

A Survey of Acarofauna in Turkey: Comparison of Seven Different Geographic Regions

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ABSTRACT

*House-dust mites play an important role in allergic sensitization in Turkey and other countries. The purpose of this study was to analyze the acarofauna in seven zones that differ in climate and altitude. Dust mites were isolated in 173 of 930 (18.6%) samples. The highest prevalence of house-dust mites was found in the most humid regions of Turkey: Mediterranean (48.4%) and Black Sea (46%). Lower levels were found in central and eastern Anatolia regions where humidity and temperature are low. Mites of the *Dermatophagoides* spp. were predominant (*D. pteronyssinus* [83%] and *D. farinae* [12%] making up the majority of the counts). The presence of mites was related to an increase both in mean temperature ($>15^{\circ}\text{C}$) and in humidity ($\geq 40\%$) as well as low altitude ($<300\text{ m}$). This study suggests that the mite population of humid coastal regions of Turkey is as prevalent as in other temperate climates. (Allergy and Asthma Proc 25:185–190, 2004)*

In the last 100 years, a continuous increase in immunoglobulin E-mediated atopic disorders has been observed worldwide. Exposure and sensitization to indoor allergens, particularly house-dust (HD) mites, are reported to be the most prevalent cause of atopic allergic diseases. Although, the prevalence of allergic diseases is not as high as in

Western populations—for reasons that are poorly understood—mites seem to constitute an important source of allergens in Turkey, as shown in a previous study.^{1,2}

Mites are found almost all over the world, but their fauna differs between regions. Growth of HD mites is related to humidity and temperature. Recent studies have suggested that the levels of domestic mite allergens are increased in countries with a temperate climate.^{3–5} The presence of indoor allergens has been examined widely in the world, but no valid data for comparison of HD mite fauna of Turkey are available. Therefore, a survey of acarofauna in the household dust of 930 homes located in seven different geographical regions of Anatolia was made to determine the prevalence, number, and species of mites as related to environmental climatic conditions.

MATERIALS AND METHODS

Study Design

Because allergic diseases are increasing in Turkey and HD has only been incidentally examined for the presence of mites, we undertook a systematic survey of mites in dust samples from various parts of Anatolia.

Collection and Analysis of House-Dust Samples

Sampling Areas. Seven traditional divisions of the country, each representing different climatic conditions, were chosen for sampling. The first four regions are on the coastal areas: (1) Marmara, (2) Aegean, (3) Mediterranean, (4) Black Sea, (5) central Anatolia, (6) eastern Anatolia, and (7) southeastern Anatolia.

Collection of Dust Samples. People (either patients or volunteers) were asked to collect dust from their homes.

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Nine hundred thirty homes from 45 cities in 7 regions were selected randomly irrespective of the presence of an atopic person in the dwelling. Dust was sampled once between March 1995 and March 1999. For logistic reasons, dust samples were collected by the inhabitants themselves, using their own vacuum cleaners provided with a new disposable paper bag under standardized conditions (a 2-minute sampling of 1 m²) from the living room/bedroom floor and mattresses. Individuals were advised not to clean their houses for 5–7 days before collection of the dust samples. The paper bags containing dust samples were returned to the laboratory in sealed plastic bags and stored at +4°C for future evaluation.

Slide Preparation of Mites. Each sample was weighed and processed by the same expert to rule out a considerable potential variability in the assay of identification. Living mites were separated using the Berlese method, which was described by Baker and Wharton.⁶ Mites were collected in an alcohol solution and heated. Thereafter, lactic acid was added into the mixture. Slide preparation of mites was made with Hoyer's mountant and dyed using the Direktief Schwartz solution.

Identification and Count of Mite Species. Two experienced independent acarologists from the Entomology and Plant Protection Department of Agricultural Faculty, Ankara, identified the species and counted the total number of mites in the samples using light microscopy at a 400× magnification. Identification was done in light of the key points suggested specially for the Pyroglyphidae by Hughes⁷ and the numbers were assessed. Finally, the number of mites per 100 g of dust (mites/100 g) was calculated for each sample.

