

Occupational rhinitis in bell pepper greenhouse workers: determinants of leaving work and the effects of subsequent allergen avoidance on health-related quality of life

R. Gerth van Wijk¹, J. A. Patiwaal¹, N. W. de Jong¹, H. de Groot² & A. Burdorf³

¹Department of Allergology, Erasmus MC, Rotterdam; ²Department of Pediatric Allergology, Reinier de Graaf Group, Delft; ³Department of Public Health, Erasmus MC, Rotterdam, the Netherlands

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Correspondence

R. Gerth van Wijk, MD, PhD, Department of Internal Medicine, Section of Allergology, Erasmus MC, PO Box 2040, 3000 CA Rotterdam, the Netherlands.
Tel.: +31 107033981
Fax: +31 107034081
E-mail: r.gerthvanwijk@erasmusmc.nl

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Abstract

Background: Avoidance of occupational allergens or reduction in exposure has been advocated as the mainstay of the management of occupational rhinitis. Sparse data to the effect of allergen avoidance are available.

Objective: To identify factors that may lead to leaving work and to address the effect of subsequent allergen avoidance on quality of life.

Methods: A survey to the prevalence of occupational allergy to bell pepper performed in 1999 comprised 472 employees, of which 254 had work-related rhinitis and 228 completed the Rhinitis-related Quality of Life Questionnaire. After 8-year follow-up in 2007, 91 workers with rhinitis in 1999 were available to fill out the questionnaire again and were used to evaluate the course of nasal disease in terms of perceived severity and impact on daily life.

Results: Workers with rhinitis at baseline were more likely to leave their job in bell pepper cultivation for another job (OR = 1.62, 95% CI 0.95–2.75). Among the 91 workers, 58 subjects were still at work, whereas 33 subjects had left work. The subjects who left jobs reported substantial improvement in quality of life. The magnitude of the changes ranged from –0.31 to –1. The effect of quitting work on the mean quality of life score amounted -0.76 ± 0.15 .

Conclusions: The current study is the first large longitudinal studies showing that leaving work and subsequent occupational allergen avoidance have a beneficial effect on rhinitis-related quality of life. The study suggests that occupational rhinitis can be a reason to leave work.

Occupational rhinitis is a disease of emerging relevance which has received little attention in comparison with occupational asthma (1). The epidemiology of occupational rhinitis has been investigated less extensively, mainly because it is not considered such a serious disease (2). Position papers focusing on occupational rhinitis became quite recently available (1). Although underestimated, the prevalence of occupational rhinitis appears to be high. It has been suggested that the prevalence is 2–4 times higher compared to occupational asthma (2). This is in line with previous studies performed in bell pepper greenhouses, showing that 49% of the workforce experiences work-related upper airway symptoms, whereas 13% reports symptoms suggestive for work-related asthma (3).

Reduction in exposure to occupational allergens or avoidance has been advocated as the mainstay of the management of occupational rhinitis (1). Sparse data to the effect of allergen avoidance on occupational rhinitis are available. In some specific occupations, information is available on the effect of reduction in allergen exposure. Helmet respirators are effective (4) in natural rubber latex (NRL) allergy but not always feasible. A previous study in bell pepper greenhouses suggests that introduction of honey bees into these greenhouses may reduce exposure to bell pepper pollen resulting into a decrease in nasal symptoms (5). Apart from these measures in the work place, complete avoidance by quitting work has not been the topic of many studies. Three longitudinal studies report

reduction of rhinitis symptoms in patients with natural rubber latex allergy after lowering or cessation of exposure (6–8). Other studies suggesting a favorable effect of leaving work on rhinitis are cross sectional (9, 10) or retrospective (11, 12).

To address the effects of leaving work on rhinitis, we examined follow-up data from a cohort of bell pepper greenhouse workers studied in 1999 (3) and in 2007. The cross-sectional survey in 1999 among 472 employees from 85 greenhouses – nearly 10% of the national bell pepper work force at that time – showed that work-related allergic symptoms were found in 54% of workers (3). Further analysis demonstrated sensitization to the bell pepper plant in 35% of workers, whereas 23% was sensitized to predatory mites that were used as a biologic control of the crops (13). Determinants associated with work-related symptoms among bell pepper employees were presence of sensitization to substances of the bell pepper plant (bell pepper pollen being the most important), age, and atopy (3).

