Mite and cockroach sensitisation in patients with allergic rhinitis in the Free State

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Background. Studies in patients with allergic rhinitis living in the Free State have shown grass pollens to be the predominant allergens, with house-dust mite sensitisation being less prevalent than in the coastal areas and a low rate of sensitisation to the storage mite *Lepidoglyphus destructor*. No studies have been conducted on sensitisation to the other storage mites, spider mites or cockroaches. We aimed to determine the prevalence of sensitisation to various house-dust mites, storage mites, spider mites and cockroaches in patients with allergic rhinitis living in the Free State.

Methods. Fifty consecutive patients with allergic rhinitis attending the ear, nose and throat clinic at Universitas Hospital underwent skin-prick testing and/or ImmunoCAP RAST testing for common aero-allergens, house-dust mites, storage mites, spider mites and cockroaches.

Results. Forty-six per cent of patients were sensitised to one of the house-dust mites, with house mite sensitisation being significantly more common in patients who had previously lived at the coast. Storage mites were not common aero-allergens, while 46% of patients were sensitised to the spider mite *Tetranychus urticae*. *Blatella germanica* was the cockroach species to which patients were most commonly found to be sensitised on ImmunoCAP RAST testing, with 38% of patients being sensitised to this aero-allergen.

Conclusions. House-dust mites, *T. urticae* and the cockroach *B. germanica* appear to be important aero-allergens in the Free State. Storage mite sensitisation is not common.

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Allergen sensitivities of patients with allergic rhinitis in the Free State have been described,[1,2] with sensitisation patterns being similar in asthmatic patients.[3] These studies showed a high prevalence of grass pollen sensitisation and a lower level of house-dust mite sensitisation than in the coastal areas, where between 65% and 95% of atopic patients are sensitised to house-dust mites.[4-7] Despite there being a large farming population, there was a low prevalence of sensitisation to the storage mite *Lepidoglypghus destructor*.[1] No studies have been performed on sensitisation to the other storage mites or to spider mites in the Free State.

The prevalence of cockroach sensitisation in atopic patients in various parts of southern Africa is similar to that in Europe, the USA and Asia.[7-9] Although sensitisation to *Blatella germanica* has been found in patients from coastal and inland areas of southern Africa,[8,9] *Periplanata americana* and *Blatta orientalis* elicit the strongest IgE responses in Cape Town and Durban, while *B. germanica* sensitisation predominates in Pretoria and Harare.[8] There are no published studies on cockroach allergy in the Free State.

Aim

We aimed to determine the prevalence of sensitisation to house-dust mites, storage mites, spider mites and cockroaches in patients with allergic rhinitis treated at the ear, nose and throat (ENT) clinic at Universitas Hospital, the tertiary referral hospital for the Free State.

Methods

Fifty consecutive patients with allergic rhinitis attending the ENT clinic at Universitas Hospital for routine follow-up visits underwent skin-prick tests (Alk-Abello; Hørsholm, Denmark) for common aero-allergens (Bermuda grass, rye grass, maize pollen, London plane tree, *Alternaria alternata*, *Aspergillus fumigatus*, cat epithelia, dog epithelia and feathers), house-dust mites (*Dermatophygoides pteronyssinus* and *D. farinae*), storage mites (*Glycophagus domesticus*, *L. destructor*, *Blomia tropicalis*, *Acarus siro* and *Tyrophagus putrescentiae*) and *B. germanica*, as well as ImmunoCAP RAST tests (Phadia; Uppsala, Sweden) for house-dust mites (*D. pteronyssinus* and *D. farinae*), storage mites (*G. domesticus*, *L. destructor*, *B. tropicalis*, *A. siro* and *T. putrescentiae*), the two-spotted spider mite *Tetranychus urticae* and cockroaches (*P. americana*, *B. orientalis* and *B. germanica*).

Skin-prick testing was performed as recommended by the Allergy Society of South Africa.[10] The test was considered positive if the size of the wheal was at least 3 mm larger than that of the negative control. Patients who had used antihistamines, oral steroids or tricyclic antidepressants in the previous 48 hours were not included. Any value greater than 0.35 kU/l was considered a positive ImmunoCAP result.

The study was approved by the Ethics Committee of the Faculty of Health Sciences of the University of the Free State and the chief executive officer of Universitas Hospital. Written informed consent was obtained from all patients.

Results were summarised by frequencies and percentages. Agreement as an indication of clustering or similarity was measured using the simple kappa statistic. For this analysis, RAST values were grouped as less than 0.35 versus 0.35 and

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larger. Kappa values below 0.4 indicate poor agreement, values between 0.4 and 0.75 fair to good agreement, and values greater than 0.75 excellent agreement.[11]

Associations between risk factors and sensitisation were investigated using chi-square tests. In cases of small cell sizes, Fisher's exact test was used.

