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Influence of Pollen Level on Hospitalizations for Asthma

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ABSTRACT. The effect of pollen level on asthma hospitalizations is still under debate. The aim of this study was to analyze hospital admissions due to asthma and its relation with environmental pollen and meteorological factors. During 13 years, we included every patient admitted with asthma as primary or secondary diagnosis. For this purpose, we used a case-crossover analysis to compare pollen concentrations at the time of admission with values of the same variables 2 to 6 days before admission. We included 6,687 hospital admissions. High maximum temperature and low humidity were associated with lower risk of asthma admissions. High mean pollen levels exerted a moderate effect and high maximum pollen levels led to a dramatic increase of hospital admissions due to asthma, especially among females. In conclusion, environmental pollen level increases the risk of asthma hospital admissions.

KEYWORDS: asthma, epidemiology, hospital admissions, pollen, respiratory diseases

Asthma prevalence and severity vary widely between geographic areas, even between genetically similar populations, a fact probably related to the influence of environmental factors on the occurrence of the disease.¹⁻⁴ One of these factors, the concentration of aeroallergens that vary largely through seasons and places, may act as a trigger for asthma attacks in susceptible subjects.^{5,6}

Hospital admissions represent a reliable tool to assess morbidity. However, few studies have assessed the impact of environmental pollen level on asthma hospital admissions.^{7,8} The effect of high levels of environmental pollen on incidence and severity of asthma exacerbations is still under debate.⁹ Whereas some studies suggest a causal effect, others failed to show any relation between pollen levels and asthma exacerbations.^{10,11} Several explanations have been advanced to explain this lack of consistency between study results: differences in pollen levels and types between regions,¹² differences in the prevalence of atopy in the study population,¹³

and differences in health indicators and statistical methods used.^{5,14}

Due to the ubiquitous nature of exposure to pollen, any effect on asthma exacerbation would cause an important public health concern. We, therefore, carried out a case-crossover study to disentangle the relationship between exposure to pollen, weather conditions, and asthma hospital admissions.

METHODS

We carried out a retrospective study in the catchment area of the University Hospital of Santiago de Compostela (north-west of Spain), where around 400,000 people are covered by the National Health System.

We included all patients living within 35 km from our hospital and admitted with asthma as primary or secondary diagnosis, from 1995 to 2007, according to International

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Classification of Disease (ICD)-9 codes. In a standard form, we recorded variables such as age, sex, date of admission, and length of hospital stay of each patient. We linked these data with average and maximum daily pollen levels as well as other meteorological variables measured in a continuous fashion by the local meteorological network, using a stationary Hirst-type volumetric sampler (Lanzoni VPPS-2000; Santiago de Compostela, Spain). This sampler collects representative samples of pollen in an area with a radius of 35 km.

We used a case-crossover design to examine the association between maximum and average pollen concentrations and asthma admissions. For this purpose, we compared pollen concentrations and incidence of admissions for asthma at the time of admission to hospital with values of the same variables 2, 3, 4, 5, and 6 days before admission. Each case is then its own control using the days preceding the admission day. For the same case-control pair, all covariates that are stable over time have the same value, a fact that reduces considerably the impact of confounding. Variables that change from day to day such as minimum and maximum daily temperatures and humidity were introduced in the model for adjustment. We analyzed the data set

using logistic regression and obtained adjusted odds ratios (ORs).

The Review Board on Human Studies at our institution approved the protocol.

All analyses were carried out with Stata Statistical Software (release 8; College Station, TX, USA).

RESULTS

Between 1995 and 2007, there were 6,687 admissions, of which 63% were female, in our hospital with asthma as first or secondary diagnosis. Mean age was 52.1 years (standard deviation, 24.8 years) and the average hospital stay was 10.4 days (standard deviation, 11.7 days).

The pollen level shows a seasonal pattern, with the highest level in April (Figure 1).

