

A randomized controlled trial of mite allergen-impermeable bed covers in adult mite-sensitized asthmatics

C. Luczynska, E. Tredwell, N. Smeeton and P. Burney

Department of Public Health Sciences, King's College London, UK

Summary

Background Mite-allergic patients with allergic disease should benefit from avoiding mite allergens. Many physicians, however, are yet to be convinced that allergen avoidance can make a significant contribution to asthma management in these patients. Many allergen-avoidance regimes include multiple measures of allergen reduction, but as mite exposure in the home is most likely to be greatest in bed dust, bedding is usually the first target for intervention.

Objective This study selected adult patients considered to be most likely to benefit from avoiding mite allergens, namely diagnosed asthmatics, sensitized to house dust mites and exposed to mite allergen in their mattresses. Patients were randomized into a placebo-controlled trial of the use of allergen-impermeable bed covers for 12 months, without any other form of mite-reduction measures.

Methods Adults with asthma were selected from general practices and asthma clinics in south-east London. Their serum IgE to mite allergens and allergen content of mattress dust samples were measured. Those with >0.70 kU/L mite-specific IgE and >2 $\mu\text{g/g}$ Der p 1 were randomized into active or placebo treatments. Information was collected on allergic symptoms and medication use and quarterly peak flow diaries were kept throughout the trial. Dog or cat allergic patients were excluded if they had a pet at home to which they were sensitized.

Results The mean decrease in $\mu\text{g/g}$ Der p 1 was 25.7 (95% CI 8.9, 74.1) in the active group and 4.5 (95% CI 1.8, 11.5) in the placebo group. Der p 1 concentrations in the active and placebo groups at the end of the trial were not significantly different. There was no effect on peak flow or asthma symptoms in a simple comparison of the treatment and placebo groups.

Conclusion In this group of patients, mite allergen avoidance in the bed by the use of allergen-impermeable bedding alone cannot be recommended as an effective way of relieving asthma symptoms.

Keywords Der p 1, mite allergen avoidance, peak flow, randomized controlled trial

Submitted 12 September 2002; revised 17 April 2003; accepted 15 May 2003

Introduction

Assuming that there is a dose–response relationship between exposure and symptoms, avoidance of an allergen to which a patient is sensitized should, in theory, result in a reduction in manifestation of allergic disease. In practice, however, the evidence that allergen avoidance can play a role in disease management has yet to be provided. In the UK, the predominant indoor allergen is the house dust mite *Dermaphagoides pteronyssinus* [1, 2], and greater than 30% of the population in East Anglia are sensitized to mites [3]. In a study in Norwich, mite allergens were present in 85% of mattresses, with a geometric mean concentration of 2 $\mu\text{g/g}$; 25% of the mattresses had mite allergen concentrations greater than 10 $\mu\text{g/g}$ [4]. Studies confirm that the most

important source of domestic mite exposure is the bed [5]. Concentrations of greater than 10 $\mu\text{g/g}$ mite allergens in the mattress are a risk factor for an increase in symptoms in sensitized individuals [6] and new mattresses quickly become infested with mites [7]. There is evidence that house dust mite allergen exposure can play a role in the aetiology of asthma [8] and that exposure to house dust mite allergens is associated with clinical activity of asthma [9]. There is also evidence that mite allergen avoidance by encasing the mattress can reduce exposure to mite allergens and improve respiratory symptoms [10, 11].

Allergen avoidance is unlikely, however, to show a positive effect in those who are not sensitized to an allergen or in those who are exposed to low doses of allergen. This implies that allergen avoidance will only be effective in a minority of asthma patients that fall into the sensitized, high-exposure category. As allergen-avoidance strategies can be costly, both in terms of materials and with patients' time commitment, avoidance regimes undertaken by all asthmatics are unlikely

Correspondence: Dr Christina Luczynska, Department of Public Health Sciences, 5th Floor, Capital House, 42 Weston Street, London SE1 3QD, UK. E-mail: christina.luczynska@kcl.ac.uk

to be effective and are very unlikely to be cost effective. If patients are carefully selected, however, it is possible that this could be a welcome and useful adjunct to therapy.

