

REVIEW

House dust mite allergy in Southern Africa — historical perspective and current status

P. C. POTTER, G. DAVIS*, A. MANJRA† and D. LUYT*

Allergology Unit, University of Cape Town, *Department of Paediatrics, University of the Witwatersrand, Johannesburg and †University of Natal, South Africa

South Africa is one of the most interesting parts of the world to study the relationships between house dust mites and allergic disease. The region is typified by contrasting geographical and climatic factors which influence house dust mite proliferation. Moreover, it is currently observing rapid urbanization of millions of its rural South Africans who have recently embraced both the indoor environment and diet typical of 'Western living' around the cities and in whom allergic diseases are reported. Both 'climatic factors' and indoor environmental living practices play significant roles in the expression of allergic diseases. This review considers some of the interactions which we have observed between the factors which have resulted in the expression of house dust mite allergy in Southern Africa during the past 40 years.

It is a notable fact that rural Africans living in the grasslands of Africa, in traditional accommodation and following traditional dietary practices, rarely, if ever, suffer from allergic diseases. So rare is asthma among certain Southern African peoples that there is no term to describe the condition in the local idiom among the predominantly Xhosa-speaking peoples of the Transkei. Similarly, diseases such as eczema and allergic rhinitis are rare in rural Africans to the extent that these diseases were not listed at all in a recent survey of health, nutrition and medical conditions found in the bushmen of the Kalahari (O'Keefe *et al.*, pers. comm.).

This situation, however, does not pertain in the peri-urban areas and the cities of Southern Africa where all types of allergies are frequently diagnosed in black people. We have also noted a marked increase in hospital admissions for allergic conditions recently, such as acute severe asthma at King Edward Hospital (Durban) [1], Baragwanath Hospital (Soweto) and the Red Cross Children's Hospital (Cape Town) [2]. An increase in the prevalence of allergic diseases in these migrating peoples is not unexpected, particularly if one considers

the marked changes in lifestyle, living conditions and diet encountered during the process of 'urbanization'. The question that we are currently addressing is: 'To what extent do house dust mites contribute to the increases in allergy observed in the peri-urban environment?'

As early as 1950 Ordman [3] identified a group of 'asthma' sufferers in South Africa who had various forms of upper and lower respiratory tract allergies, whose condition was always better inland, but worse at the coast, and whose symptoms were perennial at the coast. He noted that seasonal disease occurred particularly in the grasslands which were at higher altitude. His initial studies to find an explanation for what he termed 'climate asthma' included studies of airborne fungi and pollen as well as meteorological comparisons between the coastal areas and the higher inland regions. Marked differences were noted in the meteorological studies. The coastal climate was characterized by a narrow range of temperature and high relative humidity, whereas the inland climate was characterized by wide 24-h fluctuations of the outdoor temperature and lower relative humidity. Smaller differences were found in his comparisons between the airborne fungi and grass pollens at the coast and inland. The meteorological variations he observed could be explained by the geographical characteristics of the region. South Africa is divided into two main 'regions' by a 'ring' of mountains which run parallel to the coastline, forming an inland highveld, between 1000 and 3500 metres above sea level, and a lower lying coastal region which stretches from the southern Mozambique coast to Namibia. The East Coast is fed by a southbound warm Mozambique current, which brings warm water and humid conditions from the equator. By contrast, the western coast is fed by the cold Benguela current, which travels north from the cold southern oceans, producing cooler and less humid conditions on the southern Atlantic seaboard.

Ordman [4–6] believed that a combination of high atmospheric moisture and temperature was important, but he was initially unable to explain the link between the climatic factors and asthma, citing examples of asthma

Correspondence: Professor P. C. Potter, Allergology Unit, Department of Clinical Science and Immunology, University of Cape Town, Observatory, 7925, South Africa.

sufferers who travelled by ship from Cape Town to Europe through equatorial waters of Africa, where temperature and humidity were high, without experiencing any increase in respiratory symptoms. He also studied asthmatic miners who spent long hours, up to 1500 m underground, in warm humid environments who did not experience exacerbations of respiratory symptoms while underground either.

