

ORIGINAL ARTICLE

Dust Mite Species and Allergen Concentrations in Beds of Individuals Belonging to Different Urban Socioeconomic Groups in Brazil

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Background. *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae* and *Blomia tropicalis* dust mites are among the most important agents of hypersensitivity reactions in human beings. However, a role of other mites in the etiology of these reactions has not yet been excluded.

Objectives. To investigate the nature of the dust mite fauna and the presence of Der p 1 (allergen 1 of *Dermatophagoides pteronyssinus*) and Blo t 5 (allergen 5 of *Blomia tropicalis*) on beds used by individuals with different socioeconomic backgrounds in Salvador, a major Brazilian city and to investigate possible associations of mite frequencies and allergen levels with (a) season of the year, (b) housing characteristics, (c) bed cleaning behaviors that could affect mite densities, and (d) allergy history.

Methods. Dust samples were collected from 459 beds of 101 residences from two groups with different socioeconomic levels (hereafter called wealthy and poor groups) in the city of Salvador, Brazil, for the identification of mite species and determination of Der p 1 and Blo t 5 levels. History of allergy was collected using the ISAAC phase I questionnaire.

Results. Eighty nine percent of the beds analyzed harbored at least one mite species. *B. tropicalis* was found in 71.8%, *D. pteronyssinus* in 39.9%, *Cheyletus* sp. in 33.9%, and *Gohieria fusca* in 21.1% of the beds. *B. tropicalis* was found with a similar frequency in beds of the two socioeconomic groups; *D. pteronyssinus* was found more frequently in the beds of the wealthy than of the poor group, whereas the reverse was observed with *G. fusca*. The concentrations of Der p 1 and Blo t 5 allergens exceeded the cut-off for sensitization of 2 µg/g of dust in 94.0% and 69.3% of the wealthy and poor group beds, respectively. No associations were found between history of allergy and mite species or between history of allergy and the concentrations of mite allergens.

Conclusions. The observation of *B. tropicalis* and *D. pteronyssinus* as the most frequently found mites is consistent with previous reports from tropical regions. The higher frequency of *G. fusca* in beds of individuals from the poor group than those from the wealthy group could be a consequence of different bed cleaning behaviors between the two groups.

Keywords *Blomia tropicalis*, *Dermatophagoides pteronyssinus*, *Gohieria fusca*, der p 1, Blo t 5, socioeconomic groups, sensitization indexes

INTRODUCTION

Dermatophagoides farinae and *Dermatophagoides pteronyssinus* are the domestic dust mites most frequently associated with allergic diseases in temperate countries, while *D. farinae* is replaced, as a major allergy-associated mite, by *Blomia tropicalis* in tropical and subtropical countries (1–4). In addition to mites of these species, storage mites have been described as causes of occupational allergies and/or other hypersensitivity reactions in rural and urban populations (5–8). In addition to the need for further

studies to ascertain the importance of these mites in the pathogenesis of allergy, it may be worthwhile to investigate regional mite fauna, since particular environmental factors may favor mutations conferring specific traits to mites, such as high reproductivity and allergenicity (9, 10). This phenomenon could, therefore, determine some of the regional characteristics of the epidemiology of allergic diseases, together with other factors relating to educational and socioeconomic level such as cleaning behaviors that affect mite population densities and access to health services.

Studies on mite allergens should take into account both quantitative and qualitative aspects. It was proposed in the 1st and 2nd International Workshops on Mite Allergy, held in 1987 and 1992, respectively (11, 12), that 2 µg of Der p 1 per gram of dust (corresponding to 100 mites per gram of bed dust) is the cut-off point for sensitization, and that 10 µg of this allergen per gram of dust (corresponding to 500 mites per gram of bed dust) is the concentration necessary to trigger allergic symptoms. Although these cut-offs have been supported by several studies (13–17), they have been refuted by others (18–22). Therefore, the 3rd International Workshop on Mite Allergy, held in 1995, despite considering 2 µg of the Der p 1 per gram of dust as the cut-off for mite sensitization,

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decided that there were not sufficient data to apply this cut-off values to all climatic regions (23).

The objectives of this study were (1) to determine the different mite species present in beds and the concentrations of *D. pteronyssinus* Der p 1 and *B. tropicalis* Blo t 5 allergens (μg per gram of dust) and loads (μg per m^2 of bed) in dust collected from the beds of houses belonging to two distinct socioeconomic groups and (2) to determine possible associations of the frequencies of detected mites and of the concentrations and loads of Der p 1 and Blo t 5 allergens with (a) seasons of the year, (b) housing characteristics, (c) anti-mite bedroom practices, and (d) history of symptoms of respiratory allergy.

