
Impact of occupational and inhalant allergy on rhinitis-specific quality of life in employees of bell pepper greenhouses in the Netherlands

Giséle C. M. Groenewoud, MD, PhD*†; Hans de Groot, MD, PhD*; and Roy Gerth van Wijk, MD, PhD*

Background: Rhinitis symptoms among bell pepper greenhouse employees can be caused by an allergy to occupational allergens, such as bell pepper pollen and predatory mites, and common inhalant allergens.

Objectives: To estimate the effect of sensitization to these allergens on rhinitis-specific quality of life (QoL) during and outside the flowering period and to evaluate whether the QoL of sensitized employees is comparable with that of chrysanthemum greenhouse employees with rhinitis and an average population sample with perennial rhinitis.

Methods: We invited 233 employees with rhinitis symptoms to complete 2 rhinitis QoL questionnaires and to undergo skin prick testing with common inhalant allergens and occupational allergen extracts. Multiple regression analysis was used to estimate the impact of sensitization to the various allergens on QoL.

Results: Sensitization to bell pepper pollen had a significant negative effect on all the domain and mean QoL scores. The other allergens had no effect on QoL. A significant decrease in all the rhinitis scores was found outside the flowering period. There were no relevant differences in the mean scores of the different domains for both occupational groups. Greenhouse employees scored higher on limitations in activities and much lower on emotional, sleeping, and practical problems compared with individuals with perennial rhinitis.

Conclusions: Bell pepper greenhouse employees are impaired in QoL because of their sensitization to bell pepper pollen, suggesting that bell pepper pollen is the most important occupational allergen in greenhouse workers with allergic symptoms. A common allergy does not have more impact on a person's day-to-day life than an occupational allergy; however, there is a clear difference in the way in which an occupational group is hampered compared with a nonoccupational group.

Ann Allergy Asthma Immunol. 2006;96:92–97.

INTRODUCTION

In the past decade, the economic and social impact of chronic respiratory diseases in industrialized countries has become a topic of interest, especially because of their long-term effect on the quality of life (QoL) of affected individuals. However, this does not include only asthma and chronic obstructive pulmonary diseases but also allergic rhinitis, a rather frequent and persistent condition. Individuals with allergic rhinitis experience their complaints as troublesome and, consequently, consider their QoL to be diminished compared with healthy individuals.^{1,2} Allergic complaints, especially rhinitis, are a major health problem in bell pepper horticulture. The high prevalence of allergic symptoms in employees is not only caused by common inhalant allergens, such as house dust mite or tree pollen, but mainly by occupational allergens (53.8%). The pollen of the bell pepper plant and the predatory mite *Amblyseius cucumeris*, used for biological control, seemed to be the most important offending agents.^{3,4} Employ-

ees with rhinitis not only experience nasal symptoms, such as sneezing, itchiness, rhinorrhea, and blockage, after exposure but are also confronted with problems such as whether to continue in their current job or to leave and retrain for a new job or to sell their greenhouse. These kinds of changes in lifestyle might also have an impact on QoL. Malo et al⁵ evaluated the QoL of patients with occupational asthma. However, the influence of occupational rhinitis in a large population-based sample of employees on QoL in general has not yet been the subject of research. In this study, we investigate the possible effect of occupational allergic rhinitis on the QoL of employees in bell pepper greenhouses in the western part of the Netherlands. Apart from our interest in the effects of occupational allergy on QoL, evaluation of rhinitis using a disease-specific QoL questionnaire provided us with a method tested and accepted in terms of reliability, responsiveness, and validity,⁶ whereas other outcome measures to evaluate the severity of rhinitis, such as daily symptom scores and visual analog scales and objective measures of nasal airway resistance, are neither standardized nor generally accepted.⁷

The aim of this study was to answer the following questions. First, what is the relative influence of sensitization to bell pepper pollen, predatory mite *A cucumeris*, or common inhalant allergens on the QoL of employees with rhinitis?

* Department of Allergology, Erasmus Medical Center, Rotterdam, the Netherlands.

† Department of Internal Medicine, Erasmus Medical Center, Rotterdam, the Netherlands.

Received for publication December 9, 2004.

Accepted for publication in revised form June 13, 2005.