Environmental Data

The outdoor temperature and humidity data of all the sample sites was collected from the State Meteorology Institute. The mean outdoor temperature was 16.9°C (minimum [min], –10°C; maximum [max], 40°C) and relative humidity (RH) was 62.2% (min, 29%; max, 82%) during the sampling period. Special measurements were not done to register indoor temperature and humidity.

Statistical Analysis

χ^2 was used to examine the differences between independent groups. Prevalence odds ratios (ORs) and 95% confidence intervals were calculated with the Mantel–Haenszel method. Spearman correlation coefficient (r) was calculated to test the correlation between special intervals of temperature, RH, and altitude variables and mite presence. Results of the number of mites per 100 g of dust were analyzed using an analysis of variance (ANOVA), and a Tukey multiple comparison test was used to determine the differences between the regions. Mite as a variable was

considered as binary. Binary logistic regression analysis was used to calculate risk estimates (OR) of these meteorological variables. A value of $p < 0.05$ was regarded as significant. Statistical analysis was performed by use of SPSS 10.0 (SPSS, Chicago, IL).

RESULTS

Mites were isolated from 173 (18.6%) of the total 930 HD samples. Most of the samples (74.1%) came from apartment buildings.

Geographic Distribution of Mites

The presence of mites among the seven regional sites was different from each other. The percent of samples positive for mites was significantly higher ($p < 0.01$) in HD from the most humid regions of the country. The Mediterranean and the Black Sea regions had the top-most percentages of samples with positive HD mites (48.4 and 46%, respectively; $p > 0.05$). The Marmara region showed an infestation rate of 30% ($p < 0.01$), and in the Aegean region, 15.7% of the samples had mites. A relatively small number of samples (5.7 and 2.4%, respectively) from central and eastern parts of Anatolia were found to have mites ($p > 0.05$). Dust samples of the southeastern region showed no infestation. Distribution of samples and prevalence of mites by regions are shown in Fig. 1.

The number of mites per 100 g of dust varied from 0 to 995 mites/100 g (the latter being in a sample from Antakya, a city in the Mediterranean region), with a mean of 23.9 mites/100 g. The highest concentrations were found in the regions with the highest humidity: Mediterranean (85.8 mites/100 g) and Black Sea regions (57.1 mites/100 g). Another coastal region, Marmara, had somewhat lower concentration (22.2 mites/100 g) ($p < 0.05$), followed by east Anatolia (14.1 mites/100 g). Mite numbers were low in the household dust of the Aegean and central Anatolia regions (10.6 and 9.3 mites/100 g, respectively).

Humidity

Mites were found in dust samples collected from regions with an RH $\geq 40\%$. RH was an important factor for the presence of HD mites ($\chi^2 = 127.6$; $p < 0.001$), as the RH gets higher the risk is greater starting mainly from an RH of 60% (OR = 1.3 [1.21–1.39]) and reaches up to a sevenfold increased risk in RH $\geq 80\%$ (OR = 7 [2.46–13.96]; $p < 0.001$). A small but statistically significant correlation was found between RH and mite prevalence ($r = 0.317$; Fig. 2 A). Fewer mites were found in central and eastern Anatolia, where low humidity prevails and the mean monthly RH does not exceed 60% during most of the year; on some days it drops to 20–30%.