The maximum pollen levels had a median of 52 grains/m³ (interquartile range, 13–142 grains/m³), with 71% of the days below 120 grains/m³.

Our climate is humid (between 125 and 190 days with rain per year), with mild temperatures. During the study period, the mean daily temperatures varied between 5.9°C in February 2005 and 20.4°C in August 1999.

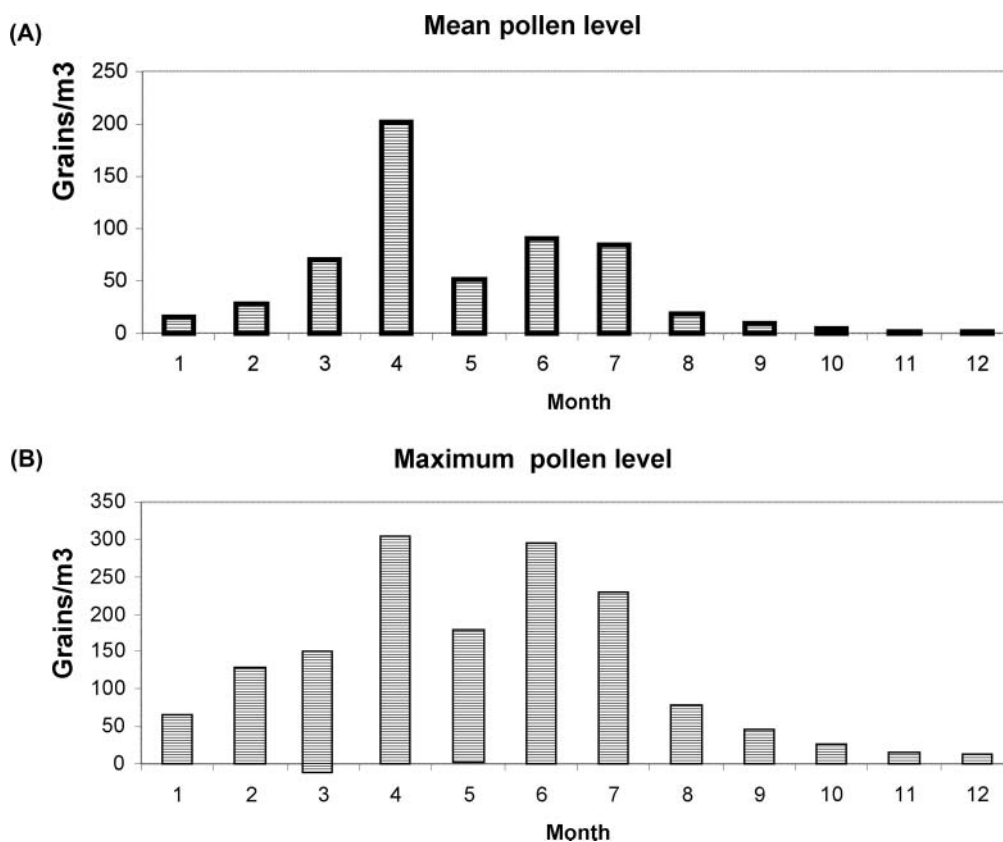


Fig. 1. Daily (A) mean and (B) maximum pollen levels by month (mean value for each month). From January (1) to December (12). Pollen level in grains per cubic meter.

Table 1.—Relative Risks (95% Confidence Intervals) of Asthma Hospital Admissions, According to the Mean Pollen Level (in Quartiles) Several Days Before Outbreak

