

Grass Pollen Counts, Air Pollution Levels and Allergic Rhinitis Severity

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Key Words

Aerobiology • Air pollution • Allergic sensitization • Grass • Pollen • Severe rhinitis • Specific immunoglobulin E

Abstract

Background: Little is known about the relation between allergic rhinitis severity and airborne pollen in combination with air pollutants. **Objective:** To model the risk of suffering from severe seasonal allergic rhinitis (SAR) as a function of both pollen count and air pollution levels in a large nationwide sample of patients whose SAR was diagnosed by a physician and confirmed by skin prick test positivity or specific immunoglobulin E to common aeroallergens. **Methods:** The severity of SAR symptoms was estimated with the Symptomatic Global Score (SGS) among 36,397 patients suffering from an untreated and uncomplicated SAR between May and August 2004 in metropolitan France. Patients who had an SGS in the upper third quartile were classified as suffering from severe SAR. A multilevel model relating SAR severity, pollen and air pollution was used to take into account the hierarchical data structure. **Results:** 18.9% of the 17,567 urban patients retained for the analysis suffered from severe rhinitis. At the Lag0 (day of the visit), a rise of 60 grass pollen grains/m³ increased the risk of suffering from a severe SAR

form by 8% in the multileveled model after adjusting for potential confounders and air pollution levels. Results were also confirmed in the subsample of individuals with documented sensitization to grass pollen. **Conclusion:** Grass pollen count aggravated SAR in terms of symptoms in our nationwide sample. These findings confirm the need for proper treatment and preventive measures in SAR patients sensitized to grass pollen.

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Introduction

Allergic rhinitis (AR) is extremely prevalent in industrialized countries [1, 2] and is becoming more frequent in developing countries. Although AR is considered a benign condition, its economical and societal impact in terms of absence from work and school, diminished performance, economic burden and on quality of life [3] is considerable. In addition, AR is strongly related to asth-

A.D. declares to have received fees in 2009 for scientific advice and symposium participation from the following pharmaceutical companies: AstraZeneca, GSK, Shering-Plough, MSD, Stallergènes, ALK and Novartis.

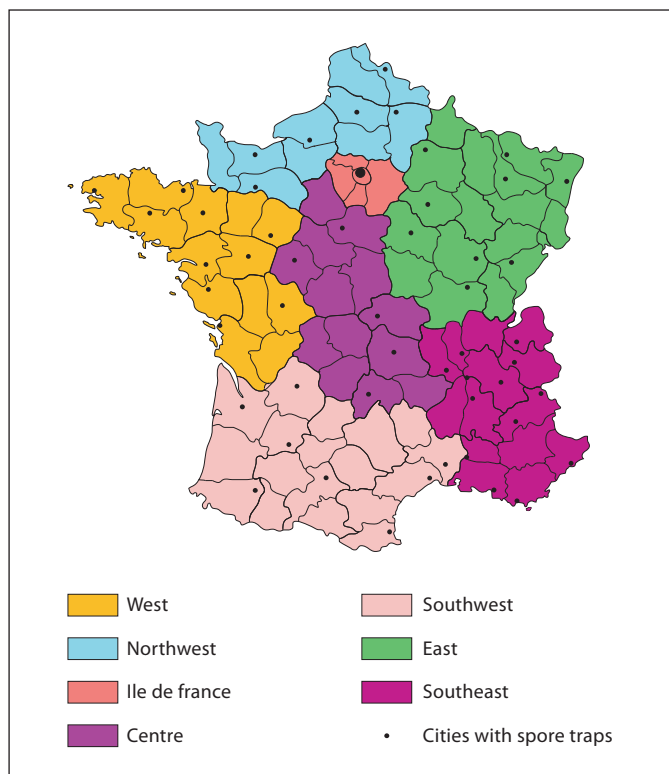


Fig. 1. Geographical areas and cities with spore traps.

ma, which still represents a potentially severe condition [4].

