

Original article

High prevalence of storage mite sensitization in a general adult population

Background and aim: Occupational and nonoccupational storage mite (SM) allergy has received considerable attention in recent years. The study aimed to evaluate both the prevalence and factors associated with sensitization to SMs in a general adult population from a warm and humid area where mites are the predominant allergens.

Patients and methods: An age-stratified random sample of 720 subjects was drawn from the population older than 18 years of A-Estrada (Galicia, Spain). From 697 eligible subjects, 469 (67%, median age 54 years, range 18–92 years, 44% males, 75% of cases from a rural environment) agreed to participate. Skin prick tests to SMs (*Lepidoglyphus destructor* and *Tyrophagus putrescentiae*), house dust mite (*Dermatophagoides pteronyssinus*), pollens, moulds and animal danders were performed in all cases. Wheals ≥ 4 mm were considered positive. Epidemiological data were assessed by questionnaire. A design-based analysis was performed and all calculations were weighted to give unbiased estimates.

Results: *Tyrophagus putrescentiae* and *L. destructor* were the leading causes of allergic sensitization throughout all ages. SM sensitization was found in 104 cases (weighted value 24.4%, 95% CI 20.6–28.2). SM sensitization was inversely associated with age. Multivariate analysis showed that SM sensitization was not significantly associated with sex, smoking, educational level, farming profession, rural environment, indoor humidity, presence of pets, livestock or grain storage facilities near home.

Conclusions: SMs (*T. putrescentiae* and *L. destructor*) are major aeroallergens in adults in the region studied, even in subjects without occupational exposure.

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Storage mites (SMs), particularly those from the *Glycyphagidae* and the *Acaridae* families (*Lepidoglyphus*, *Tyrophagus* and *Acarus* genus, among others), can cause allergic respiratory symptoms after occupational exposure in farms, dairy barns, bakeries and grain elevator stores (1–5). Over recent years, much attention has been paid to SM allergy in nonoccupational environments (6, 7). The presence of SM in house dust samples throughout the world supports their clinical significance (7, 8).

Growth of mites is related to temperature and humidity (9). SMs require higher humidity levels for optimum living conditions than house dust mites (HDMs) (10). Accordingly, SM allergy is closely associated with anamnestic indicators of damp housing conditions such as visible mould growth and condensation on double-glass windows in the winter (11). In the north-west of Spain, where climate is rainy and temperate, HDM-allergic patients show a very high prevalence (73–83%) of SM sensitization (12, 13). In the same studies, SM sensitization was found to be independently associated with damp housing condition and with the presence of grain storage

facilities near home (12). The present study was aimed to evaluate both the prevalence and the possible factors associated with SM sensitization in an adult general population from the same area.

Subjects and methods

Setting

This cross-sectional study (as a part of the A-Estrada Allergy Study) was performed in the municipality of A-Estrada, in north-west Spain. The municipality has an area of 282 km² and had an adult population (18 years and older) of 19 346 when the study was begun. About one-fourth of the population lives in the main village (A-Estrada), and the remainder live in a rural environment. A-Estrada is located at 42°40'N/8°30'W, at an altitude of 296 m from the sea level, and at a distance of 30 km from the Atlantic seashore. The climate in the area is rainy and temperate. Mean rainfall per year is 1810 l/m², with a maximum of 268 l/m² in January and a minimum of 40 l/m² in July. The number of rainy days per year goes beyond 200. Mean annual temperature is 13.2°C. Mean maximum and minimum temperatures are 19.0°C (August)

and 7.9°C (January), respectively. Indoor humidity can easily reach the 80% mark or more (14).

Participants

The study profile is summarized in Fig. 1. A detailed description has been published elsewhere (15). An age-stratified random sample of the population 18 years and older ($n = 720$) was drawn from the National Health System Registry, which covers more than 95% of the population. Eligible subjects were invited to participate in the study by a personal letter. A total of 469 subjects participated in the study (participation rate, 67%). Participation ranged from 53% (in the >80-year age interval) to 80% (in the 50–59-year age interval). There were no significant differences in age, gender and residence (rural/urban) between subjects who participated in the study and those who did not. Median age of the participants was 54 years (range 18–92 years). Two hundred and six were males (44%) and 263 were females (56%). Most participants lived in a rural environment (352 cases, 75%), and the remainder lived in A-Estrada village. From February to December 2000, all subjects were successively convened to the Primary Care Centre for evaluation, including a structured questionnaire and skin prick tests (SPT) to a standard battery of aeroallergens.