Many allergen-avoidance trials use multiple interventions in order to attempt to reduce mite allergen concentrations [12]. The problem with this design is that if the regime is successful it is not possible to identify which part of the intervention worked. Trials included in a meta-analysis that have used various methods of mite allergen avoidance have had variable success [13]. Of 27 studies in total, none of the trials using chemical methods of mite avoidance alone were able to demonstrate a reduction in mite allergens. Of 13 studies that used 'physical' or a combination of methods, four studies demonstrated a reduction in mite allergen levels by using mattress covers [14–17].

In addition to the studies included in the meta-analysis, studies by Owen et al. [18], Wickman et al. [19], Custovic et al. [20] and Frederick et al. [21] have clearly demonstrated that mite allergen concentrations can be reduced by using mattress covers. Sporik et al. [22] have shown that the use of mattress encasings was a useful long-term strategy for mite allergen avoidance in Melbourne, where the geometric mean concentration of house dust mite is much higher than in the UK. In Japan, where the geometric mean allergen level was similar to the UK, Nishioka, Yasueda and Saito used Allerguard mattress covers manufactured by Beirholms Vaeverier SA (Kolding, Denmark) and obtained decreased levels of Der p 1 and Der f 1, as well as a lower rate of allergic reactions to mite allergens in atopic infants [23].

This randomized placebo-controlled trial tested a single intervention in patients who were both sensitized and exposed to mite allergen. It aimed to assess whether the use of Allerguard allergen-impermeable bed covers, as a single intervention, resulted in an improvement in allergic disease outcomes in those patients most likely to benefit from allergen avoidance.

Methods

Selection of patients

A total of 3547 adults with mild asthma, aged 18–54 years, were identified from the general practices and outpatient clinics in south-east London who agreed to take part in the study. Fig. 1 shows the flow chart for recruiting study participants. Patients with a diagnosis of asthma and at least one prescription of inhaled steroids in the previous 12 months were invited to give a blood sample for the measurement of serum IgE antibody to *D. pteronyssinus* (d1), cat (e1) and dog (e5), using the Pharmacia CAP System (Pharmacia Diagnostics, Uppsala, Sweden). Those who had more than 0.7 kU/L specific IgE (RAST class 2) to *D. pteronyssinus* and no detectable specific IgE to cat or dog (if they had one at home) were then asked for a mattress dust sample for the measurement of Der p 1 using a monoclonal antibody ELISA. Patients with more than 2 µg/g Der p 1 were randomized into active or placebo groups. Inclusion and exclusion criteria are listed in Table 1. The study was approved by the Lambeth, Southwark and Lewisham and Bromley Research Ethics Committees.

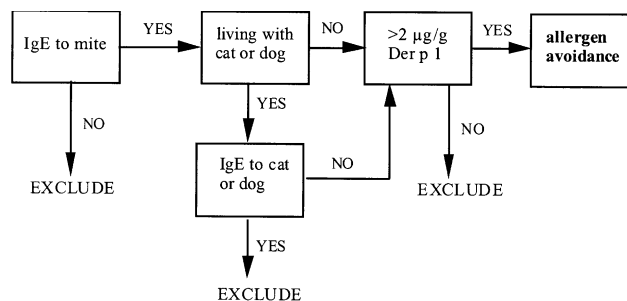


Fig. 1. Flow chart for recruiting patients into the trial.

Table 1. Inclusion and exclusion criteria for providing a blood sample for IgE

Inclusion criteria	Exclusion criteria
Diagnosis of asthma	Cat-allergic and living with a cat
Aged 18–54 years	Dog-allergic and living with a dog
At least one prescription for inhaled steroids in the last 12 months	More than one bed in the bedroom
Provided consent	Pregnant
	Planning to move house. Someone else in household already in the study

Study design

Following randomization to the trial, patients were visited at home by a fieldworker blinded to their trial status. Patients and the field worker completed questionnaires on asthma symptoms and use of asthma medication. They received an electronic peak flow meter (STI Instruments, Paris, France) and a peak flow diary, which also contained questions about asthma symptoms and use of medication, and was completed daily for 7 days. Patients undertook baseline peak flow recordings twice daily for 7 days before starting to use their allocated covers for 12 months. Further 7-day peak flow diaries were then completed at 4 months, 8 months and 12 months. Patients were visited at 6 months and at 12 months for a mattress dust sample and assessment of compliance with the trial protocol. At the final visit (12 months) they repeated the asthma symptoms and medication questionnaires. They also completed a questionnaire to check that inclusion and exclusion criteria for the trial were still being met. The trial took place between January 1998 and August 2000.