Second, does the QoL of the involved employees increase when the bell pepper plants are not in blossom? Third, is the QoL of symptomatic greenhouse employees of different crops comparable with each other. Our research group performed a cross-sectional study in 20 Dutch chrysanthemum greenhouses comprising 104 employees to investigate the prevalence and determinants of work-related allergic symptoms.⁸ Of the 95 employees who completed the Rhinitis Quality of Life Questionnaire (RQLQ) correctly, 44 had rhinitis symptoms. Because QoL was measured by using the same RQLQs as described later herein, data from both groups could easily be compared. Fourth, is the QoL of greenhouse employees with rhinitis comparable with the QoL of a large population-based sample of individuals with perennial rhinitis? This kind of research has never been performed in the Netherlands. In France, however, an extensive survey specifically designed to explore QoL in a large population-based sample of people with perennial rhinitis was performed in 1995.² For this reason, our research data were compared with the results of this French study.

MATERIALS AND METHODS

Study Design

Employees participated in a large cross-sectional study to estimate the prevalence and determinants of work-related allergic symptoms in bell pepper horticulture. Bell pepper greenhouses in the western part of the Netherlands were approached at random by telephone and were asked to participate. The investigators made 3 visits to each participating greenhouse. The first 2 visits took place between March and August 1999, when the bell pepper plants were in full blossom and biological control was provided; the last visit occurred in December 1999 or January 2000, when the bell pepper plants had been removed from the greenhouses. In this period, the employees are not likely to be exposed to bell pepper pollen and predatory mites. During the first visit, the employees were asked about their age, sex, medication use, smoking habit, work history, work-related symptoms, and atopic complaints. Furthermore, they completed an RQLQ. During the first and second visits, the use of antihistamines orally was not permitted, apart from acrivastine (8 mg) as rescue medication. Acrivastine also had to be withdrawn 3 days before the skin prick test. Two weeks after the first visit the participants underwent skin prick tests with common inhalant allergens and several occupational allergens. During the third visit, the employees completed a second RQLQ. All the employees from the greenhouses included in the study participated. Only employees without a thorough command of the Dutch language were excluded from completing the RQLQ. This study was approved by the medical ethical committee of Erasmus Medical Center. All the employees gave written informed consent, and confidentiality was maintained.

Skin Prick Tests

The skin prick tests were performed by applying 1 drop of allergenic extract to the skin of the volar side of the forearm. Subsequently, the dermis was punctured using a standardized skin test needle, and the results were read after 20 minutes. Reactions are expressed in millimeters of mean wheal diameter (adding the longest diameter to the orthogonal diameter and dividing by 2). A diameter of 3 mm or more was considered positive.⁹ Dilution buffer was used as a negative control, and histamine chloride, 10 mg/mL, was used as a positive control. The skin prick tests were performed using *Botrytis cinerea* as one of the molds found in greenhouses and 6 common inhalant allergens from ALK Abelló, Nieuwegein, the Netherlands: *Dermatophagoides pteronyssinus*, tree mix, grass mix, mugwort, dog dander, and cat dander. In addition, skin prick tests were performed using a homemade extract of the leaf, stem, pollen, stamen, and juice of the bell pepper plant and a homemade extract of the predatory mite *A cucumeris*.^{3,4}

Rhinitis Quality of Life Questionnaire

Quality of life was measured using the approved Dutch translation of the RQLQ developed by Juniper and Guyatt.^{6,10} This questionnaire more precisely describes the effect of rhinitis on different areas of the employees' day-to-day lives. It comprises 28 questions subdivided into the following domains: activities (n = 3), sleep (n = 3), nonrhinitis symptoms (n = 7), practical problems (n = 3), nasal symptoms (n = 4), eye symptoms (n = 4), and emotional problems (n = 4). In each item, participants were asked how much they were troubled by their nasal symptoms during the previous 2 weeks. Scores ranged from 0 (not troubled) to 6 (extremely troubled). For the items concerning activities, the employees were asked to identify activities that are limited because of their nasal symptoms. If more than 3 activities were identified, employees were asked to choose the 3 most significant. To ensure that all possible relevant items were considered, a list of 29 probe activities was provided as well. The investigators instructed the employees according to the guidelines defined by the designers of the questionnaire. All the employees completed their questionnaires in the canteen of the greenhouse in the presence of the investigators. In the analysis, the mean within-employee score of each QoL domain was used (these mean domain scores were measured by calculating the mean of the items within each domain). Furthermore, the total score of the means of the 7 domains was used to calculate the mean QoL score.