Questionnaire

A structured questionnaire was administered by a trained physician. It included: (a) basic demographic data; (b) educational level, in four categories of studies: none, elementary (1–8 years), secondary (9–13 years), and university; (c) profession (farming/other); (d) smoking habit; (e) house setting (rural/urban); (f) presence of pets (cats or dogs); (g) presence of livestock in the farm (cows, sheep); (h) presence of grain storage facilities either in or near home; (i) indoor dampness, considering houses as highly humid when at least two of the three following were present: absence of central heating, visible damp spots on the walls and frequent humidity of stored clothes; and (j) presence of nasal symptoms or bronchial

symptoms, explored by means of questions adopted from previously validated questionnaires (16, 17): 'Have you ever had a problem with sneezing, or a runny, or a blocked nose when you did not have a cold or the flu?' and 'Have you ever had wheezing or whistling in the chest at any time in the past?', respectively. Unless otherwise indicated, all these variables were recorded as binary ('yes/no').

Skin prick tests

The battery of skin prick tests (SPT) to aeroallergens included SM (*Lepidoglyphus destructor*, *Tyrophagus putrescentiae*), HDM (*Dermatophagoides pteronyssinus*), pollens (*Lolium perenne*, *Plantago lanceolata*, *Betula alba*, *Parietaria judaica*), moulds (*Alternaria alternata*, *Aspergillus* spp., *Penicillium notatum*, *Cladosporium herbarum*), and animal danders (dog and cat) (ALK-Abelló, Spain). Control SPT included 10 mg/ml histamine and saline solutions. Standard procedures were followed (18). Wheals ≥ 4 mm after 15 min were considered indicative of a positive reaction. SPT-positive patients (19) were considered to have allergic sensitization.

Statistical analysis

In order to account for the stratified sampling, a design-based analysis was performed. The sampling procedures used in the study departed from unequal probability selection. Compensatory weights were developed to obtain estimates (prevalences and odds ratios, with their corresponding 95% confidence intervals, CI) from the original target population in the study area (20). To account for weighting and the sampling design the STATA 7.0 (Stata Corp, College Station, TX) statistical package was employed. Cross-tabulation significance levels were based on second-order corrected Pearson chi-square for categorical variables. Student's *t*-test was employed for comparison of quantitative variables. For multivariate analysis (logistic regression), age (in years) entered the equation as a quantitative variable. The remaining variables were categorical (binary) and entered the equation as '1' ('present' or 'yes') or '0' ('absent' or 'no'). Two-tailed *P*-values lower than 0.05 were considered statistically significant.

Ethical considerations

The study conformed to the principles of the 1975 Helsinki declaration, and was reviewed and approved by the local Research Committee.

Results

Table 1 represents the rates of sensitization to the allergens tested, as revealed by positive SPT. A total of 121 subjects (weighted value 28.1%, 95% CI 24.1–32.1) had a positive SPT to at least one of the allergens tested. The rate of allergen sensitization decreased with age. The most prevalent sensitizations were mites, followed by pollens, moulds and animal danders. Sensitization to mites (either HDM *D. pteronyssinus* or SM *Tyrophagus putrescentiae* or *Lepidoglyphus destructor*) was detected in 110 subjects (weighted value 25.7%, 95% CI 21.9–29.6). Sensitization to SM (*T. putrescentiae* or *L. destructor*) was found in 104 cases (weighted value 24.4%, 95% CI

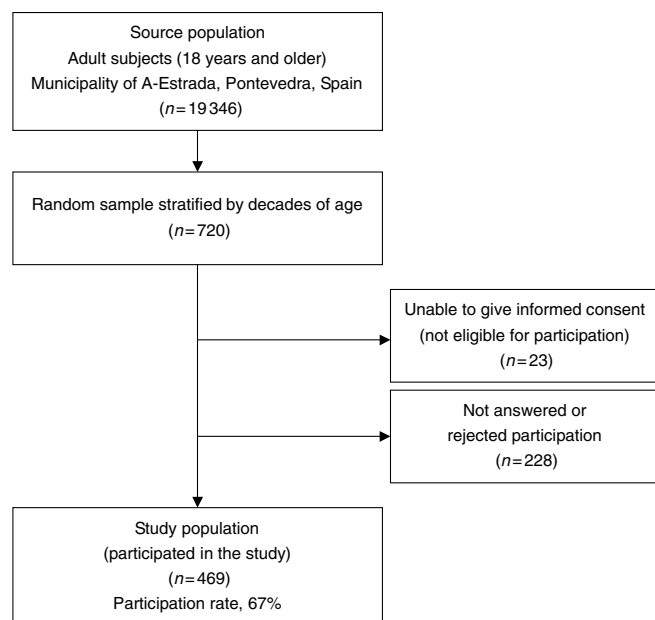


Figure 1. Study profile.