Allergen-impermeable bed covers

Identical real and sham Micro fibre allergen-proof covers were provided by Allerguard. The covers were made of 0.2 denier yarn and were 75% polyester and 25% nylon, which retained >99.5% of 0.4 µm particles. The sham covers were of the same material, but had a conventional weave of 5–10 µm in thickness. Covers were used to encase the mattress, duvet and/or any blankets and all pillows on the bed completely. Patients were able to use their own sheets over the covers and were given no other instructions.

Assessment of Der p 1 in mattress dust

Der p 1 was measured in mattress dust taken at month 0, month 6 and month 12. Mattress surfaces were vacuumed for

2 min using a Hoover Portapower vacuum cleaner and an ALK dust sampling filter cassette (ALK, Hørsholm, Denmark). Six-month and 12-month samples were taken with the allergy-proof covers *in situ*. Dusts were sieved using a 300 µm sieve and a 5% extract assayed for Der p 1 using a monoclonal antibody ELISA (Indoor Biotechnologies Inc., Cardiff, UK) as previously described [24]. Where no dust could be collected from the surface of the covers, the level of house dust mite allergen was taken to be below the detection limit of the assay. Results were expressed as µg Der p 1/g dust.

Analyses

Der p 1 values were logged for the analyses. Most studies have used peak flow as an outcome measure [25] as well as improvement of asthma symptoms. In our study, peak flow was used as the primary outcome. No effect was seen on peak flow due to 'day of the week' or 'diary day'; therefore unlogged mean daily peak flow measurements, defined as mean of highest morning value and highest evening value, were used for the analyses. Peak flow lability (diary maximum minus diary minimum/diary mean) and amplitude per cent mean peak flow (highest morning minus highest evening value/mean of highest morning and evening value for each day) were also analysed. Percentage change in diary days with chest tightness has been found to be a useful predictor of use of hospital services for asthma in children [26], so we also analysed diary days with chest tightness. Quality of life (QOL) at the beginning and end of the trial was assessed using the Marks Asthma Quality of Life Questionnaire [27]. Analyses were carried out using Stata 7 [28]. All analyses were adjusted for the age and sex of the participants.

Results

Following a recruitment period of over 2 years, 722/3547 (21.7%) of patients agreed to be screened for the trial and gave a blood sample for allergy testing. Subject selection following allergy testing is shown in Table 2. Thirty-nine patients (5.4%) were excluded because they were found to be allergic to their pet. Fifty-eight patients (73.4% of those who completed the selection process) agreed to take part in the trial and were randomly allocated to active or placebo groups. By the time the trial started, three of these patients no longer met the trial entry criteria and so were excluded, leaving a total of 55 patients – 30 in the active group and 25 in the placebo group. The baseline characteristics of the trial population are listed in Table 3.

From those patients randomized for the trial, 25 and 20 patients allocated to the active and placebo groups, respectively, started the trial. Geometric mean Der p 1 concentrations at the start of the trial were greater than 10 µg/g for both the active and placebo groups. Mean Der p 1 concentrations at the start of the trial and after the mid-trial and end-trial home visits for patients who started the trial are shown in Table 4. Der p 1 concentrations decreased significantly in the active group to less than 1 µg/g at 6 months and then rose slightly at 12 months. Der p 1 concentrations in the placebo group also fell and were significantly lower than baseline at 12 months. Mean Der p 1 levels fell in the active group by

Table 2. Selection of mite-sensitized, mite-exposed asthmatics from 722 patients who provided blood for allergy testing