Air pollution, which has extensively changed during the past decades with a drastic decrease in industrial pollution but an increase in traffic-related pollution [5], is suspected to contribute to the augmentation of the prevalence and the aggravation of asthma and allergies including hay fever [1, 6, 7]. Air pollution acts not only at the individual level by irritating and damaging the upper and lower airways and thus initiating or exacerbating asthma and AR symptoms [8, 9], but also upon pollen by modifying its biochemical structure and allergenicity [10, 11]. However, few studies have considered hay fever, pollen and air pollution simultaneously and employed direct assessments of pollen counts and air pollutant levels. Even fewer studies have considered the effects of pollen and air pollution on the severity of AR.

The aim of the present work was to model the risk of suffering from severe seasonal allergic rhinitis (SAR) as a function of both pollen and air pollution in a large sample of patients whose SAR was diagnosed and allergic sensitization assessed by a physician.

Methods

Study Design

Pollin'Air is an epidemiological observatory of SAR constituted during a wide-ranging cross-sectional multicenter study conducted in a sample of 36,397 patients consulting a doctor for an untreated and uncomplicated SAR between May and August 2004 in metropolitan France. Each patient was included only once. For each patient, the physician confirmed the diagnosis of SAR by evaluating the presence of nasal symptoms (nasal obstruction, rhinorrhea, sneezes and nasal pruritus), an ocular symptom (ocular pruritus) and allergic sensitization to major allergens, including grass pollen, either by skin prick test (SPT) and/or by specific immunoglobulin E (IgE) radioallergosorbent test (RAST). Informed written consent to participate in the survey was obtained for all patients by the physicians. The methodology of the survey has been described in detail elsewhere [12].

Airborne Pollen Data

Daily airborne pollen counts were provided by the French National Aerobiological Surveillance Network (RNSA, www.pollen.fr), which is directed by one of the authors (M.T.) for major aeroallergens (ragweed, cypress, olive tree, grass family, etc.) during the considered period. The data were collected with Hirst volumetric spore traps located in different French cities (fig. 1) and stated in pollen grains/m³/24 h. The number of spore traps was determined by the RNSA in order to be representative of metropolitan France and thus of the exposure of inhabitants. Overall, there were 52 monitoring stations for pollen.

Outdoor Air Pollution Data

Outdoor background air pollution data were provided by the ADEME (French Environment and Energy Management Agency; www.ademe.fr) for 4 pollutants: nitrogen dioxide (NO₂), sulfur dioxide (SO₂), particulate matter ≤10 µm in diameter (PM₁₀) and ozone (O₃) during the study period as assessed by background monitoring stations in metropolitan France. For NO₂, SO₂ and PM₁₀ the 24-hour averages were available and for O₃ the maximum 8-hour running average, in µg/m³, was available. Data from 261 monitoring stations were included for estimating background air pollution.

Definition of SAR Severity

After having diagnosed the patient with SAR and confirmed it with SPTs or specific IgE, the physician assessed the intensity of four nasal symptoms (nasal obstruction, rhinorrhea, sneezes and nasal pruritus) and one ocular symptom (ocular pruritus) allowing the computation of the standardized Symptomatic Global Score (SGS) for SAR [12]. For each symptom, the score can take values between 0 and 4 depending on the intensity reported by the patient to the physician (0 = absence, 1 = mild, 2 = moderate, 3 = severe, 4 = very severe), so that SGS could vary between 0 and 20. In order to separate patients with a severe SAR from those without, the distribution of the SGS was obtained. Patients who had an SGS higher than the third quartile of the obtained distribution were classified as suffering from severe SAR, whereas the others were classified as suffering from non-severe SAR. This threshold has previously shown to be pertinent to the discrimination of severe rhinitis from nonsevere rhinitis [12].