In the baseline survey, we demonstrated that rhinitis-related quality of life was mainly determined by sensitization to bell pepper pollen and not to concomitant common inhalant allergies (14). Eight years later in 2007, a follow-up study was performed to estimate the incidence of rhinitis, asthma, and sensitization to occupational allergens in the same cohort of bell pepper greenhouse workers (15).

Questionnaires obtained in 1999 (14) allowed us to identify factors that might lead to leaving work, whereas information on rhinitis-related quality of life obtained in 1999 and 2007 enabled us to evaluate the course of nasal disease in terms of perceived severity and impact on daily life. We hypothesized that greenhouse workers with nasal symptoms at baseline would express a better quality of life if they had left work in between 1999 and 2007.

Methods

From March until September 2007, a follow-up study among current and former bell pepper employees was performed. As many employees as possible of the 472 who participated in the first study were included in the follow-up study (3). Bell pepper greenhouses who participated in the cross-sectional survey in 1999 were approached by telephone and asked to take part in a second survey. Subsequently, the investigators paid a visit to the greenhouses. Subjects that had left the job were traced and also asked for participation. If they agreed to take part, the investigators paid a visit to their new workplace or made a home visit. During the visits, the (former) employees gave their informed consent. A questionnaire was administered on gender, age, smoking habit, current job characteristics, work history, atopic complaints, and allergic symptoms at work, i.e., work-related rhinitis and asthma symptoms (3). The criteria of work-related rhinitis comprised the presence of symptoms such as nasal congestion, sneezing, rhinorrhea, itching (as mentioned by the recent position paper on occupational rhinitis) (1), elicited during work in the greenhouses (3, 14). Also, the diagnosis of work-related asthma was questionnaire based. Subjects with one of the following symptoms: wheezing/coughing/

sputum/shortness of breath at work was labeled as having work-related asthma. The study was approved by our Hospital Medical Ethical Committee. Confidentiality was maintained.

Rhinitis-related quality of life

Quality of life was measured using the approved Dutch translation of the Rhinitis-related Quality of Life Questionnaire (RQLQ) developed by Juniper et al (16). This questionnaire more precisely describes the effect of rhinitis on different areas of the employees' day-to-day lives. It comprises 28 questions divided 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 emotions ($n = 4$). In each item, they were asked how much they were troubled as a result of their nasal symptoms during the previous 2 weeks. The score ranged from 0 (not troubled) to six points (extremely troubled). In case of the items concerning activities, the employees were asked to identify activities that were limited because of their nasal symptoms. If more than three activities are identified, employees were asked to choose the three most significant. To ensure that all possible relevant items are 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 employees filled in their questionnaires in the canteen of the greenhouse or at home in the presence of the investigators. In the analysis, the mean within-employee score of each RQoL domain was used (these mean domains scores were measured by calculating the mean of the items within each domain). Furthermore, all 28 items were used to calculate the mean RQoL score.

Missing values: subjects were excluded if Dutch was not their primary language. Missing values were also defined for domains consisting of three items if more than one item was missing. In case of domains with 4 or 7 items, a maximum of two missing items were allowed.

Sensitization to occupational allergens and atopic background

To characterize employees in terms of sensitization, skin tests with occupational and common inhalant allergens were carried out according to international guidelines (17). Reactions were expressed in mean wheal diameter of the longest diameter and the orthogonal diameter. A diameter of 3 mm or more was considered positive. Skin prick test was performed with occupational allergens: a home-made extract of the leaf, stem, pollen, stamen, and juice of the bell pepper plant and a home-made extract of the predatory mite *Amblyseius cucumeris* as previously described (3, 13) and *Botrytis cinera* (SQ 412 from ALK Abelló, Nieuwegein, the Netherlands) as one of the molds found in greenhouses. The allergenicity of the home-made extracts has been tested previously. With immunoblotting, major IgE-binding structures were seen at 14, 29, and 69 kDa in sweet bell pepper pollen extract (18). Allergenicity of predator mite extracts was tested with nasal provocation (13).