It was only when he compared the allergenicity of coastal and inland dust samples, obtained from Durban and Johannesburg respectively, by performing intra-dermal skin tests with dust extracts on 123 allergic patients [3], that he found that the dust from the coastal region was significantly more allergenic, with very few subjects reacting to 'inland dust'. In 1962, Voorhorst and Spieksma [7] published their findings implicating *Dermatophyoides pteronyssinus* as the probable factor causing asthma due to house dust, extending Ordman's original observations on the allergenicity of 'coastal dust'.

Ordman then commenced a large study of the mite content of house dust collected from 67 individual towns

and cities throughout South Africa. He published his results and expressed his data in relation to altitude above sea level [8] (Fig. 1). He was able to show that mite levels were consistently higher along humid coastal areas and usually lower in areas of high altitude. His findings are summarized in Table 1 and are presented in six groups according to increasing altitude. To his surprise, some towns at higher altitude had greater mite counts than those at lower altitude, shown in Table 2. These towns all fell into a more eastern inland part of the country which had a higher relative humidity, associated with the warmer Mozambique current on the East Coast. An unexpected finding was the low mite counts in some of the lower lying towns along the south western coastal plain (Table 3). This could possibly be explained by a lower relative humidity of the atmosphere in that region, and was partly attributed to the effects of the cold Benguela current, coming from the south. Of interest, was that in his survey of the 67 towns throughout the country, mite numbers were always much lower in towns where relative humidity consistently dropped below 50%