Statistical Analysis

To test for statistical significance of explanatory variables regarding the outcome variable (ie, rhinitis QoL), the method of multiple regression analysis was applied. Not only the (relative) importance of explanatory variables but also possible confounding can be simultaneously tested in the regression model; both were covariables in the model. In this study, age, sex, and smoking were considered to be confounding;

therefore, the importance of the explanatory variables was adjusted for age, sex, and smoking. The unstandardized regression coefficient of the covariable (B) indicates the importance of the covariable in the model, the corresponding SE is an estimate of sampling fluctuation, and the corresponding *P* value gives the significance level. To gain insight into the relative importance, the standardized regression coefficient (β) was estimated. The β enabled us to compare the importance of the covariables with each other. The height of the β number reflects the height of the QoL score. A 2-tailed *P* < .05 was considered statistically significant. The *t* test was used for paired and unpaired observations for purposes of comparison regarding the first and second RQLQs of bell pepper greenhouse employees, the RQLQs of bell pepper and chrysanthemum greenhouse employees, and the RQLQs of both greenhouse groups and the French population. The statistical analysis was executed using a computer package (SPSS 8.0; SPSS Inc, Chicago, IL).

RESULTS

Population Characteristics

Of 110 greenhouses contacted by telephone, 85 (77.3%) participated in the study. Reasons for refusal to participate were lack of time or lack of interest because of the absence of work-related symptoms, fear of losing (hard to find) employees with allergic complaints, and other individual reasons. The invited group of workers from 85 greenhouses comprised 487 employees, of which 472 participated (response rate, 96.9%). The greenhouses in the study together constitute 10% of all bell pepper horticulture in the Netherlands. Of 233 employees identified as having rhinitis by history,³ 209 were eligible for this study because of their knowledge of the Dutch language. This group was included for further research into rhinitis-related QoL.

Of the 209 employees with occupational rhinitis, 171 were males and 38 were females (mean [SD] age, 33.9 [10.5] years; range, 14.0–62.1 years); 28.2% were current smokers. The mean (SD) duration of employment was 8.3 (5.7) years (range, 0–31 years). Most employees (*n* = 166; 79.4%) noted substantial improvement in or complete regression of work-related symptoms on weekends and holidays. Complaints consisted of conjunctivitis in 115 employees (55.0%) and redness, itching, or eczema of the skin in 58 employees (27.8%). Asthmatic symptoms were mentioned by 54 employees (25.8%), and urticaria or angioedema was seen in only 30 employees (14.4%).

Skin Prick Tests

A positive skin prick test result to 1 of the common inhalant allergens was found in 124 employees (59.3%). Sensitization to house dust mite, grass pollen, and tree pollen were most prevalent and were found in 83 (39.7%), 73 (34.9%), and 45 (21.5%) employees, respectively. Ninety-nine employees (47.4%) seemed to be sensitized to the pollen of the plant, 71 (34.0%) to the predatory mite *A cucumeris*, and 153 (73.2%) to both occupational allergens. Positive skin reactions to the

leaf, stem, or juice of the plant were in most cases associated with sensitization to pollen or stamen, which also contains a certain amount of pollen.³

Rhinitis Quality of Life Questionnaires

Table 1 gives the mean (SD) QoL scores for all the domains and for the mean rhinitis QoL. The 3 activities selected most frequently by the employees in which they feel limited by their symptoms seemed to be work-related activities, bicycling, and sports.