Table 1. Prevalence of sensitization to the different aeroallergens according to age strata

	18–29 years	30–39 years	40–49 years	50–59 years	60–69 years	70–79 years	>80 years	All ages*
<i>Tyrophagus putrescentiae</i>	50.7% (38.9–62.5)	16.1% (6.8–25.4)	17.8% (8.9–26.6)	16.9% (8.6–25.3)	20.0% (10.5–29.5)	8.7% (1.9–15.4)	6.4% (0–13.5)	22.4% (18.7–26.1)
<i>Lepidoglyphus destructor</i>	42.2% (30.6–53.7)	11.3% (3.3–19.3)	8.2% (1.9–14.6)	7.8% (1.8–13.8)	8.6% (2.0–15.2)	5.8% (2.2–11.4)	2.1% (0.0–6.2)	14.9% (11.7–18.1)
<i>Dermatophagoides pteronyssinus</i>	36.6% (25.4–47.8)	16.4% (7.1–25.7)	12.2% (4.8–19.5)	9.1% (2.7–15.5)	7.1% (1.1–13.1)	5.8% (3.1–11.3)	0%	14.8% (11.5–18.0)
<i>Lolium perenne</i>	12.7% (4.9–20.4)	4.9% (0.0–10.3)	6.7% (1.1–12.4)	3.9% (0.0–8.2)	4.3% (0.0–9.0)	1.4% (0.0–4.2)	2.1% (0.0–6.2)	5.8% (3.6–8.0)
<i>Plantago lanceolata</i>	8.4% (1.9–14.9)	6.5% (0.3–12.7)	4.0% (0.0–8.5)	2.6% (0.0–6.1)	7.1% (1.1–13.1)	1.4% (0.0–4.2)	0%	4.9% (2.8–7.0)
<i>Betula alba</i>	11.3% (3.9–18.6)	1.6% (0.0–4.8)	4.0% (0.0–8.5)	1.3% (0.0–3.8)	4.3% (0.0–9.0)	1.4% (0.0–4.2)	0%	4.1% (2.2–6.0)
<i>Parietaria judaica</i>	4.2% (0.0–8.9)	6.5% (0.3–12.7)	4.0% (0.0–8.5)	2.6% (0.0–6.1)	7.1% (1.1–13.2)	1.4% (0.0–13.1)	0%	2.0% (0.7–3.4%)
<i>Alternaria alternata</i>	2.8% (0.0–6.6)	0%	0%	1.3% (0.0–3.8)	2.8% (0.0–6.7)	1.4% (0.0–4.2)	0%	1.4% (0.3–2.5)
<i>Aspergillus fumigatus</i>	0%	0%	2.7% (0.0–6.3)	2.6% (0.0–6.1)	1.4% (0.0–4.2)	0%	2.1% (0.0–6.2)	1.1% (0.2–2.0)
<i>Dog dander</i>	1.4% (0.0–4.1)	0%	2.7% (0.0–6.4)	0%	1.4% (0.0–4.2)	0%	0%	0.9% (0.0–1.7)
<i>Cat dander</i>	1.4% (0.0–4.1)	0%	0%	0%	1.4% (0.0–4.2)	0%	0%	0.5% (0.0–1.2)
<i>Cladosporium herbarum</i>	0%	1.6% (0.0–4.8)	0%	0%	0%	0%	0%	0.3% (0.0–0.7)
<i>Penicillium notatum</i>	0%	0%	0%	0%	1.4% (0.0–4.2)	0%	0%	0.2% (0.0–0.6)
Any allergen†	54.9 (43.3–66.5)	31.1 (19.6–42.8)	24.3 (14.6–34.0)	20.8 (11.8–29.8)	20.0 (10.7–29.3)	13.0 (5.1–20.9)	12.8 (3.2–22.3)	28.1 (24.1–32.1)

Figures are percentages, with 95% confidence intervals within parentheses.

* Weighted values.

† Positive SPT against any of the allergens tested.