	> 0.7 kU/L IgE to house dust mite	No IgE to cat or dog if exposed	Home visit for dust sample	> 2 µg/g Der p 1	Agreed to take part in the trial
Number of patients	351	312	266	79	58
% of patients tested	48.6	43.2	36.8	10.9	8.0

Table 3. Characteristics of trial patients randomized for trial

	Mean (SD)	
	Active (n = 30)	Placebo (n = 25)
Age (years)	39 (9)	33 (7)
Male gender (%)	50	48
Der p 1 in mattress (µg/g)	19.72 (5.04)	26.09 (5.10)
Specific IgE to house dust mite (d1) (kU/L)	17.37 (5.12)	13.80 (3.71)
Sensitized to cat (e1) (%)	27	44
Sensitized to dog (e5) (%)	43	44
Sensitized to grass (g6) (%)	53	50
Sensitized to mould (m2) (%)	13	17

25.7 µg/g (95% CI 8.9, 74.1) and in the placebo group by 4.5 µg/g (95% CI 1.8, 11.5); however, the difference between Der p 1 levels in the active and placebo group at the end of the trial was not significant. The individual Der p 1 concentrations for the patients in the two groups are presented in Fig. 2.

Table 5 and Fig. 3 show the mean peak flow for the active and placebo groups and the individual subject values, respectively, at 0, 4, 8 and 12 months of using allergen-proof bedding. The sample size achieved following recruitment to the trial was capable of detecting a 15% difference in peak flow with 80% power. There was no change in peak flow over time and no difference between the two groups (mean % increase in peak flow for active group 0.71 (95% CI –7.20, 8.61) vs. mean % increase for placebo group 1.71 (95% CI –5.54, 8.96); difference (active–placebo) –1.00 (95% CI –12.0, 10.18)). This was also the case when peak flow was analysed as amplitude per cent mean, peak flow lability or when using morning peak flows only (data not shown). The results were the same when the analyses were restricted to those patients who had completed the full 12 months of the trial (data not shown). The patients lost to follow-up did not differ in their baseline characteristics from the group who completed the trial.

A further disease outcome tested was number of diary days with reported chest tightness. As shown in Table 6, there was no difference in chest symptoms between the two groups or over the course of the trial. There was also no change in the number of reported asthma attacks or use of medication (data not shown). QOL did not differ from the start to the end of the trial. The mean decrease in square root of the QOL score

Table 4. Mattress Der p 1 concentrations at start, and after 6 and 12 months for patients who started the trial

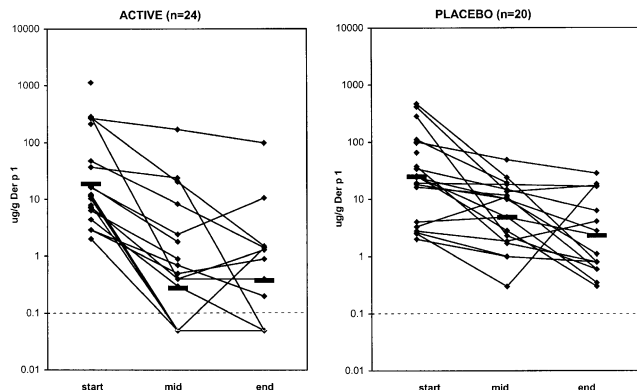
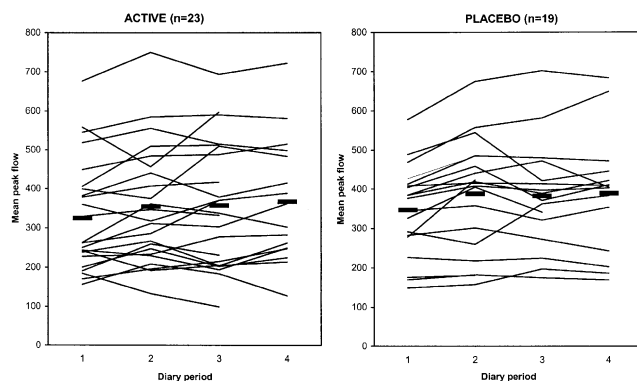
	Start		6 months		12 months	
	<i>n</i>	GM (95% CI)	<i>n</i>	GM (95% CI)	<i>n</i>	GM (95% CI)
Active	24	18.90 (9.41, 37.97)	16	0.28 (0.11, 0.69)	16	0.38 (0.13, 1.18)
Placebo	20	25.05 (11.56, 54.59)	14	4.82 (2.23, 10.40)	17	2.31 (1.11, 4.82)