An atopic background was defined as having one or more positive skin reactions to common inhalant allergens: *Derma-tophagoides pteronyssinus* (SQ 503), tree mix (SQ 108), grass mix (SQ 293), mugwort (SQ 312), dog dander (SQ553), and cat dander (SQ 555).

Statistical analysis

In the analyses, two groups of respondents were compared, those who were still employed in the bell pepper cultivation after 8 years of follow-up and those who had changed job to employment outside the bell pepper cultivation.

Baseline RQLQ data from nonrespondents were compared with responder data to evaluate the possibility that quality of life at baseline has an influence on lost to follow-up.

A logistic regression was used to determine the factors that predicted leaving paid employment in the bell pepper cultivation. Independent factors were individual characteristics, years of work history in bell pepper greenhouses, and health factors related to allergy. Variables were coded in such a manner that an odds ratio above one indicates an increased likelihood of leaving paid employment in bell pepper cultivation. The analysis started with univariate association, and those independent factors with $P < 0.20$ were investigated in the multivariate analysis. In the final multivariate model, variables were retained when statistically significant ($P < 0.05$) or when remaining almost unchanged (change in regression coefficient $< 10\%$).

The association of quitting work with changes in rhinitis-related quality of life was investigated with a mixed linear regression model for repeated measurements. This model takes account of the correlation between repeated measures on the same subject. In this model, change of job was included as fixed (categorical) effect, and the variances between and within workers were regarded as random effects under the assumption of a compound symmetry covariance structure (19). All statistical analyses were performed using SAS v 9.2 (SAS Institute Inc., Cary, NC, USA).

Results

In total, 269 of 472 employees who participated in the first study were available for questionnaires and 240 of these 269 employees were available for both questionnaires and allergy testing. However, because of language problems and handling of missing items, we could obtain eligible RQLQ data – filled in at baseline and in 2007 – from 228 employees.

The study population had a mean age of 46 years, and 80% of the study population was male (Table 1). Forty percent was owner of a greenhouse. Ownership of a greenhouse and being male were strongly associated. Thirty-five percent had an atopic background, whereas 39% were sensitized to occupational allergens. Forty-five percent had rhinitis complaints.

We evaluated the total group of bell pepper workers in 1999 in terms of lost to follow-up ($n = 150$) or participation in the study ($n = 322$). The groups did not differ in the available RQLQ data; thus, quality of life at baseline did not have any influence on lost to follow-up.

Table 1. Baseline characteristics of the workers in bell pepper greenhouses ($n = 288$) at the start of the cohort study

	All employees ($n = 228$)
Age (mean, SD) in 2007	45.7 $\pm$ 12.0
Male sex (n , %)	183 (80%)
Being owner of greenhouse (n , %)	92 (40%)
Years working in bell pepper greenhouses (mean, SD)	8.9 $\pm$ 5.9
Smokers (n , %)	59 (26%)
Subjects with atopic background (n , %)	79 (35%)
Subjects sensitized to occupational allergens (n , %)	90 (39%)
Rhinitis complaints (n , %)	102 (45%)

Ninety-one of these subjects reported nasal symptoms in 1999. In 1999 and 2007, 41.7% and 26% of these 91 subjects used antiallergic medication. In 2007, 58 subjects were still employed in bell pepper green houses, whereas 33 subjects had left work (Fig. 1).

Table 2 shows that male workers and owners were less likely to quit working in bell pepper cultivation than others. Workers with rhinitis complaints at baseline were more likely to leave their job in bell pepper cultivation for a job in another branch (OR = 1.62, 95% CI 0.95–2.75).

The multivariate analysis showed that subjects with rhinitis complaints were more likely to have left paid employment in the bell pepper cultivation, whereas men and owners more often remained employed. The magnitude of the associations remained largely unchanged after mutual adjustment, although the influence of rhinitis complaints became statistically insignificant ($P = 0.11$). In the univariate analysis, workers sensitized to occupational allergens had a decreased risk of quitting their job, but this effect disappeared when adjusted for sex and owner. A similar effect was also observed for years working in bell pepper, primarily because of its strong association with ownership.

Figure 2 shows the mean RQLQ scores at baseline and in 2007 in subjects still at work. For some RQLQ domains, the mean scores decreased, but these differences were not statistically significant.