Using multiple regression, we analyzed the effect of duration of employment and sensitization to the 3 most prevalent inhalant allergens (house dust mite, tree pollen, and grass pollen) and to the occupational allergens bell pepper pollen and predatory mite *A cucumeris* on the 7 domains of the RQLQ and on the mean QoL score. These 8 separate analyses were adjusted for age, sex, and smoking. Sensitization to bell pepper pollen had a significant negative effect on all 7 domain scores and on the mean rhinitis QoL score (*P* < .01 for both). Sensitization to tree pollen was significantly correlated only with practical problems (*P* = .01) and eye symptoms (*P* = .04), whereas sensitization to house dust mite had a significant negative effect only on nonrhinitis symptoms (*P* = .03). Figure 1 shows the relative impact of the different factors on mean rhinitis QoL expressed as the standardized regression coefficient (β). Duration of employment and sensitization to grass pollen and house dust mites had no significant effect on the different domain scores or on the mean rhinitis QoL score. The association between tree pollen sensitization and rhinitis QoL almost reached statistical significance (β = 0.14; *t* = 1.931; *P* = .06), whereas bell pepper sensitization had a major effect on QoL (β = 0.349; *t* = 4.49; *P* < .001). In contrast, the effect of sensitization to predatory mites was not significant as measured by the much lower β (β = 0.076; *t* = 1.054; *P* = .29).

The domain scores on the first RQLQ were compared with those on the second RQLQ (Fig 2). Both questionnaires were available from 161 employees. The other 48 employees were not present during the third visit to the greenhouses. We have no detailed information about the reasons for their absence. The possibility that employees with (severe) symptoms might have left the job cannot be excluded. A significant decrease in

Table 1. RQLQ Domain Scores Reported by 209 Greenhouse Employees at the Start of the Study

Domain	Score, mean (SD)
Activities	1.39 (1.22)
Sleep	0.67 (1.15)
Nonrhinitis symptoms	0.89 (1.06)
Practical problems	1.83 (1.67)
Nasal symptoms	2.02 (1.59)
Eye symptoms	1.10 (1.41)
Emotional problems	0.70 (1.02)
Mean quality of life	1.23 (1.05)

Abbreviation: RQLQ, Rhinitis Quality of Life Questionnaire.

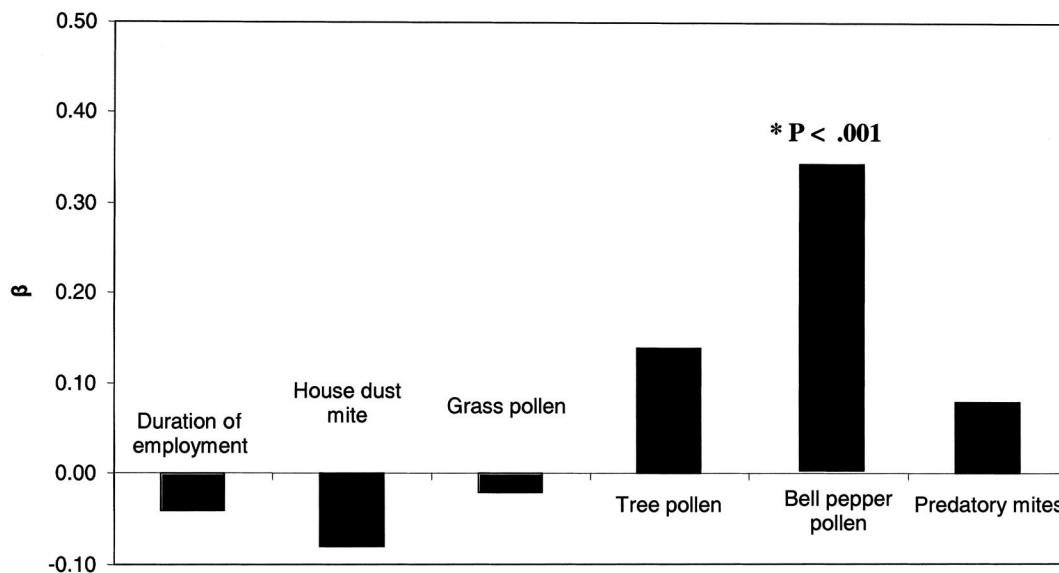


Figure 1. Standardized regression coefficients (β) representing the relative impact of factors on mean rhinitis quality-of-life scores.