Results

There were 25 males and 25 females. The age of the patients ranged between 5.6 and 57.2 years (median 30.9 years). Most patients (82%) lived in an urban environment, while 9 (18%) lived in a rural environment, of whom 3 lived on a farm. All patients had moderate to severe persistent allergic rhinitis according to the Allergic Rhinitis and its Impact on Asthma (ARIA) classification.[12]

Nasal obstruction was the most common symptom experienced by the patients (Table I). Twelve patients (24%) were asthmatic and 7 (14%) had eczema, while 38 (76%) had allergic conjunctivitis. Most patients felt that their symptoms were worse in spring (*N*=25, 50%) and summer (*N*=16, 32%) while 19 (38%) felt that their symptoms were better in winter.

Total IgE levels ranged between 3.10 kU/l and 1 443 kU/l (median 202.5 kU/l). In 4 patients the total IgE level was within normal limits.

The sensitisation rates for the common aero-allergens again confirmed that grass pollens were the predominant allergens in these patients (Table II). Forty-six per cent of patients were sensitised to at least one of the house-dust mites on skin-prick testing and ImmunoCAP RAST testing (Table III). All patients sensitised to *D. farinae* were also sensitised to *D. pteronyssinus*. There was good agreement between sensitisation to *D. pteronyssinus* and *D. farinae* on both skin-prick testing (kappa = 0.75) and ImmunoCAP RAST testing (kappa = 0.72). House-dust mite sensitisation on skin-prick testing was significantly more prevalent in patients who had previously lived at the coast (*N*=16) than in those who had not (*N*=34) (*D. pteronyssinus* 75.0% v. 32.3%, *p*=0.0048; *D. farinae* 68.8% v. 17.7%, *p*=0.0004), but there was no significant difference between those with carpets in the home (*N*=38) and those without (*N*=12) (50% v. 33%, *p*=0.3126).

Storage mites were not common allergens (Table III), while 46% of patients were sensitised to the spider mite *T. urticae*. When sensitisation to storage mites was present, this was in the lower ranges (<17.5 kU/l). There was no significant difference in the prevalence of sensitisation to any of the storage mites on skin-prick testing between patients who had previously lived at the coast and those who had not (*p*>0.05).

Table I. Symptoms experienced by 50 patients with allergic rhinitis

Symptoms	Frequency (%)
Nasal obstruction	45 (90)
Rhinorrhoea	37 (74)
Post-nasal drip	33 (66)
Sneezing	40 (80)
Nasal itching	10 (20)

Table II. Sensitisation rates (%) to common aeroallergens on skin-prick testing in 50 patients with allergic rhinitis

Cynodon dactylon (Bermuda grass)	62
Lolium perenne (rye grass)	52
Zea mays (maize pollen)	50
Platanus acerifolia (London plane tree)	22
Alternaria alternata	18
Aspergillus fumigatus	12
Cat epithelia	28
Dog epithelia	22
Feathers	10

Table III. House dust mite, storage mite, spider mite and cockroach sensitisation rates (%) in 50 patients with allergic rhinitis

	Skin-prick test	RAST
D. pteronyssinus	46	46
D. farinae	34	44
G. domesticus	14	6
L. destructor	14	10
B. tropicalis	18	20
A. siro	8	26
T. putrescentiae	10	10
B. germanica	34	38
B. orientalis		28
P. americana		22
T. urticae		46

There was fair agreement between *B. tropicalis* sensitisation and sensitisation to both *D. pteronyssinus* (kappa = 0.41) and *D. farinae* (kappa = 0.50) on skin-prick testing and between sensitisation to *D. farinae* and *G. domesticus* sensitisation (kappa = 0.48) on skin-prick testing, but no agreement between sensitisation to the house-dust mites and sensitisation to any of the other storage mites (kappa <0.4). ImmunoCAP RAST testing showed a fair agreement between sensitisation to both of the house-dust mites and *A. siro* sensitisation (*D. pteronyssinus* kappa = 0.42) (*D. farinae* kappa = 0.53) and between sensitisation to *D. farinae* and *B. tropicalis* sensitisation (kappa = 0.48), but no agreement between house-dust mite sensitisation and sensitisation to any of the other storage mites (kappa <0.4).

There was no significant difference in sensitisation to *T. urticae* between patients from urban and rural areas (46% v. 44%, *p*=1.000) or between patients who had previously lived at the coast and other patients (50% v. 44%, *p*=0.6971). There was a fair to good agreement between spider mite sensitisation and sensitisation to house-dust mites, cockroaches and the storage mite *A. siro* (kappa >0.4), but poor agreement with sensitisation to the other storage mites (kappa <0.4).