Study Population and Considered Variables

For the purpose of the study, a semi-individual approach was employed, whereby the ecologic assignment of exposure to both pollen and air pollution, based on fixed-site ambient monitoring, was related to individual health data. Since the aim of the survey was to investigate the relation between SAR severity, airborne pollen counts and outdoor background air pollution levels, only people who lived in urban zones for which pollen and air pollution data are routinely collected were included in the analysis. In addition, as the study took place between May 3 and August 29, 2004, the period corresponding to grass family pollination in metropolitan France, only grass pollen was considered in the analysis. As advised by the RNSA, each patient was attributed with the grass pollen count in his/her city/region (according to where the trap was located) the day of his/her visit (Lag0) and each the 7 days before (Lag1–Lag7). As a second step, each patient was attributed with the air pollutant concentrations provided by the monitoring station with the same postal code as his/her home the day of his/her visit (Lag0) and each of the 7 days before (Lag1–Lag7) for each pollutant. The choice to limit the study to individuals with a monitoring station for background air pollution in proximity of his/her personal address was made in order to reduce the likelihood of any misclassification. Only lags previously identified as significant by preliminary analyses were taken into account (see 'Statistical and Epidemiological Analysis').

The patients were considered sensitized to grass pollen when they had a positive SPT (a wheal diameter >3 mm and superior to the negative control wheal, with no positivity to the histamine-positive control wheal) and/or a positive RAST (specific IgE $\geq$ 35 kU/ml) to grass. SPTs were performed directly by the physicians, whereas RASTs were prescribed by the physician and performed in private or public laboratories.

Other variables of interest included age, gender, geographical area and past history of allergic or respiratory diseases. Patients were classified into four age classes: children (6–11 years), adolescents (12–20 years), adults (21–64 years) and seniors ($\geq$ 65 years).

Statistical and Epidemiological Analysis

Classical statistical methods were used to compare means and percentages. In addition, correlation coefficients were computed between pollen counts and air pollution levels. The multilevel model that allows the consideration of both contextual and individual variables and their hierarchical structure [individual level (SAR severity, allergic sensitization to grass), neighborhood level (postal code, air pollution assessment), town level (pollen assessment, air pollution assessment in the case of small towns), region level (pollen assessments)] was used to investigate the relation between the severity of SAR (severe/nonsevere) as a dependent variable on one hand and airborne pollen counts and air pollution levels as independent variables on the other hand after allowing for other individual variables [13, 14]. More precisely, the contextual variables (or group level variables) were daily airborne grass pollen counts and air pollutant concentrations assessed as previously indicated. The considered individual variables were age, date of the visit, past history of asthma (sex not being statistically significant in the univariate model) and geographical zone. The latter was defined at the individual level as the residential zone identified by the postal code indicated to the physician on the day of the visit.

To understand the respective roles of pollen and air pollutants, two multilevel models were made: (1) a model which took into account only daily airborne pollen counts as the contextual variable, and (2) a model with both daily airborne pollen counts and air pollution concentrations as contextual variables. The pollen count on the day of the visit (Lag0), NO₂, SO₂ and O₃ levels the day before the visit (Lag1) and PM₁₀ levels 2 days before the visit (Lag2) were considered as these lags were the most statistically significant in the univariate analyses. Both continuous (when the linearity hypothesis was respected) and discrete variables were considered for air pollutants. A sensitivity analysis was conducted in the individuals who were sensitized to grass pollen in order to confirm the results found in the entire sample. The strength of the associations was estimated by odds ratios and 95% confidence intervals. All analyses were performed using SAS 9.1 software (CEO Supplier).

Results

Characteristics of the Patients and SGS

8,143 physicians [GPs (83.6%), ENT doctors (9.3%), pediatricians (4.4%), and allergy doctors (2.7%)] were involved in the study. Among the 36,397 patients satisfying inclusion criteria (uncomplicated and untreated SAR) and for whom the date of the visit was between the 3rd of May 2004 and the 29th of August 2004, 19,820 lived in urban areas and had an SGS value computed (table 1). Children represented 2.07% of the consultations, adolescents 15.79%, adults 77.61% and seniors 4.53%. From a geographical point of view, 27.78% came from Ile de France, 20.90% from the Southeast, 13.33% from the Southwest, 12.84% from the Northwest, 10.33% from the East, 8.99% from the West and 5.83% from central France. The SGS score significantly differed according to age, geographical areas and presence of antecedents. According to the SGS, 18.63% of the patients suffered from a severe SAR. 17,567 patients had records filled for all the variables to be included in the multilevel models. Among them, 2,093 (11.9%) were sensitized to grass pollen according to the SPT and/or the RAST.