METHODS

Population

Individuals living in 101 dwellings from two different socioeconomic groups in the city of Salvador, State of Bahia, in the Northeast of Brazil, were investigated. A wealthy group was composed of 224 individuals from upper and upper-middle class belonging to 53 medical students' families; the poor group comprised 205 individuals belonging to 48 low-income families. These families were selected because one of their members worked in a medical student home or building as housemaid, security guard, gatekeeper, or driver. The socioeconomic status was determined by the Gallup method (24). Clinical histories of respiratory allergies were obtained using the ISAAC phase I questionnaire (25).

Dust Collection

The dust samples were collected in surveys performed during a dry season and a rainy season (mean temperature 25.1°C and 25.5°C , relative humidity of air 78.5% and 82.5%, rainfall 88.7 mm and 197.5 mm, respectively, according to the National Institute of Meteorology, Salvador, Brazil). Dust collection was carried out using a residential vacuum cleaner (Eletrolux Professional, 1220 watts; Electrolux do Brasil, São Paulo, Brazil), connected to a plastic cylindrical support holding a cellulose filter, where the dust was trapped. The filters were weighed before and after collection of the dust samples. Dust was collected from an area of 1 m^2 from the head of the mattresses for 2 minutes. The mites were collected from bed dust suspended in a 0.15 M sodium chloride solution, and were examined under a microscope after mounting on glass slides in Hoyer's mounting medium (27). The suspensions were prepared with (a) previously frozen dust samples; (b) mite-enriched dust obtained from dust-loaded Tullgren funnels (26); and (c) dust that had been enriched for mites, by its previous cultivation in the presence of 15% (v/v) fish food, at 25°C , for 2 weeks. The identification of the species was done according to Flechtman's (27) and Drys & Price's (28) taxonomic keys.

Quantification of Der p 1 and Blo t 5 Allergens

Der p 1 and the Blo t 5 allergens were quantified by commercially available capture ELISA kits (Indoor Biotechnologies, Virginia, USA), in 100-mg samples of dust preserved at -20°C since collection. The levels of allergens were expressed as concentration (μg of allergen per gram of bed dust) or as load (μg of allergen per m^2 of the analyzed bed) values.

Statistical Analysis

Data were analyzed with the use of the Statistical Package for the Social Sciences programs (29). The Chi-square test with Yates' correction was used to compare the proportions of mites in bed dust samples from the two studied groups after stratifying by season of the year, asthma and rhinitis symptoms, ironed bed linens, vacuum-cleaned mattresses, air-conditioned bedrooms and dog in household. The Mann-Whitney's test was used to compare concentrations of Der p 1 and Blo t 5 allergens.

RESULTS

Eighty nine percent of the 429 analyzed beds harbored at least one species of mite. The percentage of beds with mites was higher in the rainy than in the dry season (99.4% and 76.6% respectively; $p < 0.00001$; chi-square test). *B. tropicalis* was more frequently found in beds in the rainy season than in the dry season ($p < 0.001$; Table 1) in both the wealthy and the poor groups. *D. pteronyssinus* was found more frequently in the beds of the wealthy group in the rainy than the dry season ($p < 0.01$), while *Cheyletus sp.* was found more frequently in the poor group during the rainy season ($p < 0.05$). *Gohieria fusca* was observed more frequently in beds of the poor group than the wealthy group in both seasons ($p < 0.0005$). *Tyrophagus putrescentiae* was found in 4.1%, *D. farinae* in 2.5%, *Pyemotes tritici* in 0.5%, *Acarus siro* in 0.2%, and mites of the *Histioglyphidae* family in 0.7% of the beds (Table 1).

History of asthma and/or rhinitis symptoms was reported by 44.7% of individuals in the wealthy group and by 32.4% in

TABLE 1.—Frequency (%) of mite fauna in the bed dust of a wealthy group ($n = 224$) and a poor group ($n = 205$), stratified by season, in the city of Salvador, Brazil.

