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SHORT COMMUNICATION

Prevalence of Mouse Allergen (Mus m 1) in Homes of New Zealand Rural Children

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SUMMARY Mouse allergen has emerged as an under recognized indoor allergen associated with sensitization and contributing to asthma severity. As part of a study of farm residence, exposures, and risk of allergic diseases in children in New Zealand, 216 living room floor dust samples were analysed for the mouse allergen, Mus m 1. Associations between Mus m 1 and allergic diseases, farm residence, and presence of cats were analysed. Significantly higher levels of Mus m 1 were found in farm dwellings, while the presence of cats was associated with significantly lower Mus m 1 levels. Levels of Mus m 1 in New Zealand were considerably lower than those reported overseas. No significant associations were found between Mus m 1 levels and atopic status or allergic diseases. Mouse allergen is unlikely to be an important indoor allergen for rural New Zealand children.

Occupational allergy to mouse allergens is a major cause of disability among workers in mouse breeding and research facilities. Reported prevalence of respiratory allergy ranges from 20 to 30 %, with asthma being a predominant complaint.[1,2] Despite this, the prevalence of atopy to mouse allergens and the significance of mouse allergen exposure in domestic environments has received little attention, and no studies have been undertaken in New Zealand.

Morbidity from asthma is disproportionately high among inner-city children in the United States (US).[3] One possible explanation is increased exposure to indoor allergens, such as house dust mite, cat and cockroach[4], and mouse.[5,6] In a study of inner city homes in Ludz, Poland, mouse allergen was detected in 46% of homes and was associated with positive skin prick tests in 36% of children.[5] The authors concluded that in Polish children, mouse allergen is an important factor of sensitivity and should be considered in the diagnosis of allergic disease, as well as in allergen reduction programmes.

A study of inner city homes in the US found that 95% of all homes had detectable mouse allergen in at least one room, with the highest levels found in kitchens.[6] The levels of mouse allergen were substantial and similar to those seen in other studies for cat and dog allergens.[7,8] A related study attempted to further define the prevalence of mouse sensitivity, the risk factors for sensitization, and the relationship between mouse allergen exposure, sensitivity and

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asthma morbidity in the same population.[9] They found that, although the sensitivity to mouse allergen was not quite as common as the other major indoor allergens (cockroach, dust mite, cat), the prevalence of homes with detectable mouse allergen was similar to cockroach allergen and greater than both cat and dust mite allergens. That study demonstrated a similar exposure-sensitization relationship for mouse allergen as for cockroach allergen. The authors concluded that mouse allergen is an under recognized and important indoor allergen in inner city US homes.

As part of a study of risk factors for asthma and allergic diseases amongst children living in a rural community, dust samples were collected in New Zealand for the analysis of common indoor allergens and endotoxin.[10] Subsequently, a commercial kit became available for quantification of the major mouse allergen, Mus m 1. In the present study we report on mouse allergen levels in this population, and their association with atopic status and diseases, farm residence, and presence of cats.

MATERIALS AND METHODS

The study design has previously been published in detail.[10] Briefly, children aged 7-10 years were approached from schools in and nearby Dannevirke, New Zealand (population 5,513). Information on allergic disease history and symptoms was collected using the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire.[11] Skin prick tests to *Dermatophagoides farinae*, *Dermatophagoides pteronyssinus*, mould mix, cockroach, rye grass, timothy grass, cat and dog (Bayer allergens) were performed by standard methods. Atopy was defined as a mean wheal diameter of 3 mm or more to at least one allergen. Instructions were provided for participant collection of living room floor dust samples.

Dust was sampled from 1 m^2 for 1 minute from carpeted areas or from 2 m^2 for 2 minutes from uncarpeted areas. Dust samples were sieved (425 µm) and stored at -20^{o}C before analysis. The sieved dust samples were extracted with phosphate-buffered saline (0.1 g in 1.0 ml) for 30 minutes at room temperature, centrifuged, and aliquots of the supernatant stored at –20^{o}C. These were subsequently analysed for Mus m 1 using a commercial polyclonal ELISA kit (Indoor Biotechnologies, Cardiff, UK). Samples were run singly in 3 dilutions (1:10, 1:40, 1:160) and the results given as a weighted average using microplate analysis software (Bio Metalics Inc, Princeton NJ, USA). Duplicate standard curves were run on every plate and acted as an internal control. There is no cross reactivity with cat, dog, horse or rat allergens.