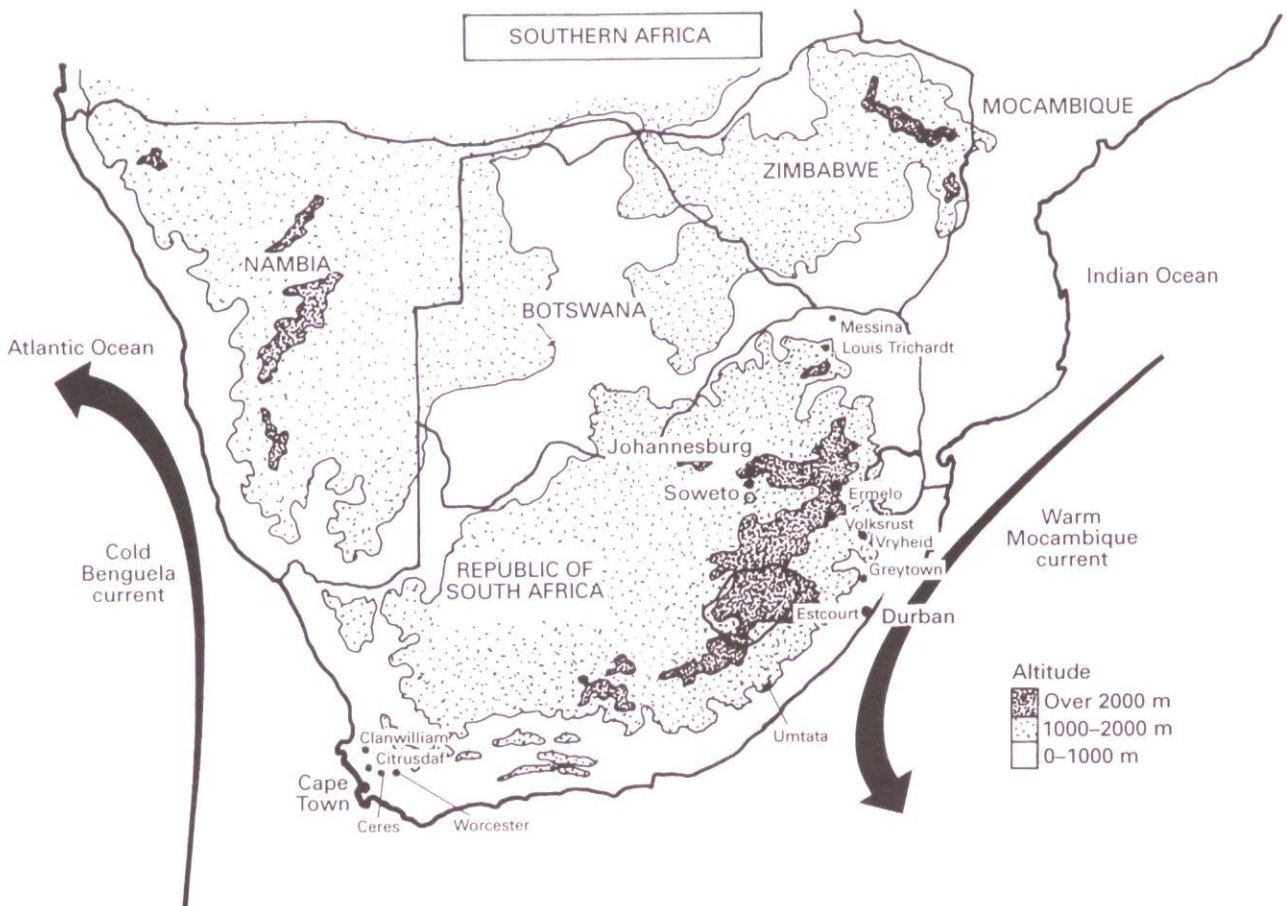


Fig. 1. Map of Southern Africa indicating warm and cold sea currents, altitudes and the towns or cities referred to in this review.

Table 1. Average mite counts per 5 g of house dust. Samples collected from towns in South Africa of the same altitude above sea level

Height above sea level (ft)	Number of towns	Average mite counts/5 g dust
Under 1000	22	91
1000–2000	4	13
2000–3000	10	3
3000–4000	11	43
4000–5000	16	2
Over 5000	4	23

(Adapted from reference 3).

during the day. Specific identification of the mite species in the dust samples he collected revealed that *Dermatophygoides pteronyssinus* was widespread throughout South Africa and that *Dermatophygoides farinae* was only identified in Jeffreys Bay and Louis Trichardt.

The 'climate factor' subsequently became a well established consideration in the clinical management of asthma patients in South Africa and for many years subsequently, patients with perennial asthma were advised to move to drier parts of the country, many patients doing particularly well in the dry semi-desert Karoo. No further studies of house dust mite distribution were performed for the next 20 years. However, several regional studies of clinical house dust mite sensitivity were performed, using skin tests and radio-allergosorbent tests (RASTs), which generally confirmed what would have been predicted by Ordman's original studies of mite prevalence in the regions studied.

In 1977 Van Niekerk *et al.* [9] noted that 65.5% of white and coloured children, living in Cape Town, were

Table 2. Anomalous high mite counts in towns of high altitude (in South Africa)

Town	Height above sea level (ft)	Number of samples	Average mite count
Messina	1704	3	36
Umtata	2228	3	19
Louis Trichardt	3145	4	133
Greytown	3607	4	72
Estcourt	3803	4	58
Vryheid	3917	1	200
Volksrust	5110	3	28
Ermelo	5689	1	63

Table 3. Anomalous low mite counts in towns of low altitude (in South Africa)

Town	Height above sea level (ft)	Number of samples	Average mite count
Clanwilliam	245	1	12
Citrusdal	566	4	17
Worcester	815	4	4
Ceres	1497	5	3

(Adapted from reference 3).

sensitive to house dust mites using skin-prick testing. In 1991, Potter *et al.* reported positive skin-prick tests to house dust mites in 80% of a similar group of allergic children in the same area, suggesting that the prevalence of mite sensitivity had increased in Cape Town [10]. This higher prevalence was similar to that observed in a previous study in 1979 by Fraser [11] conducted in the more humid Durban area, where the prevalence of house dust mite sensitivity in asthmatics was found to be 77%. A recent survey of 30 asthmatic children by Manjra (pers. comm.), found 95% of asthmatic children in the Durban area to be sensitive to house dust mites using skin-prick tests. No published data are available on the frequency of house dust mite sensitivity in asthmatics living in the west coastal towns, although patients have been encountered who live on the Namibian Coast who have strongly positive skin-prick tests to house dust mites (C. Buys, pers. comm.).

Studies from inland higher altitude towns and cities show a significantly lower prevalence of house dust mite allergy than at the coast. In 1991, Mercer and Van Niekerk reported house dust mite skin-prick test positivity rate in an all-white asthma clinic of 25.7% [12] which was very similar to a skin-prick positivity rate of 25% in all-white practice in the north western suburbs of Johannesburg [13]. It was believed that many of their patients had been sensitized to house dust mites when they went on vacation to the coast.