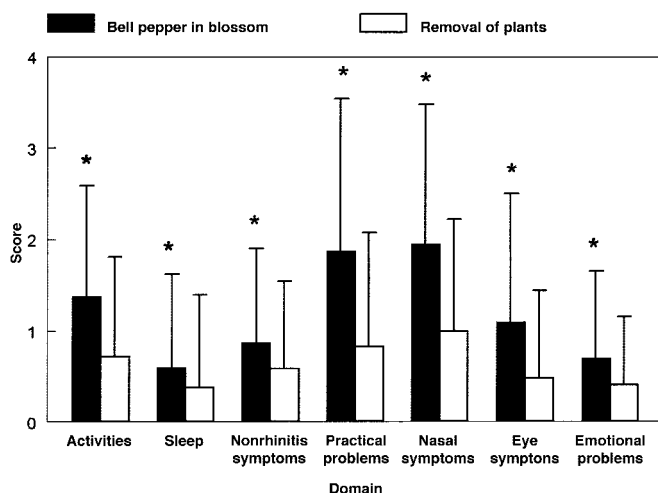


Figure 2. Mean Rhinitis Quality of Life Questionnaire domain scores at 2 occasions during the blossom period of bell pepper plants and after removal of the plants. Asterisks indicate statistical significance ($P < .05$). Error bars represent SD.

the rhinitis scores was found for all the QoL domains and for the mean rhinitis QoL score. This decrease was most pronounced for the practical problems, nasal symptoms, activities, and eye symptoms domains, with a magnitude of change in score of more than 0.5 (and >1.0 for practical problems).

However, the possibility of a seasonal effect on the decrease in rhinitis scores must be considered because the first visit took place between March and August, during the tree pollen season and the grass pollen and mugwort season. Therefore, a subgroup analysis was performed. The scores on the first and second RQLQs of 71 employees with rhinitis

symptoms and negative skin prick test reactions to tree pollen, grass pollen, mugwort, and house dust mite were compared. Once again, a significant decrease was found in the rhinitis scores for all the QoL domains ($P < .004$) and for the mean rhinitis QoL score ($P < .001$), excluding the possibility of common inhalant allergens being a confounder of the data.

The mean scores on the RQLQ of the 209 bell pepper workers were also compared with the mean scores of 44 chrysanthemum greenhouse workers with rhinitis. Although the employees of the bell pepper greenhouses had slightly higher scores on all the domains, no statistically significant differences were seen between the 2 groups except in the practical problems domain, in which bell pepper workers had a higher mean score.

In addition, the mean scores on the RQLQ of both greenhouse groups were compared with the mean scores of 1,094 patients with perennial rhinitis (Fig 3). These patients took part in a large-scale, nationwide, population-based survey in France to evaluate the impact of perennial rhinitis on QoL.² Our employees had obviously higher scores in the areas of nasal symptoms (bell pepper workers) and activities (both groups), whereas the score in emotional problems was lower compared with the French population. For the sleep and practical problems domains, the French patients had a much higher score, although the difference between the bell pepper and the French group was just less than 0.5 on a 7-point scale.

DISCUSSION

Individuals with rhinitis may have nasal symptoms that adversely affect their day-to-day lives. The main goal of this study was to estimate the impact of occupational and inhalant allergy on the QoL of bell pepper greenhouse employees. All rhinitis QoL domain and mean QoL scores were strongly and significantly associated with the extent of sensitization to bell

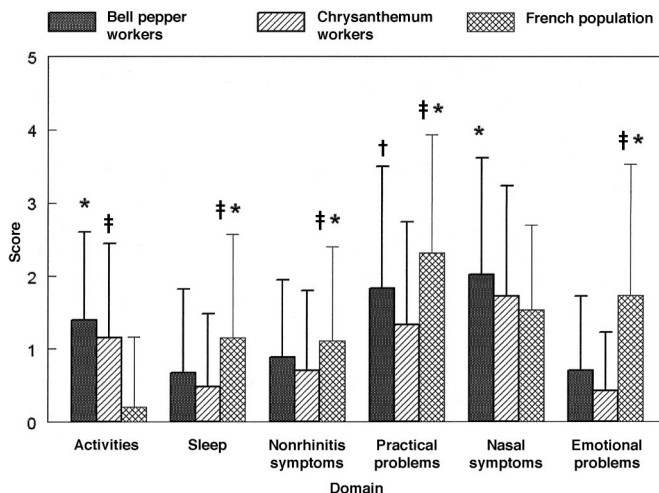


Figure 3. Mean Rhinitis Quality of Life Questionnaire domain scores for bell pepper greenhouse workers ($n = 209$), chrysanthemum greenhouse workers ($n = 44$), and a French population ($n = 1,094$). Asterisk indicates statistical significance ($P < .05$) between bell pepper greenhouse employees and the French population; dagger, statistical significance ($P < .05$) between bell pepper and chrysanthemum greenhouse employees; and double dagger, statistical significance ($P < .05$) between chrysanthemum greenhouse employees and the French population. Error bars represent SD.