Mite species/family in beds	Beds examined		
	Dry season ($n = 201$) %	Rainy season ($n = 228$) %	Total ($n = 429$) %
Any mite			
Total	76.6**	99.4**	89.0
Wealthy group	78.9	95.8	88.0
Poor group	73.5	94.2	84.6
<i>Blomia tropicalis</i>			
Total	53.9*	86.8*	71.8
Wealthy group	60.3	82.6	72.1
Poor group	47.1	89.8	69.9
<i>Dermatophagoides pteronyssinus</i>			
Total	39.7	40.1	39.9
Wealthy group	41.1	52.2#	47.1
Poor group	38.2	31.6#	34.7
<i>Cheyletus sp.</i>			
Total	28.4	38.5	33.9
Wealthy group	28.8	29.6###	29.3
Poor group	27.9	44.9###	36.9
<i>Gohieria fusca</i>			
Total	17.7	24.0	21.1
Wealthy group	6.8###	1.4###	4.0
Poor group	29.4###	39.8###	35.0
<i>Tyrophagus putrescentiae</i>	3.4	4.4	4.1
<i>Dermatophagoides farinae</i>	2.1	2.7	2.5
<i>Pyemotes sp.</i>	0.0	0.7	0.5
<i>Acarus siro</i>	0.0	0.3	0.2
<i>Histioglyphidae</i> family	0.6	0.7	0.7

* $P < 0.001$, ** $P < 0.00001$ (statistical significance of the difference of mite frequencies between seasons of the year; Chi-square test with Yates' correction); # $P < 0.01$; ### $P < 0.05$; #### $P < 0.0005$, (statistical significance of the difference of mite frequencies between the wealthy and the poor groups; Chi-square test with Yates' correction).

TABLE 2.—Frequency (%) of mite species found in bed dust stratified by history of allergic symptoms, habits and home characteristics, in 429 individuals from the city of Salvador, Brazil.

Presence of	Frequency in bed dust of			
	<i>B. tropicalis</i> (%)	<i>D. pteronyssinus</i> (%)	<i>Cheyletus sp.</i> (%)	<i>G. fusca</i> (%)
Asthma and/or rhinitis symptoms				
Yes	72.6	40.3	34.7	23.5
No	71.0	39.9	33.5	16.9
Ironed bed linens				
Yes	70.2	41.7	32.0	14.7***
No	74.7	36.7	39.1	36.7***
Vacuum cleaned mattresses				
Yes	75.0	37.5	29.2	4.2*
No	71.4	40.0	34.3	22.4*
Air conditioned bedrooms				
Yes	75.0	56.3*	25.0	6.3*
No	71.0	38.5*	35.3	22.9*
Dog in household				
Yes	81.2*	37.6	47.7**	34.1**
No	68.1*	41.7	28.6**	16.1**

* $P < 0.05$, ** $P < 0.005$ *** $P < 0.0001$ (statistical significance of the variable-dependent difference; Chi-square test with Yates correction).

the poor group (data not shown). However, history of asthma and rhinitis symptoms was not significantly associated with the frequencies of any of the investigated mite species ($p > 0.05$; chi-square test; Table 2). Relatively low frequencies of *G. fusca* in bed dust were significantly associated with ironing of bed linens ($p < 0.0001$) vacuum cleaning of mattresses ($p < 0.05$) and the presence of air-conditioning ($p < 0.05$; Table 2). The presence of air-conditioning in the bedroom was associated with a higher frequency of *D. pteronyssinus* in beds (56.3% in air-conditioned bedrooms versus 38.5% in bedrooms without air-conditioning; $p < 0.05$; Table 2). The presence of dogs in the household was associated with significantly higher frequencies of *B. tropicalis* ($p < 0.03$), *Cheyletus sp* ($p < 0.005$), and *G. fusca* ($p < 0.001$), but not of *D. pteronyssinus* ($p > 0.05$; Table 2).

Ironing of bed linen, vacuum cleaning of mattresses, and the presence of air conditioning in bedrooms were reported more frequently in the wealthy group than in the poor group (87.5% versus 54%, 18.9% versus 2.9% and 22.3% versus 1%, respectively; $p < 0.00001$ for each comparison, chi-square test). On the other hand, the presence of dogs was higher in the poor group than in the wealthy group (37.4% versus 17.1%; $p < 0.0001$; data not shown).

The frequencies of mites in bed dust were not significantly ($p > 0.05$; chi-square test) associated with the age or anti-allergic properties of beds, pillows, and linens; with the presence of air dryer, curtains, fans, mosquito nets, rugs, and carpets in the room; and with the beating of beds and pillows for dust removal or with sweeping, waxing, or wet cleaning the bedroom floor and walls (data not shown).