Table 5. Mean peak flow after 0, 4, 8 and 12 months for patients who started the trial

Months	Active		Placebo	
	<i>n</i>	Mean (95% CI)	<i>n</i>	Mean (95% CI)
0	24	325 (295, 382)	20	347 (322, 372)
4	23	354 (292, 416)	19	388 (356, 420)
8	23	357 (292, 423)	16	382 (348, 417)
12	16	367 (289, 445)	15	388 (350, 428)

Table 6. Diary days with chest tightness after 0, 4, 8 and 12 months for patients who started the trial

Months	Active		Placebo	
	<i>n</i>	Mean (95% CI)	<i>n</i>	Mean (95% CI)
0	24	7.17 (5.26, 9.08)	19	6.05 (4.09, 8.01)
4	22	6.68 (4.51, 8.85)	19	3.68 (2.00, 5.36)
8	23	5.48 (3.21, 7.75)	15	3.67 (1.76, 5.58)
12	16	4.88 (2.32, 7.44)	15	5.93 (2.98, 8.88)

**Fig. 2.** Der p 1 concentrations at start, after 6 months and at the end of the trial for patients who started the trial.**Fig. 3.** Mean peak flow at start (Diary 1), after 4 months (Diary 2), 8 months (Diary 3) and at the end of the trial (Diary 4) for patients who completed at least two diaries during the trial.

for the active group was 0.44 (95% CI -0.25 , 1.14) and for the placebo group 0.69 (95% CI -0.04 , 1.42), the difference (active–placebo) being -0.25 (95% CI -0.74 , 1.23), showing a trend opposite to that predicted.

Discussion

The results of allergen-avoidance trials carried out to date remain inconsistent [29]. In Gotzsche et al.'s [13] meta-analysis of 23 trials, only five trials achieved a lowering of mite allergen levels in the intervention group and only four reported changes in morning peak flow. This study demonstrated a decrease in Der p 1 concentrations in the active group without any change in peak flow, even in carefully selected allergic asthmatic individuals who would be expected to benefit most from allergen avoidance.

The recruitment phase of the study proved to be much more difficult than anticipated. The response rate to blood testing for IgE to screen patients for mite sensitization was only 21.7%. Under half of these patients were found to be sensitized to house dust mite. Sibbald et al. [30] skin tested patients as part of asthma patient care and reported that only 22% of the patients attending clinic would have been advised to avoid mites on the basis of a positive skin test to dust mite. In our study, the per cent of patients who provided a blood sample for IgE testing who were subsequently found to be exposed to $>2 \mu\text{g/g}$ Der p 1 was only 79/722 (10.9%) or 79/351 (22.5%) of patients allergic to dust mites. If the exposure level of $10 \mu\text{g/g}$ Der p 1 had been chosen, only 41/722 (5.7%) of patients giving a blood sample for testing (or 12% of mite-allergic patients) would have been identified as potentially benefiting from mite allergen avoidance. This demonstrates the relatively low number of mild to moderate asthmatic patients, identified from general practices or allergy clinics, where allergen avoidance could be considered as part of asthma management.

Use of allergen-proof bedding in this study resulted in a decrease in Der p 1 levels measured in bed dust. This supports other studies that have found barrier methods, either used alone or in combination with other methods, successful in reducing Der p 1. It is likely that in combined allergen-avoidance regimes, it is the mattress covers that have the most effect on allergen levels [31, 22]. In this trial, use of both the

active and placebo covers resulted in a decrease in Der p 1. It is possible that the placebo covers were themselves acting as a sufficiently effective barrier to house dust mites to cause a reduction in allergen concentrations. Since this trial began, Vaughan et al. [32] published a study on laboratory experiments on the blocking effects of different types of encasements. They found that under their test conditions, pore sizes of $<10\text{ }\mu\text{m}$ were effective barriers to mite allergens.