pepper pollen. This association indicates that employees with rhinitis symptoms caused by an occupational allergy to bell pepper pollen are impaired in QoL. Furthermore, using multiple regression analysis, we demonstrated that the pollen of the bell pepper plant is a more important occupational allergen than the predatory mite. Although 109 employees (23.0%) are sensitized to this mite,⁴ in these analyses, sensitization to *A cucumeris* did not affect rhinitis-specific QoL at all. The reason might be that in terms of prevalence, bell pepper allergy outweighs allergy not only to predatory mites (35.4% vs 23.0%) but also of workers sensitized to *A cucumeris*; 73.4% seemed to be cosensitized to bell pepper allergens.^{3,4} Previously, we demonstrated that atopy, defined as skin reactivity to 1 or more inhalant allergens, is an independent risk factor for the presence of upper and lower airway symptoms.³ However, the present analysis of the importance of sensitization to inhalant allergens separately identifies a relatively small contribution of tree pollen only. In addition, sensitization to house dust mite, the most prevalent of all the common inhalant allergens, did not affect rhinitis-specific QoL, except for the nonrhinitis symptoms domain (probably a chance finding). There was no effect of duration of employment or of age on QoL in general; therefore, the so-called healthy worker effect, found previously,³ was not clearly present in this analysis.

Juniper et al⁶ demonstrated that the RQLQ is a useful instrument in clinical studies to detect within-subject changes across time. The significant improvement in all domain and mean scores of the RQLQ in December and January may be explained by the absence of exposure to bell pepper pollen.

The mean magnitude of the difference in the nasal symptoms, practical problems, activities, and eye symptoms domains between the 2 questionnaires varied from 0.62 to 1.04. These changes are considered to be clinically significant because changes of 0.5 on a 7-point scale represent the minimal important difference.¹¹ The minimal important difference can be defined as the smallest difference in score in the domain of interest that individuals perceive as beneficial and that would mandate a change in management. The change in score in the practical problems domain (>1.0) may be considered a moderate change in QoL.

Employees of bell pepper greenhouses were more impaired in practical problems compared with employees of chrysanthemum greenhouses. There were no other important differences between the mean scores of both occupational groups, although their rhinitis symptoms are caused by different occupational allergens. The symptomatic greenhouse employees of both groups recorded strikingly higher scores in the domains of nasal symptoms, practical problems, and activities than in the domains of sleep disorders, nonrhinitis symptoms, and emotional problems. This fits in the comparison with the French population study. The bell pepper employees showed a higher score in limitations of activities and in nasal symptoms, whereas chrysanthemum greenhouse workers scored higher in limitations of activities only. On the other hand, both groups scored significantly lower with respect to sleep disorders, practical problems, and, in particular, emotional problems. These results seem to be in contrast to each other. However, these results might be biased, first of all by transcultural differences. The perception of the degree of impairment caused by rhinitis symptoms might be different between Dutch and French people. Most important, greenhouse employees may not want to admit their impairment because of rhinitis symptoms as part of their professional attitude. Personal contact with employees confirmed that in this occupational field, one does not easily complain or seek medical attention unless the daily symptoms are severe or prevent one from performing his or her job in a proper way. Financial insecurity caused by the necessity to retrain for another job, to change the crop, or perhaps to sell the greenhouse may be partly responsible for this attitude.

Social desirability has long been viewed as a potential source of error variance in self-report measures. It has been suggested that social desirability masking effects can significantly increase the likelihood of type II errors in sports medicine research that involves self-report measures.¹² We cannot exclude that such masking effects are involved when studying occupational allergy. Underestimation of the number and severity of rhinitis symptoms and, therefore, more impairment in QoL is very well possible. The RQLQ and other self-report measures, such as visual analog scales and daily symptom scores, will not identify this kind of bias. Identification and exclusion of individuals with high social desirability response set scores are required to minimize this effect.¹²

A second possibility for bias might have been the difference in the method of measurement. The greenhouse employees completed their questionnaires in the presence of the investigators, whereas the French population received their questionnaires by mail and were asked to return them after completion. This more anonymous method of measurement might encourage especially individuals who experience their symptoms as an emotional burden to complete and return the questionnaire. The potential bias of selecting volunteers was not present in this study because all employees from the participating greenhouses having sufficient knowledge of the Dutch language were included.

