

Occupational risk factors for rhinitis in greenhouse flower and ornamental plant growers

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ABSTRACT

Background: The purpose of this study was to assess the relationships between rhinitis, exposure to workplace air contaminants, and occupational characteristics in greenhouse flower and ornamental plant (OP) growers.

Methods: A random sample of growers cultivating such crops and participating in the European Farmers' Study was selected for a cross-sectional assessment of (1) rhinitis in the last year, (2) sensitization to workplace allergens, and (3) occupation characteristics. Associations between variables were assessed through univariate and multivariate analyses.

Results: Thirty-nine greenhouse flower and OP growers participated in the study (mean, 48.6; SD, 10.2 years; 35 men). Rhinitis was reported by 12 (31%) of them and was significantly related to sensitization to workplace allergens (odds ratio [OR], 13.20; 95% confidence interval [CI], 2.59–67.23) and pesticide application by hand pump (OR, 12.50; 95% CI, 2.00–78.05). After adjustment for these variables rhinitis emerged as significantly related to number of hours worked inside the greenhouse per day (OR, 1.85; 95% CI, 1.05–3.23).

Conclusion: Rhinitis is often reported by greenhouse flower and OP growers and is related to sensitization to workplace allergens and pesticide application by hand pump. The disease shows a dose–response relationship with the number of hours spent inside the greenhouse per day, a finding supporting a causal link with greenhouse exposure.

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Key words: Farmer, flower, greenhouse, grower, hand pump, occupational, ornamental plant, pesticide, rhinitis, sensitization

Crop farming has been associated with nasal and respiratory symptoms^{1,2} related to exposure to a wide range of respiratory irritants and sensitizers, including pollens, molds, mites, organic dusts, endotoxin, and pesticides.² High prevalences of asthma have been reported for flower and ornamental plant (OP) growers,^{3,4} work inside a greenhouse being an additional risk factor.^{5–7} One-half of the growers cultivating these indoor crops show sensitization to flower allergens and/or workplace molds,^{5,8} and wheezing in this workforce is partly caused by occupational asthma related to this sensitization,^{5,9} a condition diagnosed in nearly one-tenth of the growers.⁵

Rhinitis has been reported occasionally in flower and OP handlers and growers.^{10–12} The prevalence of rhinitis in participants in the European Farmers' Study who cultivated these crops, however, was similar to that of the general population, despite a high asthma prevalence^{3,4}; and this finding weighs against the hypothesis of a common sensitization-mediated pathway for the appearance of rhinitis and asthma in these growers.^{9,13} Further assessments of the relationships between rhinitis, asthma, and workplace sensitization in flower and

OP growers require a focus on indoor workers. Therefore, because one-third of the participants in the European Farmers' Study cultivating these crops worked in greenhouses,^{3,5} they provided an appropriate group in which to examine the association between rhinitis and occupation-related immunologic and irritant factors.

METHODS

Design and Population

As part of the European Farmers' Study,¹⁴ we performed a cross-sectional study of greenhouse flower and OP growers that included the assessment of (1) rhinitis, (2) sensitization to workplace allergens, and (3) occupation-related risk factors for rhinitis. Enrollment details of the random sample of European participants (response rate, 85.3%) have been reported elsewhere.³ Greenhouse flower and OP cultivation was the occupation of 85 growers participating in that study, and we defined a regional subsample of these crop farmers, consisting of all Spanish crop farmers, growing these crops indoors (73, 85.9%).⁵ Thirty-nine randomly selected growers from this subsample agreed to participate in the present study, which was approved by the regional ethics committee.

Measurements

A questionnaire with items on age, gender, smoking habits, and occupation details was used. The instrument included a question on rhinitis in the last year (Have you had any nasal allergy, including hay fever, in the last 12 months?), adapted from the questionnaire used in the European Respiratory Health Survey,⁴ as well as questions on the flowers and OPs cultivated, the number of hours working inside the greenhouse and storage area every day, and the frequency of pesticide use and its application system. Methods followed for

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Table 1 Baseline characteristics (*n* = 39)