From Fig. 3, it can be seen that employees who left their work reported substantially lower RQLQ scores in 2007 compared with 1999.

Table 3 shows that quitting work in bell pepper cultivation had strong positive effects on the rhinitis-related quality of life, with an effect size varying from 0.31 to 1.09, indicating clinically relevant effects in most domains. The largest relative improvements were observed for mean RQoL and activities, whereas sleep disorders, eye problems, and emotional problems showed the smallest relative improvement.

Discussion

The relative backlog in research to occupational rhinitis compared with occupational asthma might be attributed to the

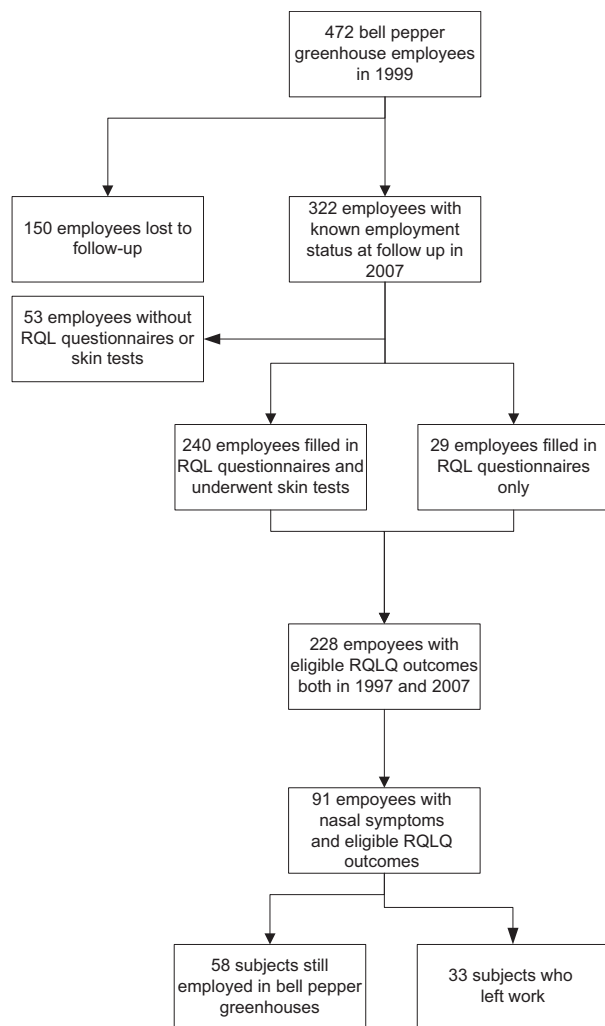


Figure 1 Flowchart of bell pepper employees with nasal symptoms and eligible rhinitis-related quality of life (RQLQ) data.

opinion that occupational rhinitis is a trivial disease. However, our data suggest that rhinitis can be a reason to leave work. Examining the mean RQLQ scores, one might argue that the impairment in quality of life was mild. However, this may be because of a healthy worker effect. The mean duration of employment in the total study population amounted 8.5 ± 6.1 years in 1999 (3). It is conceivable that employees with more serious symptoms left the greenhouses at a much earlier stage.

Apart from the healthy worker effect, the RQLQ outcomes may also be influenced by the fact that assessment of occupational rhinitis was questionnaire based. As this analysis was part of a large epidemiological study comprising almost 500 greenhouse workers, we were not able to establish a physician's diagnosis of rhinitis and asthma. It is possible that subjects, who would not have been formally diagnosed of having occupational rhinitis, are included in this analysis. Moreover, no validated questionnaires for assessment of occupational rhinitis are available. However, in our previous

Table 2 The influence of individual characteristics, rhinitis complaints, and occupational allergy on the likelihood of leaving bell pepper cultivation during a follow-up period of 8 years (logistic regression analysis)

	Left bell pepper cultivation (univariate model) Odds ratio (95% CI)	Left bell pepper cultivation (multivariate model) Odds ratio (95% CI)
Age (yrs)	1.00 (0.98–1.02)	–
Male	0.41 (0.21–0.81)**	0.50 (0.25–1.00)*
Being owner	0.43 (0.23–0.70)**	0.45 (0.26–0.80)**
Smokers	0.68 (0.37–1.25)	–
Years working in bell pepper	0.95 (0.90–0.99)**	–
Subjects with atopic background	0.85 (0.49–1.48)	–
Subjects sensitized to occupational allergens	0.64 (0.37–1.10)*	–
Rhinitis complaints	1.62 (0.95–2.75)*	1.55 (0.90–2.68)