Temperature

The presence of mites was related to increases in mean temperature of the cities within the regions where the samples were collected ($\chi^2 = 66.8$; $p < 0.001$). Significant

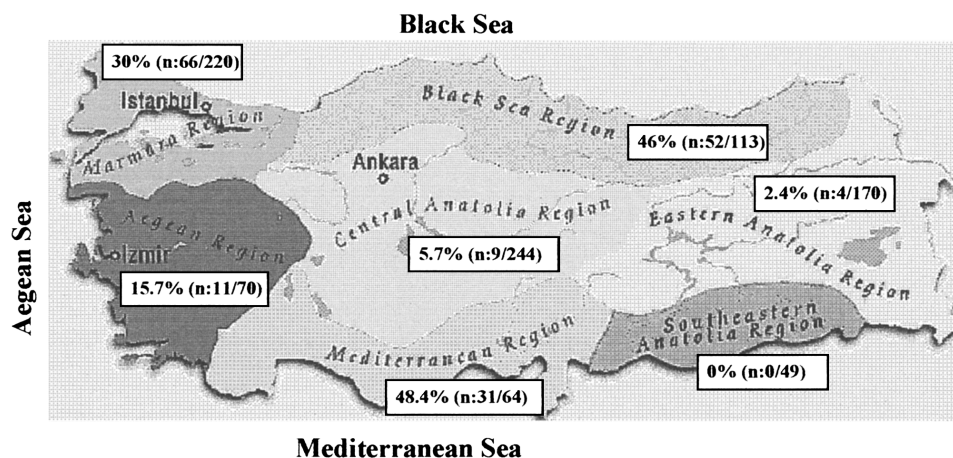


Figure 1. Distribution of samples and mite prevalence by regions. Values are given as percents (mite positive/total samples).

numbers of mites were found in samples from cities with a temperature of $>15^{\circ}\text{C}$ (Fig. 2 B).

Altitude

Infestation of dust samples from humid coastal regions showed an inverse relationship between altitude and mite positivity ($\chi^2 = 139.9$; $r = -0.366$; $p < 0.001$). Mites were most prevalent below 300 m (Fig. 2 C). Logistic regression analysis showed that every additional meter in altitude negatively affects the presence of mites (0.99 ; $p < 0.001$), and every additional 1% RH doubles the presence of mites (OR, 1.051; $p < 0.001$).

Species

Most of the mites collected during the survey belonged to the *Dermatophagoides* spp. (94.95%; *D. pteronyssinus* and *D. farinae*). *D. pteronyssinus* was the most common species and constituted 82.95% of the mites collected, and *D. farinae* represented $\sim 12\%$ of the HD mites collected. This species was more common in the Aegean and Mediterranean regions than in other coastal regions, i.e., Marmara and the Black Sea ($p < 0.05$). Glycyphagidae and Acaridae (1.2%, each) were less frequent ($p < 0.05$). Cheyletid mites, predaceous on pyroglyphids and glycyphagids, were found in only 0.4% of the samples (Fig. 3).

DISCUSSION

There is evidence that the risk of sensitization and development of allergic diseases has increased with exposure to HD mites.^{8,9} Although mites have been shown to play an important role in the pathogenesis of asthma and atopic diseases in Turkey, this multicenter investigation constitutes the first study of the prevalence, number, and species of mites in houses from various parts of Anatolia, representing different climatic conditions. The preliminary results of the distribution of HD mite fauna in Turkey showed that approximately one-fourth of the 133 samples collected from the home environment of mite-allergic pa-

tients had mites.¹⁰ However, the result found in this survey is considerably lower (18.6%). The reason for this difference may be because of sampling not only from the houses of allergic patients but also from healthy volunteers.

Regional variation in HD mite prevalence depends largely on climatic differences.^{4,11} Turkey is situated in a temperate area located mainly in Anatolia, a peninsula, and Thrace and has four distinct climatic seasons. The humidity at the coastline is much higher than inland Anatolia throughout the year. This explains the highest mite population found in the Mediterranean and Black Sea regions. However, mite prevalence was low in cold central and eastern Anatolia regions that are located ≥ 900 m above sea level where humidity is low ($\text{RH} < 60\%$). No contamination was observed in the southeastern part of Anatolia. This probably is because of high altitude and temperature as well as low RH (29–59%). As shown in laboratory studies, the combined effect of temperature $>15^{\circ}\text{C}$ and a microenvironmental RH of 45–55% decreases the survival of dust mites.^{9,12–14} In particular, *D. pteronyssinus*, which is the predominant species in Turkey, has been shown to be more sensitive than *D. farinae* to heat as a stressor. These results are consistent with current thinking on the climatic growth patterns of mites.