Pollen Counts and Air Pollution Levels

Grass pollen counts and outdoor air pollutant concentrations measured in metropolitan France over the 115 days between May and August 2004, are described in table 2. As expected, grass pollen counts varied significantly between the regions. The highest pollen count was 854 grains/m³/24 h in the Centre region followed by 725 grains/m³/24 h in Southwest France and only 245 grains/m³/24 h in Ile de France. The highest NO₂ concentrations were measured in Ile de France, Southeast and East

Table 1. SGS and severity of SAR and patients' characteristics in the study population (n = 19,820)

	SGS (mean $\pm$ SD)	p value ^a	Severe according to SGS n	p value (χ^2)
All individuals	9.47 $\pm$ 3.34	NA	3,692 (18.63)	NA
Sex				
Male	9.43 $\pm$ 3.36	NS	1,693 (18.31)	NS
Female	9.50 $\pm$ 3.32		1,977 (18.98)	
Age		<0.001		<0.001
Children	9.10 $\pm$ 3.51		65 (16.13)	
Adolescents	9.60 $\pm$ 3.32		613 (19.92)	
Adults	9.50 $\pm$ 3.34		2,866 (18.95)	
Elderly	8.64 $\pm$ 3.18		98 (11.10)	
History				
Rhinitis		<0.001		<0.001
With	9.54 $\pm$ 3.32		3,479 (19.13)	
Without	8.48 $\pm$ 3.42		165 (12.57)	
Conjunctivitis		<0.001		<0.001
With	10.00 $\pm$ 3.31		3,006 (23.00)	
Without	8.40 $\pm$ 3.13		567 (9.82)	
Asthma		<0.001		<0.001
With	10.00 $\pm$ 3.38		1,047 (23.91)	
Without	9.31 $\pm$ 3.31		2,380 (17.14)	
Atopic dermatitis		<0.001		<0.001
With	9.94 $\pm$ 3.34		620 (22.05)	
Without	9.38 $\pm$ 3.33		2,740 (18.11)	
Food allergy		<0.001		<0.001
With	9.92 $\pm$ 3.44		286 (22.43)	
Without	9.43 $\pm$ 3.33		3,039 (18.44)	
Urticaria/hives		<0.001		<0.001
With	9.93 $\pm$ 3.35		742 (22.54)	
Without	9.36 $\pm$ 3.33		2,622 (17.90)	
Geographical area		<0.01		NS
Southwest	9.51 $\pm$ 3.35		475 (18.65)	
Southeast	9.61 $\pm$ 3.29		791 (19.82)	
Northwest	9.36 $\pm$ 3.33		452 (18.43)	
West	9.25 $\pm$ 3.38		304 (17.71)	
East	9.51 $\pm$ 3.19		345 (17.49)	
Centre	9.57 $\pm$ 3.31		206 (18.51)	
Ile de France	9.44 $\pm$ 3.40		988 (18.62)	

Values in parentheses are percentages. NA = Not applicable; NS = not significant.

^a Nonparametric Wilcoxon-Mann-Whitney and Kruskal-Wallis tests.

France, and the lowest in Centre and West France (table 2). For PM₁₀, the highest concentrations were found in Northwest, Ile de France and Southern France (table 2). For SO₂, the highest concentrations were recorded in Northwest, Ile de France and Southeast France (table 2). O₃ was predominant in the South. The highest correlation coefficients between air pollutants and pollen counts were found between grass pollen at Lag0 and NO₂

at Lag1 ($\rho = -0.124$; $p < 0.0001$) and between grass pollen at Lag0 and O₃ at Lag1 ($\rho = 0.188$; $p < 0.0001$).