Patient characteristics	
Age (yr), mean (SD)	48.6 (10.2)
Gender (women), <i>n</i> (%)	4 (10.3)
Current smoking, <i>n</i> (%)	10 (25.6)
Lung function	
FEV ₁ %, m (SD)	97.6 (14.2)
FVC%, m (SD)	89.5 (11.6)
Sensitization to aeroallergens, <i>n</i> (%)	18 (46.2)
Sensitization to environmental aeroallergens, <i>n</i> (%)	16 (41.0)
Sensitization to workplace aeroallergens, <i>n</i> (%)	14 (35.9)
Flowers, <i>n</i> (%)	8 (20.5)
Molds, <i>n</i> (%)	7 (17.9)
Spider mite, <i>n</i> (%)	2 (5.1)
Rhinitis in the last year, <i>n</i> (%)	12 (30.8)
With asthma in the last year, <i>n</i> (%)	3 (7.7)
Occupation	
Cultivation of flowers, <i>n</i> (%)	25 (64.1)
Cultivation of ornamental plants, <i>n</i> (%)	14 (35.9)
Indoor work (hr/day), m (SD)	9.3 (1.6)
Inside greenhouse (hr/day), m (SD)	4.4 (2.4)
Inside storage area (hr/day), m (SD)	4.9 (2.6)
Use of pesticides inside the greenhouse	
Once per week or more, <i>n</i> (%)	30 (77.9)
Application by hand pump, <i>n</i> (%)	8 (20.5)
Greenhouse air contaminants*	
Area (m ²)	1040 (338–1848)
Temperature (°C)	24 (18–17)
Relative humidity (%)	56 (46–64)
CO ₂ (ppm)	500 (400–600)
Air velocity (m/s)	0.31 (0.18–0.51)
Total dust (mg/m ³)	0.09 (0.08–0.21)
Endotoxin in total dust (ng/m ³)	0.32 (0.17–0.89)
Molds (CFU/m ³)	5000 (1700–11000)
Bacteria (CFU/m ³)	2300 (770–5200)

*Results are expressed as median (interquartile range).

FEV₁ = forced expiratory volume in the 1st second; FVC = forced vital capacity.

skin testing, lung function testing, and field measurements in the study have been reported elsewhere.^{5,15} In brief, sensitization to common allergens was defined by at least one wheal ≥ 3 mm from eight tested allergens (*Dermatophagoides farinae* and *D. pteronyssinus*, mixed trees, grasses, *Parietaria officinalis*, and cat and dog hair). Sensitization to workplace allergens was defined as a positive reaction to extracts from specific greenhouse allergens: flowers (*Gladiolus* sp., *Hyacinthus orientalis*, *Narcissus pseudonarcissus*, *Solidago canadensis*, *Chrysanthemum leucanthemum*, and *Helianthus annuus*), molds (*Alternaria alternata*, *Aspergillus* sp., *Cladosporium herbarum*, and *Penicillium* sp.), and *Tetranychus urticae* (Leti S.A., Barcelona, Spain; Stallergènes, Antony, France). Exposure to total dust, endotoxin in total dust, and microorganisms inside the greenhouse were measured by a personal sampler at the worker's breathing zone during daily work.

Statistical Analysis

All data were analyzed using the SPSS statistical software package (SPSS, Inc., Chicago, IL). Results were expressed as absolute and relative frequencies for categorical variables and as means and standard deviations (SDs) or as medians and interquartile ranges, as appropriate, for continuous variables. For measures showing a result below the detection limit, we recorded a value of one-half the lower detection limit. Rhinitis in the last year was considered the dependent variable. Age, gender, current smoking, crop (flowers or OPs), sensitization to common and workplace allergens, frequency of pesticide use (categorized as less than weekly or weekly), application of pesticides by hand pump, and hours working inside the greenhouse and storage area daily were considered independent variables. Logistic regression modeling was used to as-

Table 2 Occupation-related risk factors for rhinitis ($n = 39$)