There are a number of potential criticisms of this study. First, we were not able to measure indoor conditions (RH and temperature). The surveys in temperate climates indicate that mite prevalence fluctuates in parallel with seasonal fluctuations in indoor RH.^{15,16} Second, the sample sites were selected randomly and thus different homes were assayed at different sites. Finally, dust samples were obtained at different times of year. Our primary aim was to compare prevalence and number of mites monthly within a sampling region, but budgetary limitations did not permit HD survey over a 12-month period. Therefore, the authors wished to minimize seasonal influences, and dust samples were collected during 4 consecutive years.

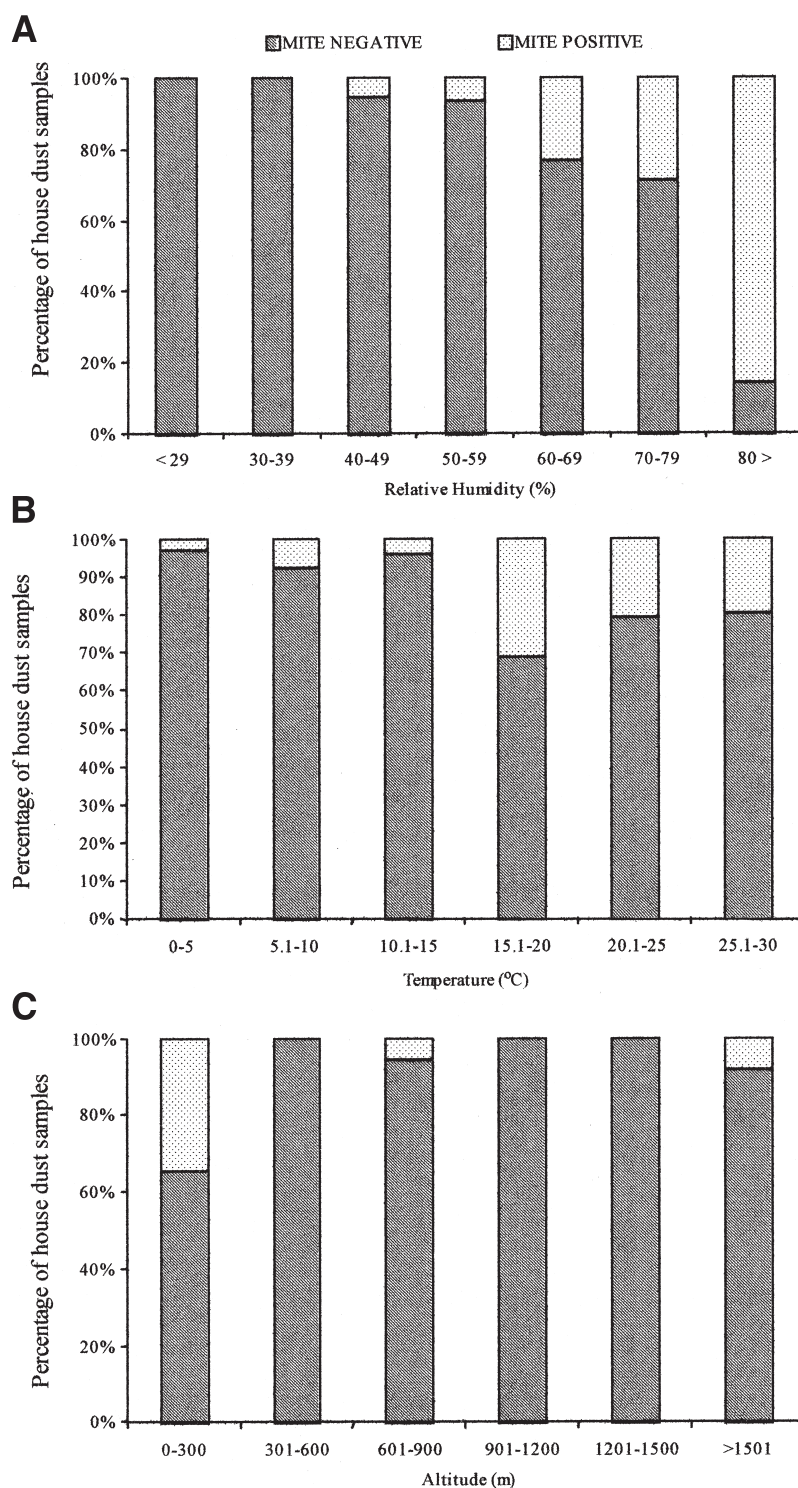


Figure 2. Distribution of mite positivity by (A) RH, (B) temperature, and (C) altitude.