Pollen, Air Pollution and SAR Severity

The 17,567 patients for whom all the variables to be included in the multilevel models were available did not differ in socioeconomic variables from the entire population. 53.17% of these subjects were women. Adults constituted the most represented age class in the sample with 77.72% of the consultations, followed by adolescents with 15.60%. Both seniors and children were poorly represented in the sample, constituting 4.61 and 2.07% of the consultations, respectively. From a geographical point of view, 29.51% of patients came from Ile de France, 21.19% from the Southeast, 13.95% from the Southwest, 13.14% from the Northwest, 8.55% from the East, 8.40% from the West and 5.25% from Central France. Similarly, the 3,708 patients for whom all the variables to be included in the multilevel models were available and that lived in proximity of a background air pollution monitoring station did not differ from the entire population.

The results of the multivariate multilevel models are presented in table 3. In the multilevel model with only grass pollen count as a contextual variable, the variables that significantly related to SAR severity were age (seniors had significantly less risk of suffering from severe SAR than younger adults), date of the visit, previous history of asthma and grass pollen count. For an airborne pollen count increase of 60 pollen grains/m³, the risk of severe SAR augmented significantly by 8% (odds ratio = 1.08; 95% confidence interval 1.04–1.11). In the model including both pollen counts and air pollutant concentrations as contextual variables, the date of the visit, a previous history of asthma and grass pollen count, but not air pollution, were significantly related to SAR severity. However, this model showed odds ratios higher than 1 for both NO₂ (for NO₂ ≥ 27.77 $\mu\text{g}/\text{m}^3$) and PM₁₀ (for an increase of 10 $\mu\text{g}/\text{m}^3$ in PM₁₀ – when including this latter pollutant as a continuous variable in the model) with a statistical trend for PM as the lower confidence limits of the corresponding odds ratio was >0.90 . The association between grass pollen count and SAR severity was confirmed with odds ratios >1 at borderline significance ($0.10 > p \text{ value} > 0.05$) in the subsample of 2,093 patients with sensitization to grass pollen (odds ratios between grass pollen count and SAR severity of 1.05 with a 95% confidence interval of 0.97–1.14 in the multilevel model with grass pollen only, and 1.10 with a 95% confidence interval of 0.96–1.27 in the multilevel model with both grass pollen and air pollutants, respectively).

Table 2. Grass pollen counts and outdoor air pollutant concentrations

	Min ^a	Max ^a	Median ^a	Third quartile ^a	Number of days with a high concentration ^b	Subjects very exposed, % ^c
Grass pollen (Lag0)	0	854	29	70	58	23.17
NO ₂ (Lag1)	0	73.05	18.63	27.88	80	8.39
SO ₂ (Lag1)	0	189.63	1.96	4.30	83	5.35
O ₃ (Lag1)	0	185.12	91.25	107.75	68	6.93
PM ₁₀ (Lag2)	0	147	17.66	23.42	77	5.19

^a Expressed in pollen grains/m³/24 h for grass pollen and in µg/m³ for pollutants.

^b Number of days for which concentration is strictly higher than the third quartile.

^c Percentage of subjects who were exposed to a concentration strictly higher than the third quartile.

Table 3. Relationships between severity of SAR and grass pollen and air pollutants

	Multilevel model with pollen only (n = 17,567)	Multilevel model with pollen and air pollutants (n = 3,708) ^a
Age		
Ref: adults	1	1
Children	0.77 (0.57–1.02)	0.84 (0.46–1.53)
Adolescents	1.02 (0.92–1.14)	0.99 (0.79–1.25)
Seniors	0.56 (0.45–0.70)**	0.66 (0.42–1.02)
Date of the visit	0.99 (0.99–1.00)**	0.99 (0.98–1.00)**
Previous asthma		
Ref: without	1	
With	1.58 (1.45–1.73)**	1.57 (1.30–1.90)**
Grass pollen count (Lag0)	1.08 (1.04–1.11)**	1.08 (1.01–1.14)*
NO ₂ (Lag1)	NI	
Ref: 0–11.82 µg/m ³		1
11.82–18.55 µg/m ³		1.03 (0.80–1.30)
18.55–27.77 µg/m ³		0.96 (0.74–1.25)
≥27.77 µg/m ³		1.12 (0.86–1.45)
SO ₂ (Lag1)	NI	
Ref: 0–0.62 µg/m ³		1
0.62–1.96 µg/m ³		1.10 (0.88–1.37)
1.96–4.25 µg/m ³		0.82 (0.64–1.05)
≥4.25 µg/m ³		1.01 (0.76–1.35)
O ₃ (Lag1)	NI	1.00 (0.96–1.04) ^b
PM ₁₀ (Lag2)	NI	1.03 (0.92–1.16) ^b