Results are expressed as ng/g dust, dust samples with undetectable Mus m 1 levels were assigned a value of 1 ng/g. Median values and ranges are presented as the data were not normally nor log-normally distributed. Relations between Mus m 1 and other parameters were determined using the Wilcoxon rank sum test in SAS version 8 (SAS Institute, Cary NC, USA). The Wellington Ethical Committee approved the study.

RESULTS

Mouse urinary allergen was detected in 152 out of 216 living room floor dust samples (70.4%). Significantly higher levels of mouse allergen were found in dust samples from farm dwellings compared with samples from non-farm dwellings but the maximum level detected was in a non-farm dwelling (Table 1). Mouse urinary allergen levels were also significantly lower in dwellings where a cat was present (inside and/or outside) than in dwellings where there was no cat present (Table 1).

No significant differences in mouse allergen levels were found between dwellings with or without a dog present. No significant associations were found

Table 1 Mus M 1 (ng/g) levels from living room floor dust samples

	N	Median	Range
All samples	216	11	1-2,162
Farm	73	24*	1-1,101
Non-farm	142	8	1-2,162
Cat present	171	10**	1-1,106
No cat	45	30	1-2,162

*p = 0.001 compared to non-farm.
**p = 0.009 compared to no cat.

between mouse allergen levels and the presence of atopy, wheeze, asthma, sneezing without a cold, hay fever, itchy rash, eczema, nor with endotoxin or house dust mite allergen levels (data not shown).

DISCUSSION

Sensitization to indoor allergens from house dust mites and domestic animals is associated with the development of allergic diseases.[12] New Zealand homes have some of the highest house dust mite allergen levels in the world, and due to high cat ownership, high levels of cat allergen.[13] Lately, attention has focussed on other indoor allergens of importance for sensitization and development of allergic diseases, such as those from cockroach,[14] and more recently mouse allergen.[5,6] In the National Cooperative Inner-City Asthma Study in the United States, a higher rate of sensitization to mouse allergen was observed with Mus m 1 levels of 1,600 ng/g or greater,[6] and levels of Mus m 1 were associated with evidence of mice and cockroach infestations.[5]

Mouse allergen was detected in 70.4% of the farm and non-farm homes in our study. The median level found was 11 ng/g (maximum: 2,160 ng/g), which is much lower than those reported overseas. For instance, the median level from living room floors in inner-city homes in the United States was 570 ng/g ,[6] while in Poland the median level in bedrooms was 230 ng/g.[5] The reason for the much higher levels of Mus m 1 in the US study is probably a reflection of the nature of the study participants. They were predominantly children living in low economic status inner-city dwellings with frequent sightings of mice and cockroach infestation; these sightings being positively related to Mus m 1 levels. Our study participants were from a cross-section of a general population in a rural setting.

However, a recent US study found a median bedroom level of 12 ng/g in a suburban middle-class area.[15] In that study a much higher median bedroom level of 757 ng/g was found in a comparable city area. The authors also found that the risk of sensitization to mouse allergen appeared to increase with increasing bedroom Mus m 1 levels and from exposure levels as low as 2.2 ng/g.

In our study Mus m 1 levels were higher in farm dwellings. It is reasonable to assume that the higher levels from farm dwellings reflects the natural presence of mice around farms, although we did not collect information on mice sightings in dwellings, nor pet mice keeping by children. However, high levels of Mus m 1 were found in many New York City homes where parents reported never sighting mice indoors.[16] Also, our study shows that the presence of a cat, whether allowed inside or not, was associated with lower Mus m 1 levels. This has also recently been demonstrated in homes in New York City.[16] Possibly, cats keep mice away resulting in lower levels of Mus m 1.

