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House dust mite allergen levels in University student accommodation in Dunedin

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Abstract

Aim To quantify the levels of *Dermatophagoides pteronyssinus* (*Der p1*) in different university student accommodation in Dunedin, and to assess relationships with housing characteristics and housekeeping practices.

Methods Dwellings (n=178) were randomly selected from a database of first year university students in Dunedin. Dust samples were collected from both bed and the bedroom floor by standardised procedures. *Der p1* levels were quantified by monoclonal antibody ELISA techniques. Details of housing characteristics, occupancy and housekeeping practices were obtained by questionnaire.

Results Geometric mean (95% confidence intervals) *Der p1* allergen levels from bedroom floors were: family homes (n=61) 5.58 (3.73-8.36) μg/g; student flats (n=43) 3.89 (2.49-6.07) μg/g; halls of residence (n=74) 0.26 (0.16-0.43) μg/g. *Der p1* allergen levels from beds were: family homes 15.85 (9.78-26.57) μg/g; student flats 10.5 (6.41-17.19) μg/g; halls of residence 3.25 (2.33-4.54) μg/g. In all accommodation lower levels of *Der p1* were found on the floor compared to the bed ($p<0.005$). Halls of residence had significantly lower *Der p1* levels in both bed and floor ($p<0.0005$). Higher levels of *Der p1* were associated with longer duration of occupancy, a history of condensation or mold in the accommodation, failure to use a hot wash for sheets, mattress age greater than one year and infrequent vacuuming of the bedroom floor.

Conclusions Wide variations in *Der p1* levels were observed between different forms of student accommodation. Higher levels of *Der p1* are found in family homes than in student flats or halls of residence.

House dust mite allergen, *Dermatophagoides pteronyssinus (Der p1)* exposure is a major risk factor for the development and maintenance of asthma in genetically susceptible individuals. Around one third of the population sufficiently exposed to house dust mite will become sensitised, particularly families with a history of atopy.[1] The suggested threshold for sensitisation to *Der p1* is 2 μg/g house dust, with the threshold for exacerbation of symptoms being 10 μg/g.[2]

The temperate New Zealand climate with high year round outdoor humidity has been found to be highly conducive to house dust mite growth and proliferation. As a result, New Zealanders are exposed to higher levels of *Der p1* in their domestic environments than individuals in other countries.[3,4] Relatively low levels of *Der p1* have been documented in Canada,[5] Denmark[6] and Sweden,[7] with relatively higher levels in the United Kingdom[8] and the Netherlands.[9] However the highest *Der p1* allergen levels have been measured in coastal Australia (mattress levels 22.5 μg/g,

bedroom floor levels 21.6 μg/g in Sydney)[10] and in New Zealand (mattress levels 46.6 μg/g, bedroom floor levels 26.4 μg/g in Wellington).[3]

Otago university students make up a relatively large and unique subsection of the Dunedin population. Many live in low cost, poorly maintained rental accommodation. Others live in newer-style but often underventilated flats. Furnishings, curtains and carpets are generally old and/or dusty in these flats. Students living in the close confines of the halls of residence have no choice in the types of bedding or flooring used or the frequency of bed linen changes, and may not have access to a vacuum cleaner. Previous studies have identified such environments as promoting house dust mite proliferation.[9,11-13] Assessment of the *Der p1* levels in the various forms of accommodation may give us some insight into risk factors for asthma morbidity in the university student population.

This study aimed to quantify the levels of *Der p1* in different university student accommodations in Dunedin, and to assess the relationship between allergen levels, housing characteristics and housekeeping practices. Levels of *Der p1* had not previously been measured in the city. Whereas the New Zealand environment differs from other countries, the Dunedin climate is not comparable to other New Zealand cities hence data on *Der p1* levels from earlier studies could not easily be extrapolated.

Methods

Subjects. A database of 1730 Otago University first year students was established from a short questionnaire administered at the commencement of the 1998 academic year. Student dwellings (n=178) were randomly selected from this database, following grouping according to the type of accommodation. All students were in their first year of University study in Dunedin and had lived in their accommodation for at least six weeks prior to the study. A history of asthma or allergy was not required.

Design. The study was cross-sectional, involving the assessment and measurement of *Der p1* levels in three different forms of student accommodation: family homes (including boarding arrangements), student flats and halls of residence.