Higher loads of dust were observed in beds from the poor group than in those from the wealthy group (geometric means of 903.4 and 595.6 mg/m², respectively; $p < 0.0001$, Mann-Whitney's test; Figure 1A). Der p 1 loads were significantly higher in beds from the poor group than in beds from the wealthy group (geometric means of 28.7 and 16.6 μ g per m² of bed, respectively; $p < 0.01$; Figure 1B) but not Der

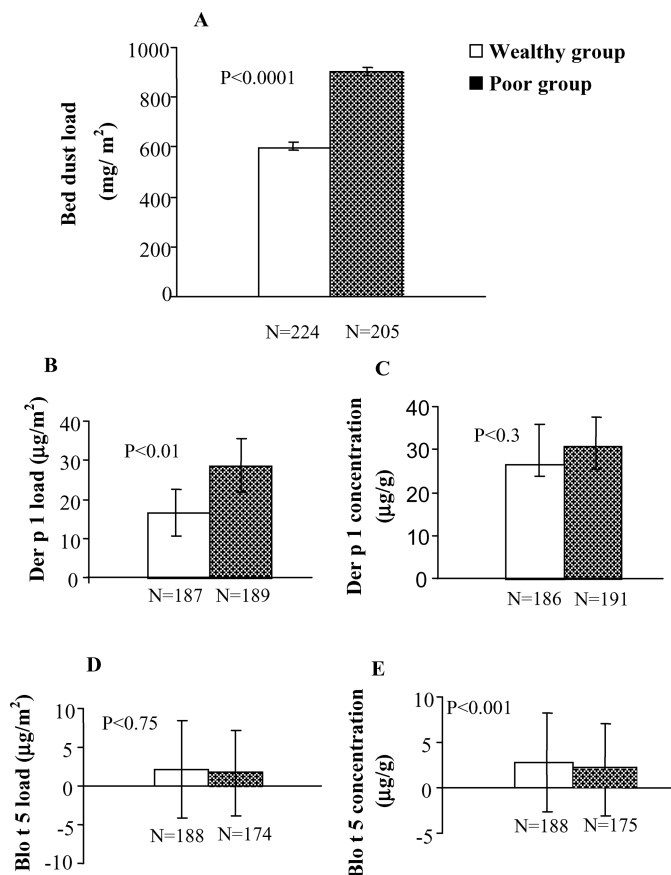


FIGURE 1.—Dust loads, and Der p 1 and Blo t 5 concentrations and loads in beds from two socioeconomic groups in the city of Salvador, Brazil. The vertical lines represent the standard deviations of the geometric means. P values were obtained by the application of Mann-Whitney's test before log transformation.

p 1 concentrations (geometric means of 30.2 and 26.6 μ g per g of dust, respectively; $p > 0.262$; Figure 1C). Blo t 5 concentrations in bed dusts were significantly higher in beds from the wealthy group than in those from the poor group (geometric means of 2.83 and 2.02 μ g/g of dust, respectively; $p < 0.001$; Figure 1E), but no differences were observed between Blo t 5 loads in the two groups (geometric means of 1.83 and 1.88 μ g/m², respectively; $p > 0.74$; Figure 1D). The frequencies of asthma and/or rhinitis symptoms reported by this population were not associated with the presence of concentrations of Der p 1 or Blo t 5 above the allergy sensitization and triggering cut-offs (data not shown), defined by the 1st and the 2nd International Workshops on Mite Allergens (12, 13).

DISCUSSION

The most frequent mite found in this study was *B. tropicalis*, in agreement with the literature, which shows that this species is the most frequently found in tropical areas (30, 31), including Brazil (32–34). The finding of a greater frequency of *B. tropicalis* in the rainy than in the dry season may be attributed to its preference for a high relative humidity. The only study of mite fauna previously carried out in Salvador was performed in the dry season (35) and showed a lower frequency of *B. tropicalis* (of 30%). This difference could be

explained by the use of three different methods for separating mites from dust used in our study. Performing dust collections in the dry season (35) may have favored the collection of *D. pteronyssinus* (present in 70% of samples) over *B. tropicalis* and other mite species. In this study, *D. pteronyssinus* was the second most frequent species, occurring in 39.9% of studied beds. Taken together, the data from both studies support the view that *B. tropicalis* and *D. pteronyssinus* are the most frequent mites in Salvador and that their relative frequencies may vary according to environmental humidity.

A relatively high frequency of *Cheyletus* sp. in beds (33.9%) was observed in this study. Although *Cheyletus* sp. has a wide geographic distribution (9, 31, 33, 36), its potential for inducing allergic sensitization has not been studied in detail, but it has been reported as a causal agent of human dermatitis (37). The high frequencies of *Cheyletus* sp. and *G. fusca* in the beds of the individuals studied here suggest that allergenic extracts from these mites should be included in studies of allergen skin prick test reactivity in Salvador to investigate their possible role in the development of allergic disease as it has been done for *G. fusca* in Italy (38) and *Cheyletus eruditus* in Germany (5).