We found no association between atopic status and Mus m 1 levels. However, we did not skin prick test to mouse allergen. The inner city US study showed that 40% of children with more than four positive skin prick tests and Mus m 1 levels above 1,600 ng/g had a positive skin prick test to mouse allergen.[9] In our study only 1 dust sample returned a Mus m 1 level of >1,600 ng/g, thus, based on the above, it is unlikely that any of our children would have returned a positive skin prick test to mouse allergen. It is unknown at present whether the levels of Mus m 1 in our study are related to symptoms in allergic children who are sensitized to mouse allergen. However, this is unlikely as in the inner city US study, where Mus m 1 levels were in general a log higher, Mus m 1 levels were not associated with asthma morbidity.

In conclusion, levels of Mus m 1 in a rural New Zealand setting were low, and no associations were found between Mus m 1 levels and allergic diseases. It seems unlikely that mouse allergen is an important indoor allergen for New Zealand children in rural areas. However, further studies are warranted to determine whether Mus m 1 levels in New Zealand city areas are higher, as has been shown in overseas cities.

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REFERENCES

1. Gross NJ. Allergy to laboratory animals: epidemiologic, clinical, and physiologic aspects, and trial of cromolyn sodium in its management. J Allergy Clin Immunol 1980; 66: 158-65.

2. Schumacher MJ, Tait BD, Holmes MC. Allergy to murine antigens in a biological research institute. J Allergy Clin Immunol 1981; 68: 310-8.
3. Gottlieb DJ, Beiser AS, O'Conner GT. Poverty, race, and medication use are correlated of asthma hospitalization rates. A small area analysis in Boston. Chest 1995; 108: 28-35.
4. Call RS, Smith TF, Morris E, Chapman MD, Platts-Mills TA. Risk factors for asthma in inner city children. J Pediatr 1992; 121: 862-6.
5. Stelmach I, Jerzynska J, Stelmach W, Majak P, Chew G, Kuna P. The prevalence of mouse allergen in inner-city homes. Pediatr Allergy Immunol 2002; 13: 299-302.
6. Phipatanakul W, Eggleston PA, Wright EC, Wood RA. Mouse allergen. 1. The prevalence of mouse allergen in inner-city homes. The National Cooperative Inner-City Asthma Study. J Allergy Clin Immunol 2000; 106: 1070-4.
7. Wood RA, Eggleston PA, Lind P, *et al*. Antigenic analysis of household dust samples. Am Rev Respir Dis 1988; 137: 358-63.
8. Ingram JM, Sporik R, Rose G, Honsinger R, Chapman MD, Platts-Mills TA. Quantitative assessment of exposure to dog (Can f 1) and cat (Fel d 1) allergens: relation to sensitization and asthma among children living in Los Alamos, New Mexico. Allergy Clin Immunol 1995; 96: 449-56.
9. Phipatanakul W, Eggleston PA, Wright EC, Wood RA. National Cooperative Inner-City Asthma Study. Mouse allergen. 11. The relationship of mouse allergen exposure to mouse sensitization and asthma morbidity in inner-city children with asthma. J Allergy Clin Immunol 2000; 106: 1075-80.
10. Wickens K, Lane JM, Fitzharris P, *et al*. Farm residence and exposures and the risk of allergic diseases in New Zealand children. Allergy 2002; 57: 1171-9.
11. Asher MI, Keil U, Andersen HR, *et al.* International Study of Asthma and Allergies in Childhood (ISAAC): rationale and methods. Eur Respir J 1995; 8: 483-91.
12. Sears MR, Burrows B, Flannery EM, Herbison GP, Holdaway MD. Atopy in childhood. I. Gender and allergen related risks for development of hay fever and asthma. Clin Exp Allergy 1993; 23: 883-5.
13. Sawyer G, Kemp T, Shaw R, et al. Biological pollution in infant bedding in New Zealand: high allergen exposure during a vulnerable period. J Allergy Clin Immunol 1998; 102: 765-70.
14. Rosenstreich DL, Eggleston P, Kattan M, *et al.* The role of cockroach allergen in causing morbidity among inner-city children with asthma. N Engl J Med 1997; 336: 1356-63.
15. Matsui EC, Wood RA, Rand C, *et al*. Mouse allergen exposure and mouse skin test sensitivity in suburban, middle-class children with asthma. J Allergy Clin Immunol 2004; 113: 910-5.
16. Chew GL, Perzanowski MS, Miller RL, *et al*. Distribution and determinants of mouse allergen exposure in low-income New York City apartments. Envir Health Persp 2003; 111: 1348-51.