Visits took place between May-September 1998. In each dwelling, reservoir dust samples were collected from two different sites, the bedroom floor and the bed. Floor samples were taken from the area adjacent to the bed. Samples were collected from $1m^2$ area of carpeted floor or $2m^2$ of uncarpeted floor. Rugs and other removable floor coverings were removed prior to sampling. Bed samples were taken from $1m^2$ area of the top of the mattress.

Sampling was performed using an Hitachi CV-2500, 1100 watt vacuum cleaner, with a small furniture head attachment. A 15 cm length collection sock, made of 25μm pore-sized nylon mesh (nytel HP25), was attached to the furniture head. Each area was vacuumed for one minute using firm pressure. The floor sample was obtained before the bed sample and a new vacuum cleaner head was used for the collection of each sample. The sock containing the sample was tied then frozen at –20 °C until further preparation in the form of sieving and weighing of the sample was carried out. Weighed fine-sifted (425 μm) dust samples were extracted in phosphate-buffered saline at room temperature for 30 minutes, and *Der p1* levels in the centrifuged extracts were estimated by double-monoclonal antibody ELISA.[14]

At the time of dust sampling, details of housing characteristics, occupancy and housekeeping practices were obtained by questionnaire.

Analysis. Floor and bed samples of *Der p1* were analysed separately. *Der p1* levels were log-transformed and compared by site and between dwelling groups by one-way analysis of variance. Multivariate analyses were done by linear regression of the log-transformed *Der p1* levels.

The study was approved by the Otago Regional Health Authority Ethics Committee.

Results

Bedroom dust samples and questionnaire data were obtained from all 178 students enrolled in the study. Accommodations were grouped into family homes (n=61), student flats (n=43) and halls of residence (n=74).

Der p1 concentrations were significantly higher in dust from beds than from bedroom floors in the three forms of student accommodation (Table 1). There were significantly lower levels of *Der p1* in halls of residence compared with family homes and student flats.

Table 1. Geometric mean (95% confidence intervals) Der p1 allergen levels according to type of accommodation.

Type of accommodation	n	Bedroom floor μg/g	Bed μg/g	p value
Family home	61	5.58 (3.73-8.36)	15.85 (9.78-26.57)	<0.001
Student flat	43	3.89 (2.49-6.07)	10.50 (6.41-17.19)	<0.003
Halls of residence	74	0.26 (0.16-0.43)	3.25 (2.33-4.54)	<0.0005
p value		<0.0005	<0.0005	

Univariate analysis showed significantly higher floor levels of *Der p1* associated with the type of accommodation (p=0.0005), fewer than fifteen people sharing the accommodation (p=0.0005), occupancy of their current accommodation for longer than two years (p=0.0005), the presence of a washing machine or clothes drier inside the accommodation (p=0.0005), pets inside the accommodation (p=0.0005), the use of electric or central heating (p=0.0005), infrequent vacuuming of the bedroom floor (p=0.0005), failure to use a hot wash for sheets (p=0.0005), a history of condensation or mold inside the accommodation (p=0.005), the sharing of the accommodation with a smoker (p=0.004) and failure to vacuum the mattress (p=0.03).

Univariate analysis showed significantly higher bed levels of *Der p1* associated with a mattress greater than one year of age (p=0.0007), the type of accommodation (p=0.0005), fewer than fifteen people sharing the accommodation (p=0.0005), occupancy of their current accommodation for longer than two years (p=0.0005), the presence of a washing machine or clothes drier inside the accommodation (p=0.0005), pets inside the accommodation (p=0.0005), the use of electric or central heating (p=0.0005), infrequent vacuuming of the bedroom floor (p=0.0003), failure to use a hot wash for sheets (p=0.0001), a history of condensation or mold inside the accommodation (p=0.005), a history of asthma in the occupying student (p=0.026) and the sharing of the accommodation with a smoker (p=0.01). There was no association between bed *Der p1* levels and vacuuming of the mattress.

The type of accommodation that the student was living in had a major influence on the measured allergen levels. When the type of accommodation was adjusted for by multivariate regression analysis, higher floor levels of *Der p1* were associated with fewer people sharing the accommodation (p=0.035), the presence of a washing machine inside (p=0.02), the presence of a clothes drier inside (p=0.01) and an electric heater being used as the primary form of heating (p=0.006).

When the type of accommodation was adjusted for by multivariate regression analysis, higher bed levels of *Der p1* were associated with a longer duration of residence in Dunedin (p=0.0005), a longer duration (>2 years) of occupancy of the

current accommodation (p=0.004), a mattress greater than one year of age (p=0.0005) and an electric heater being used as the primary form of heating (p=0.03).