All the available studies in South Africa of allergy among rural black asthmatic subjects suggest a low prevalence of house dust mite allergy. In a recent analysis of atopic asthmatic black children from the Transkei, Potter *et al.* could find no children with positive RASTs to house dust mite but a 90% positivity to cat allergen [14]. Van Niekerk *et al.* [15] also reported a very low prevalence of house dust mite allergy in rural Transkei.

Recent studies by Luyt and Davis [16,17] indicate a 45% house dust mite skin-prick sensitivity in urbanized

black asthmatic children, over the age of 3 years, in Soweto, a city at the same altitude as Johannesburg (1760 m above sea level). These findings contrast markedly with the prevalence figures for black children in the Transkei and are also significantly higher than the house dust mite skin-prick positivity rates reported for whites in Johannesburg (25%) by Erasmus [13]. Luyt and Davis compared their patients with a group of white asthmatic children attending the J. G. Strydom Hospital Asthma Clinic, 20 km away, where the house dust mite skin-prick test positivity rate was only 23.4%.

What are the reasons for this higher house dust mite skin-prick sensitivity prevalence rate in black children in Soweto? All the children in the Soweto study had been resident in Soweto since birth and none had lived at or even visited the coast. It is clear that sensitization is taking place in Soweto. No previous data are available on the prevalence of house dust mites in Soweto, but Ordman's comparative study of mites in various South African cities indicated that Johannesburg previously had one of the lowest mite counts. Clearly, these findings stress the need for further comparative studies of current mite levels in Soweto and Johannesburg.

Further north in Africa house dust mite sensitivity has been well documented, particularly in the tropics. In the small rural township of Gatooma in Zimbabwe, Cookson [18] found that 36% of asthmatics were skin-prick test reactive to house dust mite extracts. In Ndola, in Zambia's copperbelt, 1280 m above sea level, temperature and humidity conditions in the wet summer season are ideal for mite growth with a mean monthly relative humidity of 75% between January and March and a mean monthly temperature above 20°C. Buchanan and Jones found that 25 out of 30 adult asthmatics studied were house dust mite skin-prick test positive [19].

Thus, although Spieksma *et al.* [20] found that mite levels in Europe were inversely related to altitude, it would appear that humidity levels are more important than altitude. In warm climates in Africa, where the relative humidity is between 70 and 80%, high levels of house dust mites would be expected, particularly if bedding and mattresses are used. Our data from Africa are similar to the climatic influences on house dust mites reported from Australia [21].

With the availability of enzyme-linked immunosorbent assay (ELISA) technology for house dust mite antigen (Der p 1) determination, we have studied Der p 1 levels in several regions of South Africa in an attempt to identify the causes of a rising prevalence of mite sensitivity in children. Our initial studies have focused particularly on three cities: Cape Town, Johannesburg and Durban.

The first Der p 1 studies in Southern Africa were conducted in 1991 by Manjra *et al.* [22] in Cape Town

who reported a mean level of 17 µg/g dust in the carpets and 33 µg/g dust in the bedding in a study of the homes of 60 asthmatic city children. We found that although benzyl benzoate was partially effective in reducing carpet mite levels, it was totally ineffective when applied to the bedding.

Similar levels were also found in 1992 in studies of the carpets and beds in Durban homes (Manjra, pers. comm.). However, while all homes in the Cape Town area studied were found to be uniformly heavily 'infested', the finding of heavily infested homes in Durban was more patchy with some homes having extremely high levels (i.e. >100 µg Der p 1/g dust) while other homes had low levels (less than 0.5 µg Der p 1/g dust). This is possibly related to the greater use of tiles on the floors in the warmer Durban area compared with the almost uniform use of carpets on the floors in Cape Town.

A second study conducted in 1992 serially measuring Der p 1 levels in the homes of 60 asthmatic children in the Cape Town area by Jooma *et al.* [23], confirmed the presence of high Der p 1 levels in Cape Town, with mean levels ranging between 8.3 and 19.2 µg/g dust on the bedding. In this study he also demonstrated that these very high levels were present throughout the year. Jooma found that after the application of mattress covers to the beds, they were heavily colonized by mites within a month and, in fact, beds with covers attained very high levels of Der p 1 (µg/g) significantly greater than control (uncovered) beds, if the mattress covers and bedding was not washed regularly using hot water (greater than 70°C).