20.6–28.2). Among subjects sensitized to mites, 55 cases (50.0%) were sensitized to both SM and HDM, six (5.6%) were exclusively sensitized to HDM and 49 (44.6%) were exclusively sensitized to SM. Specifically, 32 subjects (29% of mite-sensitized subjects), representing 7.3% of the studied population (95% CI 4.0–10.6) were exclusively sensitized against *T. putrescentiae*. *Tyrophagus putrescentiae* and *L. destructor* were the leading causes of allergic sensitization throughout all ages (Table 1). Median diameters of positive SPT to *T. putrescentiae* and *L. destructor* were 7 mm (range 4–19 mm) and 7 mm (range 4–25 mm), respectively.

A comparison of epidemiological characteristics from subjects with and without SM sensitization is represented in Table 2. There were no significant differences between

subjects with and without SM sensitization with regard to sex, setting (rural/urban), anamnestic data of high indoor humidity and presence of pets, livestock or grain storage facilities near home (Table 2). Young age ($P < 0.001$), smoking ($P = 0.01$), high educational level ($P < 0.001$) and nonfarming profession ($P = 0.006$) were associated with SM sensitization on this univariate analysis. However, only age maintained a significant association with SM sensitization when all variables listed in Table 2 were introduced in a multivariate analysis (OR 0.95, 95% CI 0.93–0.97, $P < 0.001$). The prevalence of SM sensitization decreased from 52.1% (95% CI 40.3–63.9) in the 18–29-year age interval to 8.5% (95% CI 3.5–16.7) in subjects older than 80 years.

Clinical manifestations (history of nasal and bronchial symptoms) in the different groups of patients with allergic sensitization are represented in Table 3. Among individuals without any allergic sensitization (nonatopics), one-fourth referred nasal symptoms and a similar proportion referred bronchial symptoms as questioned during the interview. The proportion of subjects with either nasal or bronchial symptoms was higher among SM-sensitized individuals than in nonatopic individuals. The proportion of symptomatic subjects tended to be higher among individuals with HDM sensitization. The proportion of subjects with nasal symptoms was particularly high in individuals with both SM and HDM sensitizations. The proportion of symptomatic subjects in the group with exclusive SM sensitization was lower (Table 3).

Discussion

In the present study, nearly one-fourth (95% CI 20.6–28.2) of the general adult population showed sensitization

Table 2. Characteristics of subjects with and without SM sensitization

	SM-positive (n = 104)	SM-negative (n = 365)
Age (years)	40.0 (36.9–43.3)	53.7 (52.5–54.8)
Male gender	44.1% (34.3–53.8)	43.4% (34.4–48.5)
Educational level		
No studies	7.9% (4.4–14.0)	12.2% (9.5–15.6)
Elementary	55.0% (45.9–63.8)	66.6% (61.7–71.1)
Secondary	21.6% (14.5–30.1)	17.3% (13.9–21.4)
University	15.5% (9.5–24.2)	3.9% (2.3–6.5)
Farming occupation	17.3% (10.6–24.0)	30.1% (25.9–34.3)
Smoking habit	33.1% (23.9–42.3)	21.1% (17.0–25.2)
Housing conditions		
Rural setting	70.1% (61.0–79.1)	75.3% (70.8–79.8)
Grain storage facilities	60.1% (50.5–68.7)	62.7% (57.8–67.6)
Presence of livestock	69.5% (60.4–78.5)	72.6% (68.1–77.2)
High indoor humidity	45.0% (35.6–54.5)	43.5% (38.4–48.6)
Presence of pets	76.7% (68.6–84.8)	73.5% (68.9–78.1)

Figures are weighted values (mean or percentages), with 95% confidence intervals within parentheses.

Table 3. History of nasal and bronchial symptoms in relation to allergic sensitization

Variable	Non-atopics ¹ (n = 348)	SPT-positive ² (n = 121)	SM-positive ³ (n = 104)	HDM-positive ⁴ (n = 61)	Exclusively SM-positive ⁵ (n = 49)	SM and HDM-positive ⁶ (n = 55)
Nasal symptoms ^a	26.1% (21.4–30.8)	46.7% (37.7–55.7)	50.4% (40.7–60.2)	56.6% (44.1–69.1)	31.4% (26.9–35.9)	62.3% (49.4–75.1)
Bronchial symptoms ^b	26.6% (22.0–31.2)	39.7% (31.0–48.5)	40.7% (31.3–50.2)	48.5% (35.9–61.1)	30.0% (25.6–34.4)	47.4% (34.1–60.7)

Figures are weighted percentages, with 95% confidence intervals within parenthesis.

¹ Subjects with negative SPT. ² Subjects with positive SPT against any of the 13 allergens tested. ³ Subjects with positive SPT against storage mites (*T. putrescentiae* or *L. destructor*), with or without house dust mite sensitization. ⁴ Subjects with positive SPT against house dust mites (*D. pteronyssinus*), with or without storage mite sensitization.