No association was demonstrated between *Der p1* levels and the sex of the student, use of a mattress cover, type of mattress on the bed, the washing of bedding, age of carpet in the bedroom, the presence of carpet or rugs on the bedroom floor, a lack of heating in the accommodation or the frequency of clothes drier and washing machine usage.

Detailed tables of results are available from the authors on request.

Discussion

Dunedin is a city where, during the university term, approximately 10% of the population is composed of University of Otago students. This study was designed to quantify levels of *Der p1* in university student accommodation and determine factors that might influence the levels.

We found that *Der p1* levels varied widely between the three different forms of student accommodation. Students were exposed to higher levels of the allergen living in family homes, boarding environments and in student flats when compared with halls of residence. Similar low levels of *Der p 1* have been demonstrated in University Colleges compared with nearby homes in Sydney, Australia.[15]

A number of possible explanations exist for this difference. Rooms in halls of residences are cleaned and sheets laundered on a regular basis. These rooms tended to have low pile, commercial grade carpet and be well heated and ventilated. Halls of residences are typically vacant for a three month period over summer, possibly resulting in a fall in house dust mite levels from the ensuing reduction in food sources and humidity.

Other studies have shown that significant differences exist between *Der p1* levels in public buildings when compared to domestic dwellings.[16,17] Our results suggest that the level of *Der p1* students are exposed to in halls of residence is more in keeping with that of a public building. The geometric mean floor level of *Der p1* in halls of residence was 0.26μg/g, compared with 0.58μg/g measured in public buildings in two New Zealand cities.[16] The geometric mean bed level of *Der p1* in the halls of residence was 3.25μg/g, very similar to the 3.57μg/g measured in hotel beds in the same study.[16]

In all forms of accommodation the *Der p1* concentrations were significantly higher in dust collected from beds than from bedroom floors, consistent with results from both earlier New Zealand studies as well as overseas research. Indeed the *Der p1* levels measured in mattress dust in student flats and family homes were above the recognised threshold for the exacerbation of allergy symptoms, and bedroom floor levels exceeded the sensitisation threshold.[2]

Our results suggest that bed and floor *Der p1* levels may be influenced by different environmental factors. Higher bed levels were associated with factors relating to a longer duration of residence in the studied dwelling. Our finding of higher levels of *Der p1* allergen in mattresses greater than one year of age is in keeping with an earlier study by Custovic et al,[18] where it was demonstrated that mattresses can become a

significant source of exposure to mite allergens after as little as four months, with allergen levels generally stabilising after one year.

We found that higher floor levels of the allergen were associated with the presence of a washing machine and clothes drier inside. Although both factors may contribute to increased indoor relative humidity, there is uncertainity as to the importance of this in terms of *Der p1* levels. The design of our study did not allow for the actual measurement of relative humidity in the dwellings. Earlier studies[16,19,20] however have found that the measurements of relative humidity did not consistently correlate with the *Der p1* levels. Possibly the measure is an inadequate indicator of the more humid mite microclimate in beds and carpets or alternatively mite growth occurs independently of humidity once minimum conditions for mite breeding are satisfied.[19]

We were unable to demonstrate in our study a relationship between the *Der p1* levels and the use of a mattress cover or vacuuming of the mattress. This was most likely to be due to the low number of students practicing these measures, which are generally perceived as being for sufferers of asthma and allergy. Barrier covers have been advocated to trap house dust mites and their allergen inside the mattress. Although some studies have demonstrated a significant reduction in allergen levels with their use,[21,22] other studies have failed to show benefit.[23]

It is difficult to explain why, even after adjusting for the type of accommodation, higher floor levels of Der p1 were associated with fewer people sharing that accommodation. Although this negative correlation was also reported by Kuehr et al,[24] most studies have shown an association between increased occupancy and higher mites levels.[5,9,16] Our finding would suggest that in our accommodation environments, food supply may not be the most important factor in limiting mite population growth.

In conclusion, this study has demonstrated that significant variations in the levels of *Der p1* allergen can be found in different forms of university student accommodation. Students are exposed to lower levels of allergen living in halls of residence than in other types of accommodation. Further research needs to be carried out in order to determine the relative impact of differing allergen levels results on asthma and allergy symptoms in this population.

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