

Specific IgE Levels to *Dermatophagoides pteronyssinus* Are Associated with Meteorological Factors

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Key Words

Dermatophagoides pteronyssinus • Sensitization • Meteorological factors

Abstract

Background: *Dermatophagoides pteronyssinus* specific IgE (sIgE) measurement is a major diagnostic test for the detection of sensitization to that allergen. **Methods:** To investigate the effect of climate on the seasonal variations of *D. pteronyssinus* sIgE, we studied the tests performed in an insular population during a 10-year period. The association with meteorological factors was evaluated with multiple regression analyses. **Results:** Of 24,879 tests performed for *D. pteronyssinus* sIgE, 16,719 (67.2%) were *D. pteronyssinus* sIgE positive; 24.5% were tested for asthma and 46.07% for rhinitis. *D. pteronyssinus* sIgE levels showed a seasonal pattern with an annual peak in November. In the multivariate analyses solar radiation ($r = -0.94$) and relative humidity ($r = 0.86$) were independent factors associated with *D. pteronyssinus* sIgE levels. The resulting model could explain 93% ($p < 0.001$) of *D. pteronyssinus* sIgE variability. **Conclusions:** Our population showed a seasonal pattern of *D. pteronyssinus* sIgE explained by relative humidity and solar radiation.

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Introduction

Dermatophagoides pteronyssinus is a major cause of allergic asthma and rhinitis in different parts of the world [1–3]. Although the presence of house dust mites can be detected throughout the year, several studies have demonstrated the existence of annual variations [4, 5]. Humidity is considered the main cause of annual changes in the *D. pteronyssinus* population [6]. However, studies on the association between variations in the mite population and the clinical status of asthmatic individuals have rendered contradictory results [7–9].

D. pteronyssinus specific IgE (sIgE) measurement is a major diagnostic test for the detection of sensitization against *D. pteronyssinus*, but its role in predicting the allergen's clinical relevance is still unclear. In food allergy, sIgE levels are often used to predict a positive food challenge [10]. Similarly, in recent years, the levels of sIgE to aeroallergens have been suggested to predict a positive bronchial challenge to different inhalant allergens [11]. Moreover, an increase in serum sIgE has been described after *D. pteronyssinus*-specific bronchial challenges [12].

Changes in *D. pteronyssinus* sIgE may be the result of differences in exposure to mite allergens due to variations in the population of mites, mite allergen concentrations, and/or airborne factors such as particle size, relative hu-

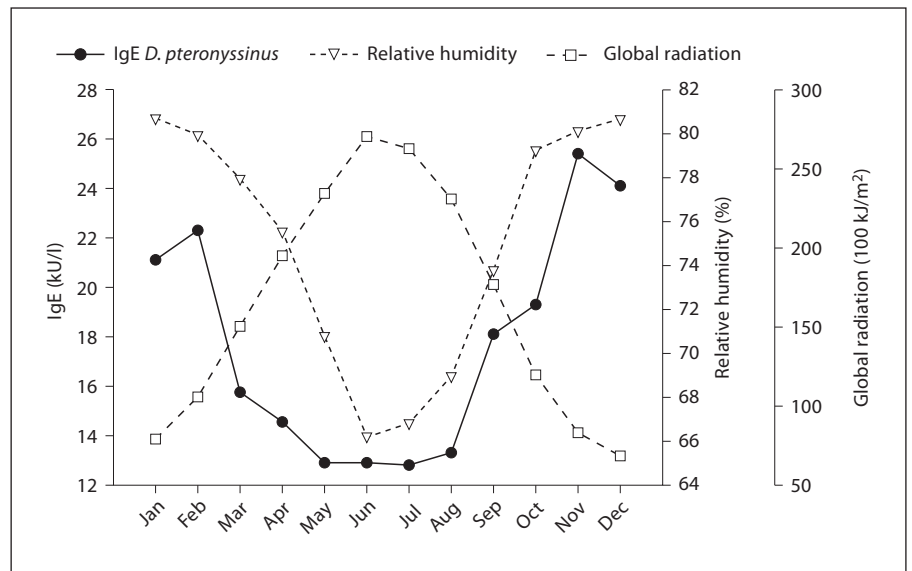


Fig. 1. *D. pteronyssinus* sIgE, relative humidity, and global solar radiation annual distribution.

midity, Stokes forces, etc. [13]. Airborne factors might explain the discrepancy between mite levels and clinical symptoms [14]. In a similar way, factors that could modify the immune status of the individual might also explain the differences in symptoms after the same levels of mites.