⁵ Subjects with positive SPT against storage mites and negative SPT against house dust mites. ⁶ Subjects with positive SPT against both house dust mites and storage mites.

^a Presence of sneezing, a runny or a blocked nose in absence of a cold or the flu. ^b Presence of wheezing or whistling in the chest at any time in the past.

to SM (*T. putrescentiae* and/or *L. destructor*). Such prevalence is, to our knowledge, the highest ever reported even if studies of occupational exposure are considered. In farming populations, the prevalence of sensitization to SM varies from 5% (21) to 12% (22). To our knowledge, the present study is the first to evaluate the prevalence of sensitization to SM in an adult general population without limits of age. In an urban population aged 20–44 years from Iceland, Gislason and Gislason found a 6.3% prevalence of sensitization to *L. destructor* (23). In the same study, however, wheals equal or higher than 1 mm in SPT were considered indicative of sensitization (23). Using this criterion, the prevalence of SM sensitization in adult subjects aged 18–92 years from our region would be even higher. Sensitization to SM was more prevalent than sensitization to HDM (*D. pteronyssinus*), traditionally considered the main allergen in the region (24).

SPT reactivity to SM can represent either true positivity or false positivity. False SPT positivity to SM due to cross-reactivity with HDM may exist (25). However, it should be noted that a significant proportion of subjects showed positive SPT to SM together with negative SPT to HDM. Recently, the usual ≥ 3 mm criterion for positive SPT has been questioned for *T. putrescentiae* due to the high rate of false-positive results using serum specific IgE as the standard (26). SPT specificity increases when the threshold criterion is put on 4.5 mm (26), which is close to the ≥ 4 mm criterion followed in the present study. True-positive SPT to SM would represent exposure and sensitization. SM exposure is probably common in the studied area. *Lepidoglyphus destructor* and *T. putrescentiae* were found in 46 and 33%, respectively, of house dust samples from 76 HDM-allergic patients from the same and neighbouring areas (unpublished observation). Prevalence studies of mite presence in house dust samples from the general population are lacking in the area. It is noteworthy that, unlike in previous studies (11, 12), no relationship was found between SM sensitization and factors that theoretically could favour the growth and/or exposure to SM such as damp housing conditions, rural environment, farming and presence of livestock or presence of grain storage facilities in/near home. Probably, SMs are so widespread in the studied area that most of the

population can be exposed to SM throughout their life. In this sense, the limitations of cross-sectional studies should be taken into account, as exposure to relevant factors may have occurred years before (temporal ambiguity bias). Univariate analysis revealed that high educational level, smoking and, paradoxically, nonfarming occupation were associated with SM sensitization. However, these associations were spurious due to the confounding effect of age, which was the only factor significantly associated with SM sensitization on multivariate analysis. Stratification of random sampling by decades of age offered a broad view of time-course changes of allergic sensitization and, as expected, the prevalence of SM sensitization decreased with age. Subjects aged 18–29 years showed the highest prevalence of SM sensitization (higher than 50%), but even 8.5% of subjects older than 80 years showed SM sensitization. The overall prevalence of SPT positivity could be overestimated if the presence of allergic symptoms had favoured the participation. However, the overall prevalence of SPT positivity was similar to that previously reported in other regions of Spain (27), and this potential bias would not explain the high relative proportion of subjects sensitized to SM.

Patients with SM sensitization showed a high rate of clinical symptoms, but these results should be interpreted with caution. The temporal ambiguity bias and the prevalence-incidence bias associated with a cross-sectional design can be particularly prominent in this aspect, as the questions about clinical manifestations explored the presence of bronchial or nasal symptoms throughout the entire life. In addition, similar symptoms can be related to allergic disease or not. In fact, subjects with no allergic sensitization reported symptoms in a high proportion of cases. The proportion of subjects with symptoms was higher among subjects sensitized HDM and, in the case of nasal symptoms, particularly higher among subjects with both SM and HDM sensitizations. Altogether, these results suggest that SM sensitization may be of clinical importance, but probably of lesser importance than HDM sensitization. It is difficult, however, to separate the relative effect of SM and HDM sensitization, as most subjects (90%) with HDM sensitization also had SM sensitization.

The profile of aeroallergen sensitization in a given region has obvious diagnostic and therapeutic implications. Storage mite (*T. putrescentiae* and *L. destructor*) should be considered as major aeroallergens even in subjects apparently nonexposed in our region and, perhaps, in other similar regions.

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