Despite lower exposure to mite allergens, there did not appear to be any beneficial effect on asthma or allergic symptoms in either the active or the placebo group. This lack of association between fall in mite allergen exposure in the bed and change in symptoms or lung function argues that the failure of the trial to show any benefit was not due to the unexpected partial success of the placebo covers in reducing allergen levels. It is possible that the trial protocol was not adhered to consistently enough over the 12-month period, for example, if patients were away from home, to achieve an improvement in symptoms. However, this would be a limitation of any practical intervention of this kind. Avoiding mite allergens in the bed alone and not in other parts of the house may be insufficient to reduce exposure to mite allergens adequately and it is possible that a combined approach is necessary. Although this study eliminated the possibility of confounding of the effect due to allergy to pets, it did not take into account the effect of other allergies such as those to grass pollen or moulds, or other environmental factors that can influence the course of the disease.

In conclusion, mite allergen avoidance by the use of allergen-proof mattress encasings is capable of reducing Der p 1 concentrations in bedding. However, despite the fact that mite allergens are considered to be a dominant cause of asthma in countries such as the UK, there is no evidence of its usefulness as an addition to the management of mite allergic asthma in this urban/suburban UK population.

Acknowledgements

The authors would like to thank the Department of Health for supporting the study. Our gratitude is also due to Pharmacia Diagnostics AB (Uppsala), who provided the reagents for IgE testing, Allerguard PTE for providing the allergen-proof bedcovers, the general practitioners, practice managers and nurses from LSL Health Authority who helped to recruit patients, and Joanna Phillips for assistance in preparing the manuscript.