Recently, Davis and Luyt [24] have studied Der p 1 levels in the carpets and mattresses in 30 randomly selected Soweto homes, 15 from a more affluent area and 15 from less privileged areas of Soweto. These homes used electricity for heating and cooking and all except six bedrooms were carpeted. Der p 1 levels were detected in 16/30 homes, but in only eight of these were the Der p 1 antigen levels greater than 2 µg/g dust and in two homes the levels were greater than 10 µg/g dust. The differences in the levels of Der p 1 in Soweto compared with the coastal areas is striking, levels in Soweto being very low and the frequency of positive skin-prick tests to house dust mite antigens appears to be disproportionately high. It is not clear why sensitization is occurring to such low levels of Der p 1. A new study of Der p 1 levels is currently underway in the Soweto surrounding areas to explore the relationship between Der p 1 levels, skin-prick sensitivity and the development of asthma in urbanizing children.

Our observations about the levels of mite antigens in coastal areas with high humidity such as Cape Town are remarkably similar to those in Sydney, Australia [21,22].

We have also found it virtually impossible to eradicate house dust mites from homes on the South African coast, and have obtained disappointing results using acaricides alone. Factors which may be associated with mite growth in our country and in cities like Soweto could include relative overcrowding, washing linen in cold water and reduced ventilation of homes in which cooking is frequently performed in the room where the family sleeps.

Our observations support those of Dowse *et al.* [25] that house dust mite sensitivity increases with the introduction of Western style living to rural peoples. Early exposure to house dust mite antigens is an important risk factor for the subsequent development of asthma by the age of 11 [26]. It would be prudent to introduce avoidance measures prior to the birth of the baby and to sustain low Der p 1 levels in high risk homes. Der p 1 levels in Soweto are much lower than the Der p 1 levels we have observed at the coast. It is possible that factors other than Der p 1 levels are contributory to sensitization in urbanizing populations. Further studies are required to identify such factors.

Broadly speaking thus, we can divide the house dust mite issue into two main types. The first, or 'coastal type', is the perennial occurrence of house dust mite infestation in the high humid and warm parts of South Africa, which like the tropics, is conducive to mite proliferation throughout the year. This type of mite problem is difficult to eradicate and avoidance depends on a combination of fastidious management of the bedroom, mattress covers, hot washing of linen and acaricides.

The second type of house dust mite infestation and sensitization occurs in a less humid ambient environment often at higher altitude usually in urban and peri-urban environments. We do not know if this is made worse by the adoption of living conditions which promote a high indoor humidity of the homes, or whether or not overcrowding, cooking in the same rooms as sleeping (e.g. in 'open plan' design), carpeting, poor ventilation and keeping pets indoors play a role.

Worldwide attempts are being made to reduce mite growth and thereby reduce exposure and allergic symptoms. It is possible that low numbers of mites in circumstances such as those occurring in Soweto can induce sensitization and symptoms in a susceptible population and that more stringent or comprehensive measures may be necessary to reduce sensitization.

The medical and economic implications of preventing or reducing the development of asthma, or altering its natural history in millions of urbanizing South Africans, are enormous and worthy of intensive research, particularly for those migrating to inland cities where mites are not normally found. The challenges of providing low

cost homes for urbanizing peoples should not overlook the specific design of the homes. Like the traditional African village, the cooking areas should be kept well away from the sleeping areas and ventilation of these areas should be separate.

The finding of significant house dust mite sensitization in communities living altitude, where mite levels have been shown to be low suggests that factors other than Der p 1 levels contribute to the rate of sensitization and begs further research.