* p < 0.05; ** p < 0.001. Values are adjusted odds ratios with 95% confidence intervals in parentheses for the association between SGS and grass pollen count and NO₂. n = Number of patients with no missing value for all the variables included in the model; NI = not included in the model.

^a Patients who lived in proximity of a background air pollution monitoring station.

^b OR for a pollutant concentration increase of 10 µg/m³.

Discussion

In our large sample of patients, a rise of 60 grass pollen grains/m³ increased the risk of suffering from a severe form of SAR by 8% among individuals living in urban areas, even after adjustment for the levels of the major air pollutants. Additionally, odds ratios higher than 1 were observed between SAR severity and NO₂ (exposure ≥ 27.77 $\mu\text{g}/\text{m}^3$) and PM₁₀ (for an increase of 10 $\mu\text{g}/\text{m}^3$ in PM₁₀), respectively, after adjustment for pollen counts. Our findings confirm and extend at the population level the link between the severity of AR and pollen counts observed in clinical practice and experimental studies in the case of grass. In addition, they show that air pollution does not modify this link as the results persisted after controlling for various air pollutants. The results were also confirmed in the subsample of individuals for which sensitization against grass pollen was objectively documented. Such results become important in the light of climate change for which impacts on pollen, air pollution and respiratory and allergic diseases have been described [15]. Indeed, the increase of temperatures in more northerly latitudes could enable the spread of some plant species to wider areas, thus exposing new populations to novel allergens [16]. In particular, grasslands are increasing in the northern latitudes, although they may be decreasing in the urban areas.

AR to grass pollen is the most common rhinitis at the world population level, with a prevalence reaching 30% in industrialized countries [17]. Thus it is clear that knowing the impact of pollen and air pollution on AR is of relevance in terms of public health. Yet, before our study, little was known about the relationship between rhinitis and airborne pollen counts in combination with air pollutants and few studies had investigated the severity of the disease. Although several studies have related pollen exposure to AR [18, 19], few have employed objective assessments of exposure to pollen [18, 19]. In addition, although epidemiologic studies have largely explored the respiratory effects of air pollution, these have primarily focused on the lower airways [20–22]. Associations between the prevalence of AR and NO₂ have been highlighted by few population studies [23, 24]. De Marco et al. [23] have established an ecologic-geographical relationship between NO₂ and AR in a large population-based sample. In their study, carried out in two different Italian climatic regions, the prevalence of AR increased significantly in the Mediterranean region but not in the subcontinental one when the outdoor NO₂ level exposure rose. Similarly, hay fever, symptoms of AR and sensitization against pollen

have been associated with outdoor background NO₂ among children drawn from the general population in Germany [24]. Recently, the use of a dispersion model for estimating exposure to air pollution at close proximity showed that lifetime AR was associated with PM₁₀ and sensitization against pollen with benzene and PM₁₀ in a sample of 4,907 children who had resided permanently at the address where the concentrations of the air pollutants were estimated [25]. A significant link between the severity of AR and outdoor air pollution has also been demonstrated [26, 27]. Hajat et al. [26] showed that elevated levels of air pollutants worsened AR symptoms, leading to substantial increases in GP consultations. In a more recent study which considered various urban settings in the same season and incorporated a symptom score, similar to our study, rhinoconjunctivitis in pollen-allergic patients seemed to be strongly influenced by air pollutants throughout the pollen season [27]. However, this survey included only 15 patients. For the first time, our study investigated the short-term effects of both grass pollen counts and concentrations of major pollutants on the severity of SAR by using a multilevel model simultaneously allowing for individual and contextual variables in a large sample of geographically dispersed individuals. Previously, one of the authors had shown, after adjusting for air pollutants using a GAM model, the effect of airborne pollen on the incidence of asthma among patients, but unfortunately no data on rhinitis severity were available [28]. All previous investigations modeling the risk of pollen and air pollution had used more traditional statistical approaches.