** $P < 0.05$, * $P < 0.10$.

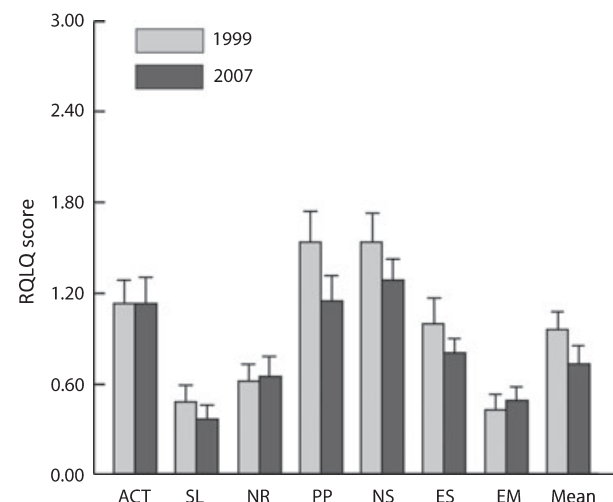


Figure 2 Rhinitis-related Quality of Life Questionnaire scores obtained from subjects still at work ($n = 58$). Mean scores and SEM for activities (ACT), sleep disorders (SL), nonrhinitis symptoms (NR), practical problems (PP), nasal symptoms (NS), eye symptoms (ES), emotions (EM), and mean RQL (MEAN).

study, bell pepper workers with rhinitis at work reported in 81.5% of the cases substantial improvement or complete remission of symptoms during holidays or weekends (3). In addition, removal of bell pepper plants resulted in remission of symptoms (expressed in changes of rhinitis-related quality of life) (14). Finally, in this study, population sensitization to bell pepper pollen appeared to be the only significant factor determining the level of rhinitis-related quality of life (14). Although the data do not provide us with a definite diagnosis of occupational rhinitis based on challenge tests, we believe that our study population meets the criteria of a probable

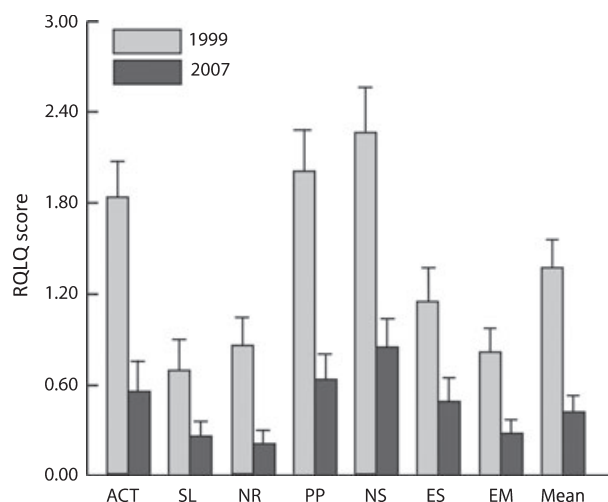


Figure 3 Rhinitis-related Quality of Life Questionnaire scores obtained from subjects who left the job ($n = 33$).

Table 3 The influence of quitting work in bell pepper cultivation on the presence of rhinitis-related quality of life, adjusted for age and sex, among 91 workers at the end of the follow-up

RQoL domain	Effect of quitting work in bell pepper cultivation (SD)
Activities	-0.99 (0.21)*
Sleep disorders	-0.31 (0.15)*
Nonrhinitic symptoms	-0.56 (0.16)*
Practical problems	-1.07 (0.24)*
Nasal problems	-1.09 (0.24)*
Eye symptoms	-0.55 (0.20)*
Emotional problems	-0.40 (0.12)*
Mean RQoL	-0.76 (0.15)*

* $P < 0.05$.

occupational rhinitis (suggestive history plus sensitization) (1).