In addition to such distribution patterns, neither Marmara nor Aegean regions show an infestation rate similar to those of other coastal sites, *e.g.*, Mediterranean and Black Sea regions. Thus, the effect of other environmental factors related to lifestyle should be considered. One possible explanation is that housing characteristics are responsible for these differences by affecting indoor humidity.^{15,17,18} Most

people live in multistory apartment flats in the Marmara and Aegean regions and in inner parts of Anatolia (data not shown). However, the rest of the population prefers single-story houses made of bricks or concrete blocks and heated by wood-burning stoves. The houses have natural ventilation due to low building standards, and mechanical ventilation systems are absent. As has been shown in our previous

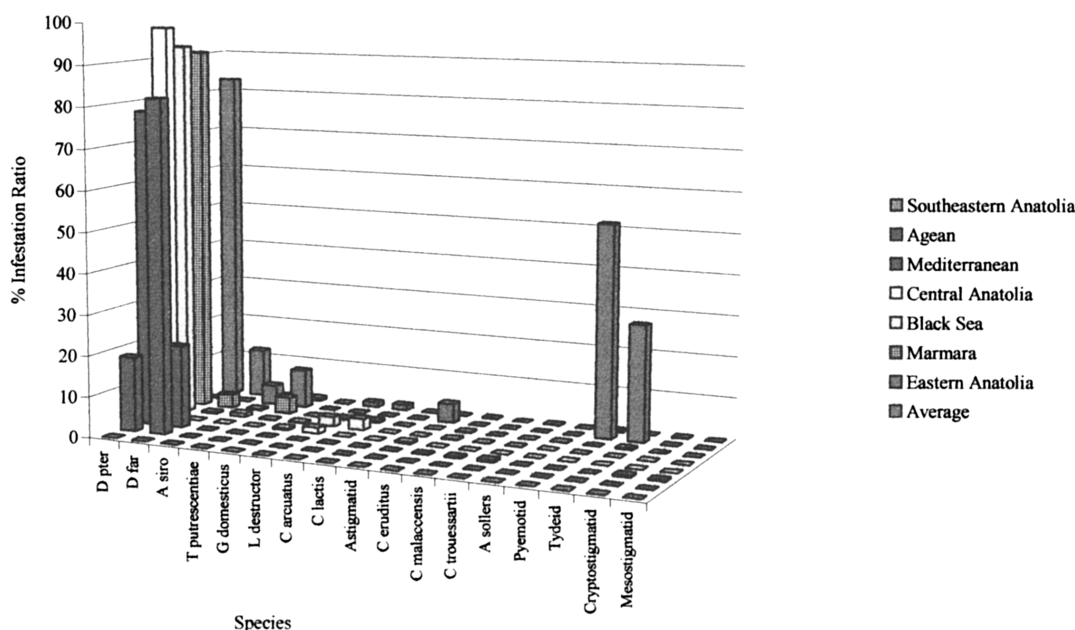


Figure 3. Distribution of mite species found in HD samples in seven geographic regions.