B. germanica was the cockroach species to which most patients were sensitised (Table III) and was also the cockroach species with the highest concentration of specific IgE on the ImmunoCAP RAST tests.

There was good agreement between sensitisation to any one of the cockroach species and sensitisation to the other cockroach species (*B. germanica* and *B. orientalis*, kappa = 0.69; *B. germanica* and *P. americana*, kappa = 0.63; *B. orientalis* and *P. americana*, kappa = 0.84). There was no significant difference

between patients who had previously lived at the coast and other patients with regard to sensitisation to any of the cockroaches on ImmunoCAP RAST testing (*B. germanica* 38% v. 38%, p=1.000; *B. orientalis* 38% v. 24%, p=0.3304; *P. americana* 25% v. 21%, p=0.7278).

Discussion

Most patients had an elevated total IgE level, but in 4 cases (8%) this was within normal limits in spite of the patients having moderate to severe persistent allergic rhinitis with sensitisation to one or more aero-allergens, confirming that total IgE is a poor screening test for the diagnosis of atopy.

The rate of sensitisation to pollens (Table II) was similar to that previously reported from our clinic,[1] using the same allergens and technique for skin-prick testing. The rate of sensitisation to *D. pteronyssinus* was higher than previously reported by us (24%),[1] possibly because our previous study included patients with all grades of allergic rhinitis while only patients with moderate to severe disease were included in this study. A re-analysis of only the patients with moderate to severe persistent allergic rhinitis in our previous study found that the rate of sensitisation to *D. pteronyssinus* in these patients was 32%, compared with 46% in this study. The prevalence of house-dust mite sensitisation in this study is still lower than the prevalence of house-dust mite sensitisation in atopic patients in the coastal areas.[4-7]

House-dust mite levels have been studied in various towns and cities in South Africa and have been found to be higher along the humid coastal regions and usually lower in the inland areas of high altitude where the climate is characterised by wide 24-hour temperature fluctuations and lower relative humidity. These levels are reflected in the rate of house-dust mite allergy in South Africa, which ranges between 65.5% and 95% in atopic patients in the humid coastal areas of South Africa and between 25% and 45% in the dry inland regions.[4]

House-dust mites require a relative humidity of between 55% and 73% in the temperature range of 15ºC to 35ºC and die from dehydration if the relative humidity is below 51%.[13] *D. pteronyssinus* has slightly higher relative humidity requirements than *D. farinae*, with *D. farinae* better surviving long periods of low relative humidity.[14] Bloemfontein is located in the Dry Highveld Grassland climatic region of South Africa with a climate classified as semi-arid.[15] The average annual minimum temperature in Bloemfontein ranges between 15.3ºC in January and –1.9ºC in July, while the average annual maximum temperature ranges between 30.8ºC in January and 17.4ºC in July.[16] The average daily humidity ranges between 35% and 69% in January and between 29% and 85% in July. The eastern Free State is located in the Moist Highveld Grassland climatic region and has a similar climate but higher rainfall.[15]

We found an association between house-dust mite sensitisation and having previously lived at the coast, suggesting that sensitisation had occurred when the patients had been living at the coast. This is also supported by the fact that *D. pteronyssinus* sensitisation was more common than *D. farinae*. With the lower humidity requirements of *D. farinae*,[14] it would be expected that *D. farinae* sensitisation would be more common. Further studies are required on the prevalence of house-dust mites in the homes of these patients to determine whether the concentration of house-dust mites is high enough to cause the patients' nasal symptoms before house-dust mite control measures are instituted.

Storage mites mainly comprise members of the Acaridae and Glycyphagidae families.[17] The preferred habitat of these mites is stored food.[17] Although storage mites have been shown to be important allergens, both in farmers and in urban populations,[17-20] this was not the case in our patients. This may also be due to the low humidity. The optimal living conditions for storage mites are temperatures of 25 - 30ºC and 80% relative humidity.[18]

B. tropicalis was the storage mite with the highest rate of sensitisation on skin-prick testing, while *A. siro* had the highest sensitisation rate on ImmunoCAP RAST testing. It is possible that sensitisation to *B. tropicalis* also occurred while patients were at the coast, as *B. tropicalis* is a common mite in homes in tropical and subtropical areas of the world,[17] although there was no significant difference in the rate of sensitisation to *B. tropicalis* between patients who had previously lived at the coast and those who had not. Studies on the mite flora present in homes in the Free State would show whether exposure to this mite occurs in patients' homes. *A. siro* has a considerably greater tolerance to temperatures as low as 5ºC and humidity of 67.5%,[18] which could explain the higher rate of sensitisation to this mite on ImmunoCAP RAST testing.