References

- Colloff MJ. Mites from house dust in Glasgow. *Med Vet Entomol* 1987; 1:163–8.
- Hart BJ, Whitehead L. Ecology of house dust mites in Oxfordshire. *Clin Exp Allergy* 1990; 20:203–9.
- Jarvis D, Luczynska C, Chinn S, Burney P. The prevalence of positive skin tests in East Anglia. *Clin Exp Allergy* 1994; 24:172.
- Luczynska C, Sterne J, Bond J, Azima H, Burney P. Indoor factors associated with concentrations of house dust mite allergen, Der p 1, in a random sample of houses in Norwich, UK. *Clin Exp Allergy* 1998; 28:1201–9.
- Sakaguchi M, Inouye S, Yasueda H, Shida T. Concentrations of airborne mite allergens (Der I and Der II) during sleep. *Allergy* 1992; 47:55–7.
- Peat JK, Tovey ER, Toelle BG et al. House dust mite allergens. A major risk factor for childhood asthma in Australia. *Am J Respir Crit Care Med* 1996; 153:141–6.
- Custovic A, Green R, Smith A, Chapman MD, Woodcock A. New mattresses: how fast do they become a significant source of exposure to house dust mite allergens? *Clin Exp Allergy* 1996; 26:1243–5.
- Dowse GK, Turner KJ, Stewart GA, Alpers MP, Woolcock AJ. The association between Dermatophagoides mites and the increasing prevalence of asthma in village communities within the Papua New Guinea highlands. *J Allergy Clin Immunol* 1985; 75:75–83.
- Custovic A, Taggart SO, Francis H, Chapman MD, Woodcock A. Exposure to house dust mite allergens and the clinical activity of asthma. *J Allergy Clin Immunol* 1996; 98:64–72.
- Marks GB, Tovey ER, Green W, Shearer M, Salome CM, Woolcock AJ. The effect of changes in house dust mite allergen exposure on the severity of asthma. *Clin Exp Allergy* 1995; 25:114–8.
- van der Heide S, Kauffman HF, Dubois AEJ, de Monchy J. Allergen reduction measure in houses of allergic asthmatic patients: effects of air-cleaners and allergen-impermeable mattress covers. *Eur Respir J* 1997; 10:1217–23.
- Colloff MJ, Ayres J, Carswell F, Howarth PH et al. The control of allergens of dust mites and domestic pets: a position paper. *Clin Exp Allergy* 1992; 22 Suppl. 2:1–28.
- Gotzsche PC, Hammarquist C, Burr M. House dust mite control measures in the management of asthma: meta-analysis. *BMJ* 1998; 317:1105–10.
- Huss K, Squire EN, Carpenter GB et al. Effective education of adults with asthma who are allergic to dust mites. *J Allergy Clin Immunol* 1998; 89:836–43.
- Walshaw MJ, Evans CC. Allergen avoidance in house dust mite sensitive adult asthma. *Q J Med* 1986; 58:199–215.
- Carswell F, Birmingham K, Oliver J, Crewes A, Weeks J. The respiratory effects of reduction of mite allergen in the bedrooms of asthmatic children – a double-blind controlled trial. *Clin Exp Allergy* 1996; 26:386–96.
- Ehnert B, Lau-Schadendorf S, Weber A, Buettner P, Schou C, Wahn U. Reducing domestic exposure to dust mite allergen reduces bronchial hyperreactivity in sensitive children with asthma. *J Allergy Clin Immunol* 1992; 90:135–8.
- Owen S, Morganstern M, Hepworth J, Woodcock A. Control of house dust mite antigen in bedding. *Lancet* 1990; 335:396–7.
- Wickman M, Nordvall SL, Pershagen G, Korsgaard J, Johansen N, Sundell J. Mite allergens during 18 months of intervention. *Allergy* 1994; 49:114–9.
- Custovic A, Simpson BM, Simpson A et al. Manchester Asthma and Allergy Study: low-allergen environment can be achieved and maintained during pregnancy and in early life. *J Allergy Clin Immunol* 2000; 105:252–8.
- Frederick JM, Warner JO, Jessop WJ, Enander I, Warner JA. Effect of a bed covering system in children with asthma and house dust mite sensitivity. *Eur Respir J* 1997; 10:361–6.
- Sporik R, Hill DJ, Thompson PJ et al. The Melbourne house dust mite study: long-term efficacy of house dust mite reduction strategies. *J Allergy Clin Immunol* 1998; 101:451–6.
- Nishioka K, Yasueda H, Saito H. Preventive effect of bedding encasement with microfibre fibers on mite sensitization. *J Allergy Clin Immunol* 1998; 101:28–32.
- Luczynska CM, Arruda LK, Platts-Mills TAE, Miller JD, Lopez M, Chapman MD. A two-site monoclonal antibody ELISA for the quantification of the major *Dermatophagoides* spp. allergens, Der p I and Der p II. *J Immunol Methods* 1989; 118:227–35.
- Higgins BG, Britton JR, Chinn S et al. The distribution of peak expiratory flow variability in a population sample. *Am Rev Respir Dis* 1989; 140:1368–72.

- 26 Mortimer KM, Redline S, Kattan M, Wright EC, Kerckmar CM. Are peak flow and symptom measures good predictors of asthma hospitalizations and unscheduled visits? *Ped Pulmonol* 2001; 31:190–7.
- 27 Katz PP, Eisner MD, Henke J, Shiboski S, Yelin EH, Blanc PD. The Marks Asthma Quality of Life Questionnaire: further validation and examination of responsiveness to change [erratum appears in *J Clin Epidemiol* 2001; 54:106–7]. *J Clin Epidemiol* 1999; 52:667–75.
- 28 Stata Corporation., 702 Univ Dr E, College Station, Texas 77840, USA.
- 29 Strachan DP. House dust mite allergen avoidance in asthma. Benefits unproved but not yet excluded. *BMJ* 1998; 317:1096–7.
- 30 Sibbald B, Barnes G, Durham SR. Skin prick testing in general practice: a pilot study. *J Adv Nursing* 1997; 26:537–42.
- 31 Weeks J, Oliver J, Birmingham K, Crewes A, Carswell F. A combined approach to reduce mite allergen in the bedroom. *Clin Exp Allergy* 1994; 25:1179–83.
- 32 Vaughan JW, McLaughlin T, Perzanowski M, Platts-Mills TAE. Evaluation of materials used for bedding encasement: effect of pore size in blocking cat and dust mite allergen. *J Allergy Clin Immunol* 1999; 103:227–31.