Taking these restrictions into account, we conclude that bell pepper greenhouse employees with rhinitis are impaired in QoL because of their sensitization to bell pepper pollen, whereas concomitant allergies to predatory mites or common inhalant allergens do not affect rhinitis QoL substantially. These findings suggest that bell pepper pollen is the most important occupational allergen in bell pepper greenhouse workers with allergic symptoms. The QoL of these employees is comparable with that of chrysanthemum greenhouse employees with nasal symptoms. This may suggest that in horticulture, the kind of causative occupational allergen does not have a substantial effect on the impact of an occupational allergy on a person's daily life. Furthermore, a common allergy does not have more impact on a person's day-to-day life than an occupational allergy; however, there is a clear difference in the way in which an occupational group is hampered in daily life compared with a nonoccupational group. The results of this study underline the importance of QoL measures in occupational settings. Considering the health care of this important branch of horticulture, further studies are required to evaluate the impact of reducing pollen exposure levels in the work environment and individual management of employees with severe symptoms.

ACKNOWLEDGMENTS

We thank N. W. de Jong, research analyst, and A. J. van Oorschot-van Nes, research nurse, for their valuable contribution to this study.

REFERENCES

1. de Graaf-in 't Veld T, Koenders S, Garrelds IM, Gerth van Wijk R. The relationships between nasal hyperreactivity, quality of

- life, and nasal symptoms in patients with perennial allergic rhinitis. *J Allergy Clin Immunol.* 1996;98:508–513.
2. Pariente PD, Le Pen C, Los F, Bousquet J. Quality-of-life outcomes and the use of antihistamines in a French national population-based sample of patients with perennial rhinitis. *Pharmacoeconomics.* 1997;12:585–595.
3. Groenewoud GC, de Jong NW, van Oorschot-Van Nes AJ, et al. Prevalence of occupational allergy to bell pepper pollen in greenhouses in the Netherlands. *Clin Exp Allergy.* 2002;32:434–440.
4. Groenewoud GCM, de Graaf-in 't Veld C, van Oorschot-van Nes AJ, et al. Prevalence of sensitisation to the predatory mite *Amblyseius cucumeris* as a new occupational allergen in horticulture. *Allergy.* 2002;57:614–619.
5. Malo JL, Boulet LP, De witte JD, et al. Quality of life of subjects with occupational asthma. *J Allergy Clin Immunol.* 1993;91:1121–1127.
6. Juniper EF, Guyatt GH. Development and testing of a new measure of health status for clinical trials in rhinoconjunctivitis. *Clin Exp Allergy.* 1991;21:77–83.
7. Bousquet J, Van Cauwenberge P, Khaltaev N. Allergic rhinitis and its impact on asthma. *J Allergy Clin Immunol.* 2001;108:S147–S334.
8. Groenewoud GCM, de Jong NW, Burdorf A, et al. Prevalence of occupational allergy to Chrysanthemum pollen in greenhouses in the Netherlands. *Allergy.* 2002;57:835–840.
9. Dreborg S, Frew A. Allergen standardization and skin tests. *Allergy.* 1993;48:49–75.
10. Juniper EF. Impact of upper respiratory allergic diseases on quality of life. *J Allergy Clin Immunol.* 1998;101:S386–S391.
11. Juniper EF, Guyatt GH, Willan A, Griffith LE. Determining a minimal important change in a disease-specific Quality of Life Questionnaire. *J Clin Epidemiol.* 1994;47:81–87.
12. Wiechman SA, Smith RE, Smoll FL, Ptacek JT. Masking effects of social desirability response set on relations between psychosocial factors and sport injuries: a methodological note. *J Sci Med Sport.* 2000;3:194–202.

Requests for reprints should be addressed to:

Giséle Groenewoud, MD, PhD

Department of Allergology

Erasmus Medical Center

PO Box 2040

3000 CA Rotterdam, the Netherlands

E-mail: g.groenewoud@erasmusmc.nl