From the point of view of the involved mechanisms, it has been demonstrated that air pollution acts directly on pollen [29] and that particles might carry pollen allergen molecules [30–32]. In our study, grass pollen count was poorly correlated to gases and no significant correlations existed between grass pollen count and the concentration of PM. In addition, the relationship between the severity of SAR and grass pollen was not modulated by air pollution. This was shown by the fact that the values of the odds ratio between SAR severity and pollen count did not change after the taking into account of air pollution, probably because only background air pollution was considered in our study. Including background air pollution could have led to exposure misclassifications, particularly in the case of large cities. The assessment of air pollution exposure remains extremely difficult at the population level because of spatiotemporal variations of the pollutants [33] but also due to the fact that the individuals travel to work or for other activities. To better

assess outdoor air pollution exposure, the use of dispersion models which are able to consider both background and local pollutions, fixed or mobile emission sources (industry, traffic, etc.) as well as dispersion conditions (meteorology, topography) can be advocated. Unfortunately, this was not possible in our study because the full patients' addresses were not available. However, the modeling of the effects of air pollution was uniquely restricted to the patients that lived close to a background monitoring station of air surveillance, which should have reduced exposure misclassification. The lack of correlations between grass pollen and air pollutants could also be due to the fact that, except in well-known locations, air pollution levels are not exaggerated in metropolitan France according to EC standard guideline levels (www.eea.org).

The semi-individual approach in which ecologic assignment of exposure is employed can be criticized. However, the issue of exposure misclassification is of general concern in epidemiology and not an exclusive problem of the semi-individual design. Furthermore, it has been shown that semi-individual studies, i.e. individual level air pollution studies with ecologic exposure assignment, more readily permit valid inference to individuals and should not be labeled as ecologic studies [34]. Another limitation of our statistical analysis is that it did not take into account the confounding effects of cigarette smoke, indoor pollutants, socioeconomic factors or respiratory infections (these factors being able to increase the risk of having a severe SAR). However, the link between pollen exposure and rhinitis is well documented by clinical and experimental data and it can be hypothesized that these factors can only intervene partially in the exposure-effect relationship. Lastly, the small sample size which resulted

from selecting individuals living in proximity of air pollution monitoring stations also constitutes a limitation of our study. Such a small sample size could explain the lack of a full statistical significance between SAR severity and air pollutants [20]. Odds ratios higher than 1 were observed for both NO₂ and PM₁₀ with a statistical trend for PM.

The strengths of our survey can be found in the fact that there are no other similar data for pollen and air pollutants using a semi-individual design at a large scale in the field of SAR severity, which was diagnosed objectively by a physician through a standardized score [12], and that both pollen and air pollution were objectively assessed using standardized protocols. An additional advantage of our study is the fact that allergic sensitization was objectively identified in the sample through SPT or specific IgE and also that the results persisted in the subsample of individuals with confirmed allergic positivity to grass.

In conclusion, grass pollen count aggravated SAR in terms of clinical nasal and ocular symptoms in our nationwide sample and this was not modulated by air pollution. On the day of the visit, a rise of 60 pollen grains/m³ increased the risk of suffering from a severe form of SAR by 8%. Our results obtained in urban locations indicate that physicians should adapt AR treatment and preventive action according to grass pollen counts during the grass pollen season in city areas.

Acknowledgements

The authors are indebted to the patients and the physicians involved in the study and are thankful for the contribution of the UCB, without which this survey would not have been conducted.

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