References

- 1 Jeena P. Childhood asthma at King Edward Hospital. *Current All Clin Immunol* 1994; 7:8.
- 2 Luyt D, Green R. Prevalence of asthma in Southern African children: A Review. *Current All Immunol* 1994; 7:4-7.
- 3 Ordman D. The evolution in South Africans of the concept of 'climate asthma' and of the associated climate patterns. *S Afr Med J* 1970; 1236-40.
- 4 Ordman D. Pollinosis in South Africa. *S Afr Med J* 1947; 21:38-48.
- 5 Ordman D. The climate group of respiratory allergy patients in South Africa. *S Afr Med J* 1958; 32:853-5.
- 6 Ordman D. The regional aspects of respiratory allergy in South Africa. *S Afr Med J* 1964; 38:369-72.
- 7 Voorhorst R, Spieksma-Boezeman MIA, Spieksma FTh M. Is a mite (*Dermatophagoides* sp) the producer of housedust allergen? *Allergic Asthma* 1964; 10:329-34.
- 8 Ordman D. The incidence of climate asthma in South Africa: its relationship to the distribution of mites. *S Afr Med J* 1971; 10th July: 739-43.
- 9 Van Niekerk CH, Shore SC, Weinberg EG. The housedust mite and childhood asthma in the Cape Peninsula. *S Afr Med J* 1977; 25:74-5.
- 10 Potter PC, Berman D, Toerien A, Malherbe D, Weinberg EG. Clinical significance of allergen identification in the Western Cape. *S Afr Med J* 1991; 79:80-4.
- 11 Fraser BN. Cockroaches in relation to bronchial asthma in the Durban area. *S Afr Med J* 1979; 55:637-8.
- 12 Mercer MJ, Van Niekerk CH. Clinical characteristics of childhood asthma. *S Afr Med J* 1991; 79:77-9.
- 13 Erasmus RJE. Skin testing with inhaled allergens: a family physician's experience. *S A Family Practice* 1990; March: 126-30.
- 14 Potter PC, Malherbe D, Lee S, Vermuelen J. Comparison of Paediatric and Adult Phadiatop screening assays in Xhosa and Caucasian Children. *Clin Exp Allergy, Suppl.* 1990; 20:15.
- 15 Van Niekerk C, Shore SC, Weinberg EG. The housedust mite and childhood asthma in the Cape Peninsula. *S Afr Med J* 1977; 52:74-5.
- 16 Luyt DK, Davis G, Dance M, Simmark K, Patel D. Clinical characteristics of black asthmatic children. *S Afr Med J* 1995 (in press).
- 17 Luyt DK, Davis G. Skin prick tests — a measure of allergen exposure? *Current All Clin Immunol* 1994; 7:4-7.

- 18 Cookson JB. 'A handful of dust'. Asthma and bronchitis in Rhodesia. *Central Afr J Med* 1977; 23:96-101.
- 19 Buchanan DJ, Jones IG. Allergy to housedust mites in the tropics (letter). *Br Med J* 1972; 23rd September: 764.
- 20 Spieksma FTh M, Zuiderma P, Leupen MJ. High altitude and housedust mites. *Br Med J* 1971; 1:82-4.
- 21 Green WF, Sedwick C, Woolcock AJ, Leeder SR, Stuckey M. Housedust mites and skin tests in different Australian localities. *Aus NZ J Med* 1986; 16:639-43.
- 22 Manjra AI, Berman D, Toerien A, Weinberg EG, Potter PC. The effects of a single application of an Acaricide (Acarosan) and a detergent (Metsan) on Der p 1 levels on carpets and mattresses of asthmatic children. *S Afr Med J* 1994; 84:278-80.
- 23 Jooma OF, Weinberg EG, Berman D, Manjra AI, Potter PC. Accumulation of housedust mite (Der p 1) levels on mattress covers. *S Afr J*; in press.
- 24 Davis G, Luyt D, Prescott R, Potter PC. Housedust mites in Soweto. *Current All Clin Immunol* 1994; 7:16-7.
- 25 Dowse GC, Turner KJ, Stewart GA, Alpers MP, Woodcock AJ. The association between dermatophygoide mites with increasing prevalence of asthma in village communities within the Papua New Guinea Highlands. *J Allergy Clin Immunol* 1985; 75:75-83.
- 26 Sporik R, Holgate ST, Platts-Mills TAE, Cogswell JJ. Exposure to housedust mite allergen (Der p 1) and the development of asthma in childhood. *N Engl J Med* 1990; 323:502-7.

This document is a scanned copy of a printed document. No warranty is given about the accuracy of the copy. Users should refer to the original published version of the material.