
B020	B0201	0.46	0.12				0.015	0.09	131			

* "Time" is the time difference in days between the day of a new mattress installation and the sampling.

Table 2. Summary statistics for *Der p* 1 and *Der f* 1 ($\mu\text{g/g}$ dust).

	N	% of detects	min	p25	p50	mean	p75	max
<i>Der p</i> 1 baseline	37	29.7	0.02	0.02	0.02	1.07	0.08	15.94
<i>Der p</i> 1 last	37	2.7	0.02	0.02	0.02	0.62	0.02	8.34
<i>Der f</i> 1 baseline	36	77.8	0.02	0.03	0.36	1.07	1.57	11.13
<i>Der f</i> 1 last	36	2.8	0.02	0.02	0.04	0.47	0.19	5.38

Figure 2. Cumulative distribution of *Der p 1* allergen.

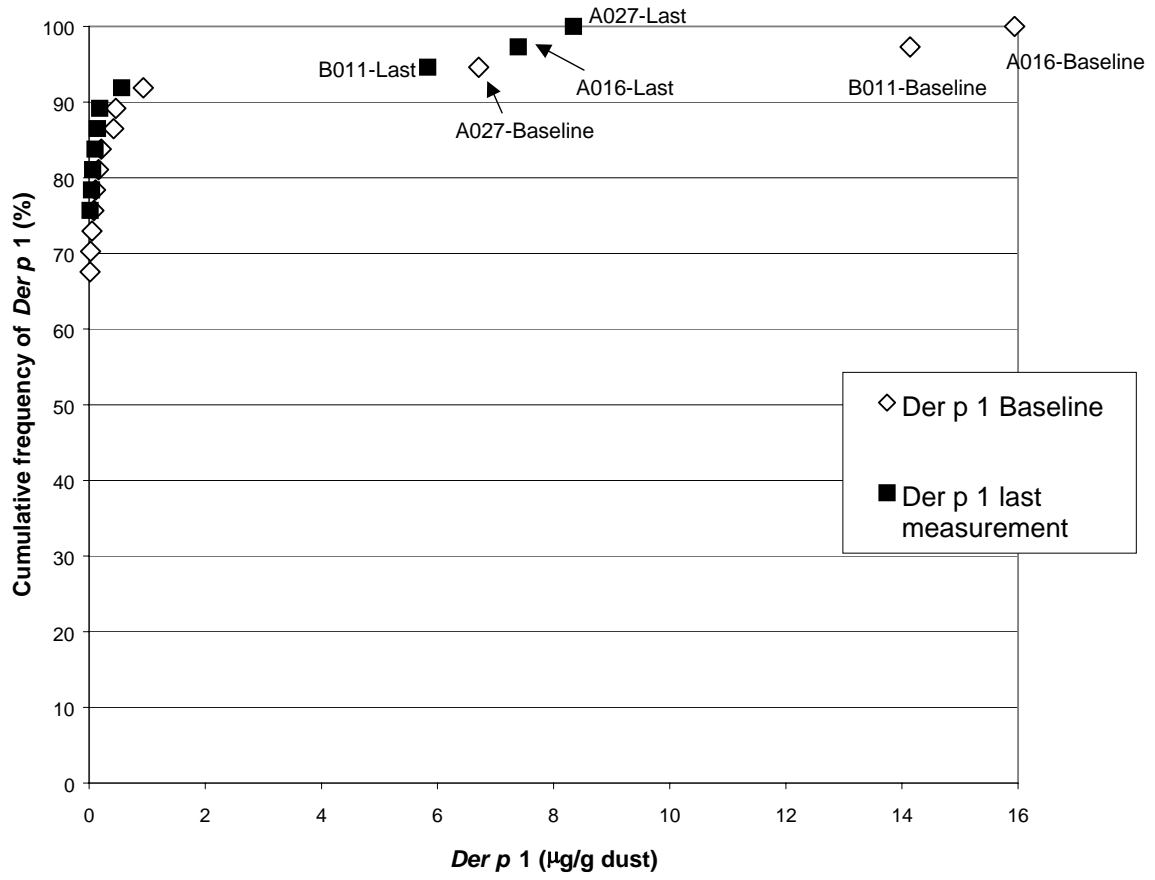


Figure 3. Cumulative distribution of *Der f 1* allergen.