This study showed different frequencies of *D. pteronyssinus* and *G. fusca* between the two socioeconomic groups. These differences might depend on the different environmental conditions in which the two groups live. Lower frequencies of *G. fusca* correlated with some anti-mite practices and bedroom characteristics, such as (a) ironing of bed linens, (b) vacuum cleaning of beds and floors, and (c) use of air-conditioning. These findings suggest that this species may be more sensitive than others to these measures, which are known to reduce mite populations and, as shown in the Results section, were frequent behaviors in the wealthy group homes. On the other hand, *D. pteronyssinus* was found more frequently in the air-conditioned rooms of the wealthy homes than in the non-air-conditioned poor houses. This is consistent with the view that, although inhabiting tropical regions, *D. pteronyssinus* is better adapted to a cool environment, which was most frequently observed in the wealthy group houses.

The history of allergy was not significantly associated with the presence in beds of mites of any of the studied species (every species was found in similar frequencies in beds of allergic and non-allergic individuals; Table 2). As can also be seen in Table 2, no single mite species was found in 100% of the allergic patients' beds, suggesting that different species of mite may be triggering the allergic symptoms in different individuals.

The fact that *D. pteronyssinus*, the most recognized allergenic mite, was found more frequently in beds of the wealthy than of the poor group, and the reverse was observed with *G. fusca*, could suggest that the finding of a higher frequency of allergy in the wealthy group could be associated with higher numbers of *D. pteronyssinus* in their beds. However, this finding could be readily accounted for by other factors, such as lifestyle and childhood infections, which are more prevalent in low socioeconomic groups. Indeed, microbes, helminths or their molecules, in accordance with the hygiene hypothesis, may modulate the immune response, inhibiting the development of allergic diseases more intensely in the poor than in the rich population (39–41).

Exposure to more than 2 µg of Der p 1 per gram of dust during infancy has been suggested to be an important risk factor for allergic sensitization, and exposure to more than 10 µg of Der p 1 per gram of dust during infancy has been associated with the development of asthma by the 11 years of age and with hospital admissions (11,12). In this study, approximately 94% of the analyzed beds had concentrations of Der p 1 above 2 µg per gram of dust and 76% of the beds had concentrations of Der p 1 higher than 10 µg/g of dust, indicating that most of the individuals are at risk of developing allergic diseases.

Two studies performed in the South and Central regions of Brazil found dust allergen concentrations above 10 µg/g of Der p 1 in 90% and 50% of analyzed samples, respectively.

In these studies, no correlation was found between the presence of allergic symptoms and a high Der p 1 concentration. A lack of association between allergy symptoms and dust mite allergen levels was observed also in this study, that was performed in the poorer northeast region of Brazil. According to Korsgaard (44), in areas where the population has a low exposure to mite allergens, there is a strong association between exposure and allergy. However, in areas where the population is uniformly exposed to high allergen concentrations, as seems to be the case in Salvador, no differences in allergy risk were observed between sensitized and non-sensitized individuals and the percentage of individuals, with low-level exposure to these allergens was very small. In such cases, high-level exposure to allergens may not be essential for the development of allergic diseases, and other factors, such as genetic background, and, as mentioned above, lifestyle and childhood infections, may be more important. Microbes and helminths, which are more frequently found in tropical and in subtropical regions, may explain the low frequency of atopy and allergy in the population, even in the presence of high environmental allergen burden.

The dust concentration of Blo t 5 was higher in beds of the wealthy group than in those of the poor group. However, when the data were analyzed in terms of load, the two groups did not differ. The opposite was observed for Der p 1, which was found at similar concentrations in the beds of the high and low socioeconomic level groups, but a higher load was observed in the beds of the poor group. Further studies should be carried out to assess whether allergen loads, rather than allergen concentrations, as proposed elsewhere (11, 12), are more strongly associated with sensitization to allergens and/or with the triggering of respiratory allergy symptoms.

Blo t 5 concentrations were lower than those of Der p 1 in the beds analyzed in this study. As *B. tropicalis* frequencies were higher than those of *D. pteronyssinus* in these same beds, the observed lower concentration of Blo t 5 in relation to Der p 1 could be attributed to a possible greater expression of Der p 1 than of Blo t 5 allergen per mite.

The present results suggest that conditions in most houses in Salvador, where temperatures and humidity are high, favor the growth of large and varied mite populations. This phenomenon may contribute to the high prevalence of allergy in Salvador that has been described here and elsewhere (45) and indicates that allergic individuals should maintain permanent and strict control environments that favor mite proliferation.

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