In recent years, the effectiveness of measures to change the indoor environment in the treatment of allergic rhinitis and asthma has been challenged (20). It is a matter of debate as to whether effective allergen avoidance can be achieved in daily life. In contrast, in occupational allergy, there is general consensus that subjects should completely avoid the occupational agent when the patient is sensitized (21). Cessation of occupational allergen exposure can be achieved by leaving work. The effect of complete allergen avoidance has been studied in occupational asthma. A systematic review with 38 longitudinal studies on the symptomatic and functional outcomes of occupational asthma after avoidance of exposure to the causative agent was carried out. Proportions of symptomatic recovery varied from 0% to 100%, with a pooled estimate of 32% (95% CI 26–38%). Patients with the shortest durations of exposure had the highest recovery (36%; 95% CI 25–50%), but the effect was not linear (22).

In contrast, sparse data are available on the effect of cessation of allergen exposure on occupational rhinitis. In a small retrospective study among 39 health care workers allergic to natural rubber latex, over 90% of the participants reported that their nose and eye symptoms had no longer impact on their quality of life after removal of latex from their work environment (12). The same observation was seen in another retrospective latex study (11). A cross-sectional study among 119 subjects with occupational rhinitis indicated that those with continuing occupational exposure had worse health-related quality of life when compared to subjects with decreased or eliminated exposure to allergens (10). As previous allergen exposure at the time of the occupational rhinitis diagnosis (on average 10 years before) was retrospectively estimated using a visual analog scale, this study could be subject to recall bias.

To our knowledge, only three longitudinal studies – all focused on natural rubber latex allergy – have been published. One study focused on occupational asthma to natural rubber latex. It appeared that 36 subjects with concomitant rhinitis experienced reduction in rhinitis severity after cessation of latex exposure or under reduction in exposure (7). In another longitudinal study among 1040 health care workers, 20 subjects with occupational rhinitis because of natural rubber latex allergy were identified. Changeover to the use of powder-free gloves resulted in improvement of symptoms in 16 of 20 subjects. In neither study, however, a control group of employees continuously exposed to latex was included. A recent study reported that ten of 34 latex sensitized health care workers left their job. This resulted in a significant decrease in the prevalence of work-related rhinitis (6).

The current study clearly shows that bell pepper greenhouse workers with work-related nasal symptoms experience a substantial improvement in rhinitis-related quality of life after leaving the work environment. In a previous study, we demonstrated that rhinitis-related quality of life in these subjects is predominantly associated with sensitization to bell pepper pollen and not to other concomitant sensitizations to common inhalant allergens (14). Therefore, we consider the improvement in quality of life as a result of cessation of bell pepper exposure. Interestingly, the greenhouse workers reported the most impairment and the largest effects of leaving work in the domains of activities, practical problems, and nasal symptoms. Apparently, these subscales are the most important domains with the largest room for improvement. We already demonstrated that patients with perennial allergic rhinitis to common inhalant allergens perceive sleep disorders and emotions as more important than greenhouse workers do (14). Possibly, this can be attributed to differences in cultural and social background. Very few studies focus on quality of life in occupational rhinitis (10, 14). The advantage of quality of life assessment is that an estimation of the burden of occupational disease is provided. Moreover, in allergic rhinitis, quality of life instruments are the best-validated outcome measures available. Finally, the use of the RQLQ introduced by Juniper (16) allowed us to evaluate the clinical significance of the changes in quality of life. For those leaving the job, the magnitude of the change exceeded the minimal clinically important difference (MCID) of 0.5 (23) in all domains

except the subscale of sleep disorders and emotions. The magnitude of the effect of leaving work was comparable to that reported in a previous grass pollen subcutaneous immunotherapy study corrected for the placebo-effect (24) and superior to that reported in studies investigating the effect of sublingual immunotherapy (25, 26) or antihistamines (27, 28).

In conclusion, the current study is one of the first large longitudinal studies showing that occupational allergen avoidance has a beneficial effect on health-related quality of life in workers with occupational rhinitis. The study suggests that occupational rhinitis can be a reason to leave work.

Conflict of interest

The authors have declared that they have no conflict of interest.

Authors' contributions

All authors have substantially contributed to the study design (RGvW, HdG, AB), the realization of the study (JP, NdJ), the methodology (RGvW, AB), and the writing of the manuscript (RGvW, JP, NdJ, HdG, AB).

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