In the present ecological study we investigated the existence of seasonal variations in *D. pteronyssinus* sIgE in an insular population of Spain, as well as its possible association with the meteorological conditions obtained from a close weather station.

Material and Methods

All serum sIgE to *D. pteronyssinus* tested from January 1, 2001, to December 31, 2010, at a tertiary-care hospital was retrospectively reviewed. Serum samples were provided by primary care centers and hospital outpatient clinics. Clinical information was based on the physician's petition form. Data on *D. pteronyssinus* sIgE, age, gender, and date of request were recorded.

Measurement of sIgE to *D. pteronyssinus* was performed by fluorescent enzyme immunoassay (ImmunoCAP System; Sweden) as described elsewhere [15, 16]. Levels higher than 0.35 kU/l were considered positive.

During the study period (2001–2010), data on barometric pressure (hPa), relative humidity (%), wind speed (km/h) and distance (km), rainfall (mm), global solar radiation (10 kJ/m²), and temperature (°C) were obtained from the Spanish Agency of Meteorology. This agency collects daily information from a weather station located 15 km from the hospital. Water vapor pressure (hPa) was obtained using the stochastic equation as described elsewhere [17].

All continuous variables were confirmed to be normally distributed, or to have skewness not significantly different from zero. As ImmunoCAP limits the sIgE count to 100 kU/l, data on month-

ly sIgE were analyzed with the median as a measure of central tendency. Data were grouped by months of the year, obtaining *D. pteronyssinus* sIgE from the average of monthly medians and the meteorological variables from the average monthly means. Analysis was started with simple linear regression. After selecting the associated variables, stepwise regression was performed to study the independent association between *D. pteronyssinus* sIgE and the meteorological conditions. $p < 0.05$ was considered statistically significant. Data were analyzed with the statistical software package IBM SPSS 19.0.

Results

From January 1, 2001, to December 31, 2010, a total of 24,879 tests for *D. pteronyssinus* sIgE were performed in 24,463 individuals. Of the tests, 67.2% (16,719/24,879) were *D. pteronyssinus* sIgE positive. Regarding sex and age distribution, 51.84% (8,667/16,719) of the positive tests were from male patients and the median age was 23.56 years (SD ± 15.21). The reason for sIgE testing was available in 65.07% (10,879/16,719) of the cases sensitized to *D. pteronyssinus* and was as follows: asthma, 2,665 (24.5%); rhinitis, 5,012 (46.07%); urticaria/angioedema, 591 (5.43%); atopic dermatitis, 182 (1.67%); blood eosinophilia, 300 (2.76%); chronic cough, 173 (1.59%); nonspecified allergy, 1,328 (12.21%); immunotherapy, 373 (3.42%), and others, 255 (2.34%).

D. pteronyssinus sIgE levels showed a marked seasonal pattern (fig. 1). It increased during autumn, with an annual peak in November (25.4 ± 4.64 kU/l), maintaining

Table 1. Multivariate analyses of the association between *D. pteronyssinus* sIgE and meteorological factors

Independent variables ^a	Coefficients (SE)	p values
Global radiation	−0.011 (0.002)	<0.001
Relative humidity	−0.73 (0.32)	0.045

Values are adjusted for rainfall, mean temperature, vapor pressure, atmospheric pressure, global radiation, wind speed and distance, and relative humidity. Coefficient of determination $R^2 = 0.93$ ($p < 0.001$). SE = Standard error.

^a Equation constant 91.32.

high levels during the winter and decreasing during the spring and summer. There was a 98.4% increase in the levels from July to November.

All of the studied variables showed statistical correlation with *D. pteronyssinus* sIgE levels (table 1). However, after multivariate analyses only global solar radiation ($r = -0.94$; $p < 0.001$) and relative humidity ($r = 0.86$; $p < 0.001$) were independently associated with *D. pteronyssinus* sIgE levels. During the month with the highest median *D. pteronyssinus* sIgE level (November), the relative humidity was 80.13% (annual range 66.23–80.7%) and the global solar radiation was 8,320 kJ/m² (annual range 6,850–27,070 kJ/m²). These two variables explained 93% of the annual variations in *D. pteronyssinus* sIgE (table 1).