We found only a fair agreement between house-dust mite sensitisation and sensitisation to some of the storage mites, which may be a result of co-sensitisation or immunological cross-reactivity. Most investigations have found a positive association between storage mites and house-dust mite sensitisation, while other studies have found no association.[1,17,19-21] The rate of sensitisation to storage mites in house-dust mite-allergic patients has been reported to be 60 - 90%,[19-22] but it is uncertain whether this is a result of co-sensitisation or of cross-reacting antibodies.[18] This study was not designed to determine which of these possibilities is most likely.

Spider mites are outdoor phytophagous mites, with the spider mite *T. urticae* being the most important pest species in the family Tetranychidae.[23,24] They have emerged as an important allergen in agricultural workers dealing with fruit trees or working in greenhouses as well as in the surrounding populations, the main symptoms associated with sensitisation and exposure to Tetranychidae mites being rhinoconjunctivitis and asthma.[17,23,25] Jeebhay *et al*. found that *T. urticae* could be responsible for work-related asthma symptoms in their study of table grape farm workers in the Western Cape and that skin reactivity to *T. urticae* was more common than to house-dust mite.[25] A Korean study found that these mites might be common sensitising allergens in the general adult population and that they may play a role in the manifestation of rhinitis and asthma symptoms.[26]

T. urticae has a worldwide distribution and is a pest on deciduous trees, fruit trees, ornamental trees, fields, strawberries, gooseberries and most vegetables.[24] The mites

feed and breed throughout the year but remain quiescent in winter in areas of extreme cold and are most numerous in hot, dry weather as they thrive in areas of low humidity with the optimal temperature for growth being 26 - 30ºC.[24] Spider mites are present in farms throughout the Free State as well as the Golden Gate National Park and are probably also in most gardens (personal communication, E Ueckermann, Agricultural Research Council), which is probably the site of exposure to these mites for most patients. We found a high rate (46%) of sensitisation to *T. urticae* in our patients, suggesting that this mite is a previously unrecognised allergen in patients in the Free State, but further studies are required to determine the clinical significance of this sensitisation. It was not possible to determine whether any patients were monosensitised to *T. urticae* as all patients included in the study were known to be sensitised to one or more common aero-allergens.

Among table grape farm workers a strong correlation was found between house-dust mite sensitisation and storage mite sensitisation, but there was only a modest correlation between spider mite sensitisation and sensitisation to either house-dust mites or storage mites.[25] In contrast, we found a fair to good agreement between sensitisation to *T. urticae* and sensitisation to the house-dust mites and *A. siro*, and a fair agreement between sensitisation to any of the house-dust mites and sensitisation to the storage mites *B. tropicalis* and *A. siro* but not the other storage mites. Although spider mite-derived extracts contain allergens that are shared in common with domestic mites, major allergens derived from spider mites are unique in terms of cross-reactivity with domestic mites.[23]

The prevalence of cockroach sensitisation is between 30% and 70% worldwide and between 12% and 40% in South Africa.[8] Cockroach allergens are derived from several sources, including saliva, faecal material, secretions, cast skins, debris and dead bodies.[27]

The strongest IgE response among patients in Durban was to *P. americana*, and in patients in Pretoria and Harare to *B. germanica*, while in Cape Town the level of specific IgE responses to the three cockroach species (*P. americana*, *B. germanica* and *B. orientalis*) were similar.[8] *P. americana* favours coastal areas as it requires a high temperature and humidity for optimal population growth, while *B. germanica* is found throughout the country, but is the main inland domestic cockroach.[27,28] It is therefore not surprising that *B. germanica* was the most common sensitising cockroach in our study, as in the inland cities of Pretoria and Harare.[8]

Conclusions

We showed a high rate of sensitisation to house-dust mites in patients with moderate to severe persistent allergic rhinitis living in the Free State. There was an association between house-dust mite sensitisation and having previously lived at the coast, suggesting that sensitisation to this aero-allergen may have occurred while the patients were at the coast and did not occur in the Free State. Studies on the dust mite flora in the homes of patients would shed more light on the role of house-dust mites in causing sensitisation and symptoms in atopic patients living in the Free State. There was a low rate of sensitisation to storage mites but a high rate of sensitisation to the spider mite *T. urticae*, suggesting that spider mites may be a previously unrecognised allergen in the Free State. Further work is required to determine the clinical relevance of *T. urticae* sensitisation. Cockroaches appear to be important allergens in the Free State, with *B. germanica* appearing to be the most important of the cockroach species in the Free State, as in other inland areas in South Africa.

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