study, damp/poor housing conditions in single-story houses were associated with increased mite exposure.¹⁰ The causes of indoor humidity in Turkey and the Western world are probably different. In Europe, dampness problems are related to efficient insulation and poor ventilation, while in Turkey, dampness appears to be related more to leaking roofs and walls and damp cellars.^{10,17,18}

Many authors recognize the strength of the association between type of building and mite prevalence. Chew *et al.* found that dust-mite allergen concentrations were almost two times higher in houses than those in apartments.¹⁹ Studies in the United States and Europe have established higher levels of dust-mite allergens in houses than in multistorey apartments with hotter and drier interiors during all seasons.^{19–22}

Our results indicate that HD mites probably occur in homes at any one time, but with variation both in quantity and in species. Almost three-quarters of the samples surveyed in our study were collected from cities where apartment flats constitute the major type of building. Furthermore, mean relative outdoor air humidity in Turkey (62.2%) is somewhat lower than in Europe. This too may explain considerably lower mite numbers (23.9 mites/100 g of dust sample) as compared with other regions with similar climates. In addition, the difference may be associated with the separation methods used; with our technique, only live mites were isolated.

Various environmental factors also influence the species in HD. The most prevalent species found belong to the *Dermatophagoides* spp. (94.95%). Dust samples from the coastal areas contained more mites, mainly *D. pteronyssinus*, than the metropolitan areas, but very little *D. farinae*. Because the total number of HD mites collected at a site reflects the number of *D. pteronyssinus*, our results show

that under the climatic conditions of Turkey, RH determines the abundance of this species. These results are consistent with the observations that optimal temperature is higher (25–30°C) and optimal humidity is lower (RH, 50–60%) for *D. farinae* than for *D. pteronyssinus*.¹⁸ This explains why *D. farinae* is most prevalent in the Aegean region. Either the humidity is too high or the temperature is too low for *D. farinae* at the other sites. Storage mites were found extremely rare in this investigation of the distribution of mite species. Other species reported to be very common in some tropical regions can be clinically important in individual cases and should be considered therein.^{23,24}

In conclusion, this survey provides information about dust-mite prevalence and mite ecology in Turkey. Some factors such as humidity, temperature, and small houses for large families probably favored the heavy mite infestation. The highest prevalence of HD mites found in the most humid regions is consistent with the widespread occurrence of allergy in coastal parts of Turkey. Definition of geographically specific patterns of indoor allergens, particularly HD mites, could enable investigators to assess the extent to which exposure assessment might influence diagnosis and treatment.