Discussion

Our study shows the existence of a seasonal variation of *D. pteronyssinus* sIgE levels in our population. Peak levels occurred from mid-autumn to winter, decreasing to minimum levels in early summer. To our knowledge, only one previous study has described the existence of a seasonal pattern for *D. pteronyssinus* sIgE, but the authors analyzed *D. pteronyssinus* sIgE qualitatively and did not quantify the differences between months [18]. The existence of a seasonal pattern for *D. pteronyssinus* sIgE is consistent with previous reports and may indicate fluctuations in mite or allergen concentrations throughout the year [4, 19–21].

In this report, we analyzed the impact of various meteorological conditions on sIgE and observed that *D. pteronyssinus* sIgE levels are independently associated with relative humidity and global radiation. This association might be due to a direct effect on the individual or an indirect effect through variations in allergen concentration

or exposure. Regarding the effect of humidity, there are no studies indicating an increase in sIgE directly associated with relative humidity. Relative humidity could be indirectly associated with *D. pteronyssinus* sIgE through changes in the concentration of allergens or their exposure. Benitah et al. [18] reported an association between *D. pteronyssinus* sIgE and humidity, but a 2-month lag was needed to obtain a significant association. In the same way, several studies have observed a 2-month latency between humidity and mite population or mite allergen concentration [21, 22]. These observations do not necessarily contradict our findings. A latency period should be required when allergen variations depend mainly on the increase in the mite population. However, in geographical areas with high humidity levels throughout the year, a stable population of mites may be favored with these conditions. In this situation, a rise in humidity increases the feeding rates of mites and the production of allergens without the need for a latency period [23]. Moreover, the influence of humidity on the airborne levels of aeroallergens such as pollens has been suggested [13]. Therefore, the possibility that relative humidity could favor the airborne *D. pteronyssinus* allergens and in consequence greater exposure to the upper and lower airways has to be considered.

In recent years there has been increasing interest in the relationship between exposure to sunlight and allergic diseases [24]. Sunlight is responsible for the synthesis of vitamin D, and a growing number of reports have suggested that vitamin D plays an important role in the regulation of the immune system and allergic diseases [25, 26]. Vitamin D deficiency has been correlated with total IgE levels, suggesting that an increase in sIgE is also likely to occur [27]. This could explain the annual variations in *D. pteronyssinus* sIgE annual levels observed in this study.

It is well known that mites thrive better with little sunlight, but there are few studies on the optimum solar radiation for mite proliferation [28]. Tovey et al. [29] showed that under direct sunlight exposure mite populations in carpets substantially diminished. The high levels of solar radiation observed in our study during the spring/summer may have reduced the population of mites, thus inducing a lower allergen load and subsequent decreased *D. pteronyssinus* sIgE levels. However, in our study we did not observe a time lag between solar radiation and *D. pteronyssinus* sIgE levels, which suggests that lower solar radiation levels during the autumn/winter seasons unlikely increased the mite population and subsequently raised *D. pteronyssinus* sIgE levels.

Other factors could also explain the interaction between *D. pteronyssinus* sIgE and meteorological condi-

tions. A decrease in the time spent indoors due to better weather conditions may decrease mite exposure. On the other hand, meteorological factors may influence other immunomodulators such as viral particles or endotoxins that are strongly associated with asthma in mite-sensitized individuals [30].

The main limitation of the present study is its ecological nature, which precludes applying its results from a population level to an individual level. Another limitation is the absence of information on the patient's clinical situation or the ongoing therapy. However, the very large

sample size and the quite local population (a relatively small island) exposed to very similar environmental factors, including climate, probably reduces biases derived from its ecological design.

In conclusion, we found that *D. pteronyssinus* sIgE has a seasonal pattern which should be considered in order to better assess the clinical relevance of the allergen. *D. pteronyssinus* sIgE seasonality is clearly associated with relative humidity and solar radiation, but the mechanisms responsible for these associations remain to be elucidated.

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