	Rhinitis in the Last Year		Crude OR (95% CI)	p	Adjusted OR (95% CI)	p
	Absent	Present				
n	27	12	—	—	—	—
Subject characteristics						
Age, mean (SD)	48.9 (11.1)	47.8 (8.1)	0.99 (0.92–1.06)	>0.25	—	—
Gender (women), n (%)	2 (7.4)	2 (16.7)	2.50 (0.31–20.27)	>0.25	—	—
Current smoking, n (%)	8 (29.6)	2 (16.7)	0.47 (0.08–2.67)	>0.25	—	—
Sensitization workplace aeroallergens, n (%)	5 (18.5)	9 (75.0)	13.20 (2.59–67.23)	0.002	—	—
Pesticide use						
Once per week or more, n (%)	20 (74.1)	10 (83.3)	1.75 (0.31–10.02)	>0.25	—	—
Application by hand pump, n (%)	2 (7.4)	6 (50.0)	12.50 (2.00–78.05)	0.007	—	—
Occupation characteristics						
Cultivation of flowers, n (%)	16 (59.3)	9 (75.0)	2.06 (0.45–9.39)	>0.25	—	—
Cultivation of ornamental plants, n (%)	11 (40.7)	3 (25.0)	0.48 (0.11–2.21)	>0.25	—	—
Indoor work (hr/day), m (SD)	9.4 (1.8)	9.0 (0.9)	0.84 (0.54–1.31)	>0.25	—	—
Greenhouse work (hr/day), m (SD)*	4.0 (2.3)	5.2 (2.6)	1.22 (0.91–1.64)	0.17	1.85 (1.05–3.23)	0.03
Storage area (hr/day), m (SD)*	5.4 (2.4)	3.8 (2.6)	0.77 (0.57–1.04)	0.08	0.49 (0.25–0.96)	0.04

*Greenhouse work and storage area work adjusted for sensitization to workplace allergens and application of pesticides by hand pump in independent models. OR = odds ratio.

sess of associations between rhinitis and subject and occupation characteristics, expressing the results of these analyses as crude and adjusted odds ratios (ORs), with 95% confidence intervals (CIs). Variables showing an association with the dependent variable ($p < 0.25$) in the univariate analysis were included in subsequent multivariate analysis. All statistical tests were two-tailed, and a value of $p \leq 0.05$ was reported as statistically significant.

RESULTS

Rhinitis in the last year was reported by 12 of the 39 (30.8%) growers, 11 of them sensitized to aeroallergens. Workplace flower, mold, and/or mite sensitization was identified in 9 of the 12 growers reporting nasal symptoms, 3 of them with asthma. Pesticides were used more than once per week by most of the studied subjects, and almost a one-quarter of them used a hand pump for its application (Table 1). Participating growers cultivated 5–10 different plants, changing species seasonally. *Gladiolus* sp., *Chrysanthemum* sp., *Dianthus* sp., *Gerbera jameisonii*, *Rose* sp., and *Geranium* sp. were the most commonly cultivated crops.

Rhinitis was significantly related to sensitization to workplace allergens (OR, 13.20; 95% CI, 2.59–67.23) and pesticide application by hand pump (OR, 12.50; 95% CI, 2.00–78.05). After adjustment for these variables, rhinitis was also significantly associated with the number of hours worked inside the greenhouse per day (OR, 1.85; 95% CI, 1.05–3.23; Table 2).

DISCUSSION

The present study confirmed that rhinitis is often reported by greenhouse flower and OP growers and identified that sensitization to workplace allergens, use of hand pumps for pesticide application, and daily duration of work inside the greenhouse are important risk factors for the disease. The European Farmers' Study reported an unexpectedly high prevalence of respiratory symptoms in flower and OP growers, mainly related to the indoor work required for greenhouse cultivation.^{3,6} Our study on growers selected because they currently worked inside greenhouses additionally indicates that up to one-third of flower and OP growers report nasal symptoms, confirming the high prevalence of rhinitis in this subpopulation. Rhinitis was significantly associated with sensitization to workplace allergens and pesticide application using a hand pump, observations confirming that workplace sensitization to pollens, molds, and/or mites is a main cause of nasal disease in these growers, indoor exposure to pesticides during manual application being an additional cause. Direct exposure to pesticides when using a hand pump for application may cause symptoms through irritant or other mechanisms, having an effect on both sensitized and nonsensitized cultivators.

Rhinitis was significantly related to the number of hours per day spent inside the greenhouse, after adjustment for workplace sensitization and pesticide application by hand. The higher frequency of nasal symptoms in growers with longer work shifts in a greenhouse points to a dose-response

relationship and supports the causal hypothesis for this type of indoor work, because disease is mediated by higher cumulative exposures to both pesticides and sensitizing allergens.

In summary, rhinitis is a common disease in greenhouse flower and OP growers and symptoms are more often reported by growers sensitized to workplace allergens and/or exposed to indoor pesticides, a finding suggesting that occupational rhinitis develops in these growers through more than one pathway. Risk increases for growers working more hours inside the greenhouse, an observation suggesting that the duration of work in this indoor environment should be reduced when workplace sensitization is identified, and pesticide application through hand pumps avoided in growers cultivating these indoor crops.

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