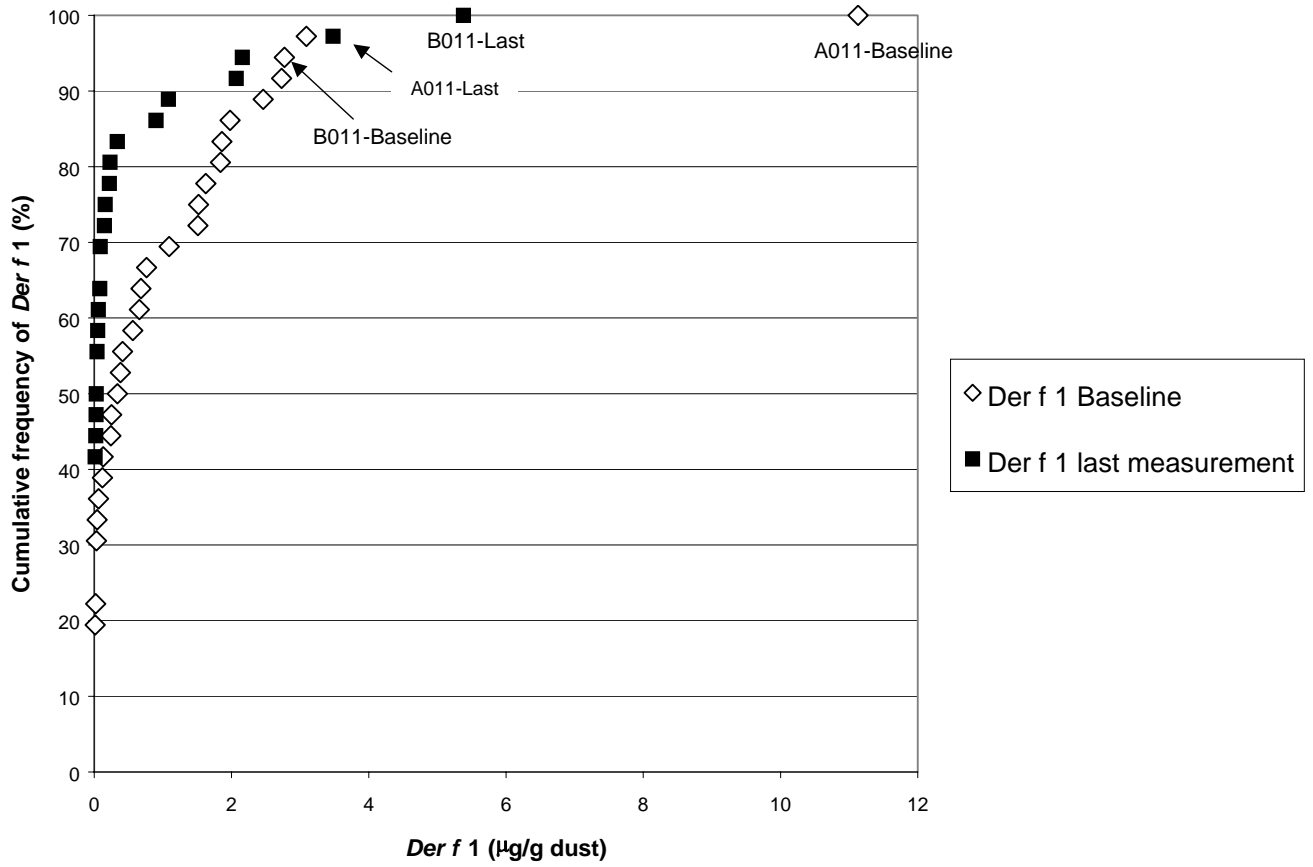


Figure 4. Box-and-whisker plots for the log-transformed *Der p 1* allergen levels at the baseline and after the intervention.

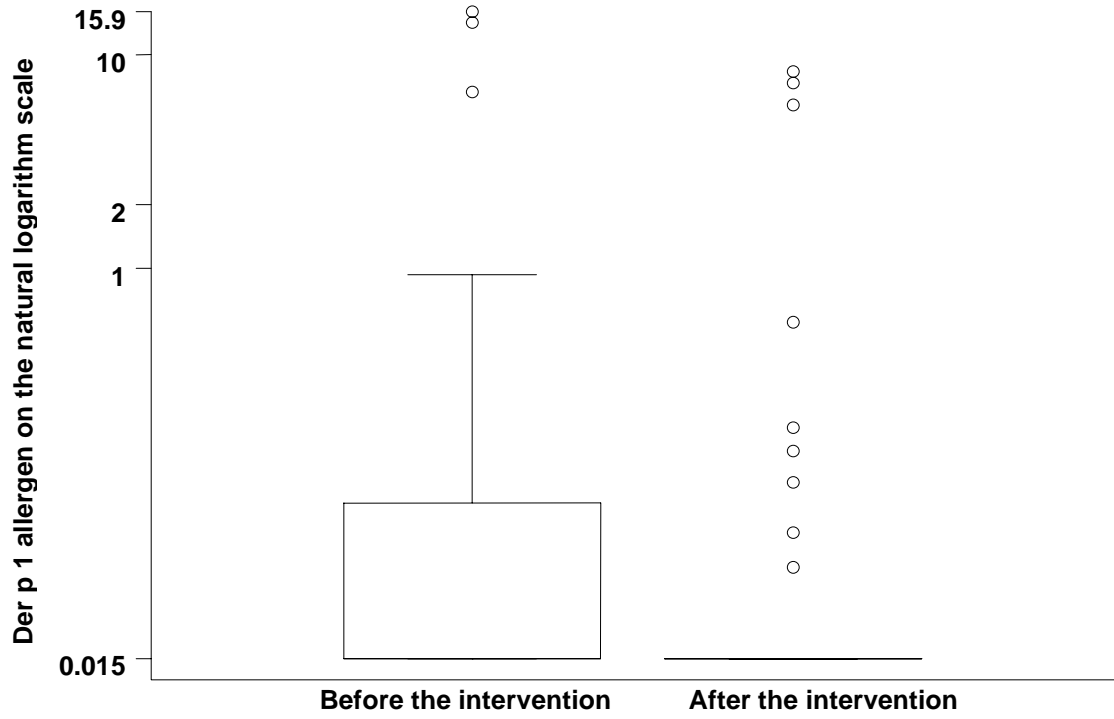


Figure 5. Box-and-whisker plots for the log-transformed *Der f 1* allergen levels at the baseline and after the intervention.