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REFERENCES

1. Platts-Mills TAE, Vervloet D, Thomas WR, et al. Indoor allergens and asthma: Report of the third international workshop. *J Allergy Clin Immunol* 100:S1–S24, 1997.
2. Mungan D, Demirel YS, Kalpaklıoğlu F, et al. In Skin Test Reactivity of Asthmatic Patients in Turkey. XVI European Congress of Allergology and Clinical Immunology ECACI '95 Proceedings II. Bassomba A, Hernandez MD, de Rojas F (Eds). Bologna, Italy: Monduzzi Editore, 1995. pp 15–19.
3. Garrett MH, Hooper BM, and Hooper MA. Indoor environmental factors associated with house-dust-mite allergen (*Der p 1*) levels in South-Eastern Australian houses. *Allergy* 53:1060–1065, 1998.
4. Lintner TJ, and Brame KA. The effects of season, climate, and air-conditioning on the prevalence of *Dermatophagoides* mite allergens in household dust. *J Allergy Clin Immunol* 91:862–867, 1993.
5. Li C-S, Wan G-H, Hsieh K-H, et al. Seasonal variation of house dust mite allergen (*Der p 1*) in a subtropical climate. *J Allergy Clin Immunol* 94:131–134, 1994.
6. Baker EW, and Wharton GW. Introduction. In An Introduction to Acarology. Baker EW, and Wharton GW (Eds.). New York: The MacMillan Company. 1952. pp 1–35.
7. Hughes AM. The mites of stored food and houses. Ministry of Agriculture, Fisheries, and Food, Technical Bulletin No. 9. London: Her Majesty's Stationery Office. 1976. p 400s.
8. Platts-Mills TAE, Hayden ML, Chapman MD, et al. Seasonal variation in dust mite and grass-pollen allergens in dust from the houses of patients with asthma. *J Allergy Clin Immunol* 79:781–791, 1987.
9. Arlian LG, and Platts-Mills TAE. The biology of dust mites and the remediation of mite allergens in allergic disease. *J Allergy Clin Immunol* 107:406–413, 2001.
10. Kalpaklıoğlu AF, Emekçi M, Ferizli AG, et al. House dust mite fauna in Turkey. *J Invest Allergol Clin Immunol* 7:578–582, 1997.
11. Munir AKM, Björkstén B, and Einarsson R. Mite allergen in relation to home conditions and sensitization of asthmatic children from three climatic regions. *Allergy* 50:55–64, 1995.
12. Korsgaard J. House-dust mites and absolute indoor humidity. *Allergy* 38:85–92, 1983.
13. Arlian LG, Confer PD, Rapp CM, et al. Population dynamics of the house dust mites *Dermatophagoides farinae*, *D. pteronyssinus*, and *Euroglyphus maynei* (Acari: Pyroglyphidae) at specific relative humidities. *J Med Entomol* 35:46–53, 1998.
14. Arlian LG, Bernstein IL, and Gallagher JS. The prevalence of house dust mites, *Dermatophagoides* spp, and associated environmental conditions in homes in Ohio. *J Allergy Clin Immunol* 69:527–532, 1982.
15. Wickens K, Siebers R, and Ellis I. Determinants of house dust mite allergen in homes in Wellington, New Zealand. *Clin Exp Allergy* 27:1077–1085, 1997.
16. Murray AB, and Zuk P. The seasonal variation in a population of house dust mites in a North American city. *J Allergy Clin Immunol* 64:266–269, 1979.
17. Korsgaard HH, and Dahl J. House-dust mites and associated environmental conditions in Danish homes. *Allergy* 48:106–109, 1993.
18. Wickman M, Nordvall SL, Pershagen G, et al. House dust mite sensitization in children and residential characteristics in a temperate region. *J Allergy Clin Immunol* 88:89–95, 1991.
19. Chew GL, Higgins KM, Gold DR, et al. Monthly measurements of indoor allergens and the influence of housing type in a North-Eastern US city. *Allergy* 54:1058–1066, 1999.
20. Van Strien RT, Verhoeff AP, Brunekreef B, et al. Mite antigen in house dust: Relationship with different housing characteristics in the Netherlands. *Clin Exp Allergy* 24:843–853, 1994.
21. Arlian LG, Bernstein D, and Bernstein IL. Prevalence of dust mites in the homes of people with asthma living in eight different geographic areas of the United States. *J Allergy Clin Immunol* 90:292–300, 1992.
22. Hirsch T, Range U, and Walther KU. Prevalence and determinants of house dust mite allergen in East German homes. *Clin Exp Allergy* 28:956–964, 1998.
23. Chew FT, Zhang L, Ho TM, et al. House dust mite fauna in tropical Singapore. *Clin Exp Allergy* 29:201–206, 1999.
24. Baratawidjaja IR, Baratawidjaja PP, Darwis A, et al. Mites in Jakarta homes. *Allergy* 53:1226–1227, 1998. □

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