Exposure day	Male			Female		
	Quartile	RR	95% CI	Quartile	RR	95% CI
-2	1st quartile	1		1st quartile	1	
	2nd quartile	0.99	(0.82–1.20)	2nd quartile	1.02	(0.88–1.18)
	3rd quartile	0.88	(0.68–1.14)	3rd quartile	1.16	(0.95–1.41)
	4th quartile	0.98	(0.71–1.35)	4th quartile	1.11	(0.87–1.41)
-3	1st quartile	1		1st quartile	1	
	2nd quartile	1.01	(0.83–1.22)	2nd quartile	0.98	(0.84–1.13)
	3rd quartile	0.99	(0.77–1.26)	3rd quartile	1.08	(0.89–1.31)
	4th quartile	1.06	(0.78–1.43)	4th quartile	1.17	(0.93–1.48)
-4	1st quartile	1		1st quartile	1	
	2nd quartile	1.01	(0.84–1.21)	2nd quartile	1.07	(0.92–1.23)
	3rd quartile	1.06	(0.83–1.35)	3rd quartile	1.11	(0.91–1.34)
	4th quartile	1.23	(0.92–1.65)	4th quartile	1.12	(0.89–1.41)
-5	1st quartile	1		1st quartile	1	
	2nd quartile	0.93	(0.77–1.12)	2nd quartile	1.07	(0.93–1.24)
	3rd quartile	0.84	(0.66–1.07)	3rd quartile	1.14	(0.95–1.38)
	4th quartile	0.93	(0.70–1.23)	4th quartile	1.23	(0.99–1.54)
-6	1st quartile	1		1st quartile	1	
	2nd quartile	1.01	(0.85–1.21)	2nd quartile	1.01	(0.87–1.17)
	3rd quartile	0.86	(0.68–1.09)	3rd quartile	1.22	(1.01–1.48)
	4th quartile	0.94	(0.71–1.25)	4th quartile	1.24	(0.99–1.55)
-7	1st quartile	1		1st quartile	1	
	2nd quartile	1.04	(0.87–1.25)	2nd quartile	1.07	(0.93–1.23)
	3rd quartile	0.90	(0.71–1.14)	3rd quartile	1.30	(1.08–1.57)
	4th quartile	1.08	(0.82–1.44)	4th quartile	1.32	(1.06–1.65)

Note. Relative risks were adjusted for maximum temperature and humidity.

We did not observe any effect of the rainfall quantity, humidity, and daily minimum temperature on the risk of admissions due to asthma. High daily maximum temperature and low relative humidity were associated with lower probability of admissions due to asthma, although the magnitude of the effect was slight (data not shown).

When we considered the 5th, 6th, and 7th days before admission, high levels (4th quartile of distribution) of daily average pollen levels showed a moderate but statistically significant effect on the risk of asthma admissions among women, with ORs that varied between 1.22 and 1.32. The same levels for the rest of the days analyzed did not exert any increase in the risk of admission for any gender (Table 1, Figure 2).

Whereas the effect of high mean levels of pollen was weak to moderate, that of high maximum levels was dramatic. The risk of asthma admission was significantly increased in both genders for the 2nd, 3rd, and 4th quartiles of distribution of daily maximum pollen. This increase in the risk can be observed for every day considered in our analysis (2 to 7 days before admission) and ranged between 5.5 and 11.8 times (Table 2, Figure 3). However, we could not detect any dose-response gradient, as, in general, the effect in the 2nd quartile

of distribution was stronger than that of the 3rd and 4th quartiles.

COMMENT

Our results show that high average pollen levels cause a slight to moderate increase in hospital admissions due to asthma, whereas high daily peak exposures exert a much more dramatic effect. This difference between minute effects of average values and important effects of peak values was demonstrated for other inhaled agents. Pulp mill workers exposed to peak levels of irritant gases have a higher risk of asthma or respiratory symptoms than those workers exposed to the same gases but not exposed to peak levels.¹⁵

An increase in consultations and admissions associated with high levels of environmental pollen was observed in former studies.^{5,16,17} However, other authors failed to observe any relationship.^{18,19} The debate on the effect of pollen on morbidity has no clear answer yet. These conflicting results could be due to methodological differences between studies, including differences in the statistical analysis, the populations studied, and the effect considered, as some authors

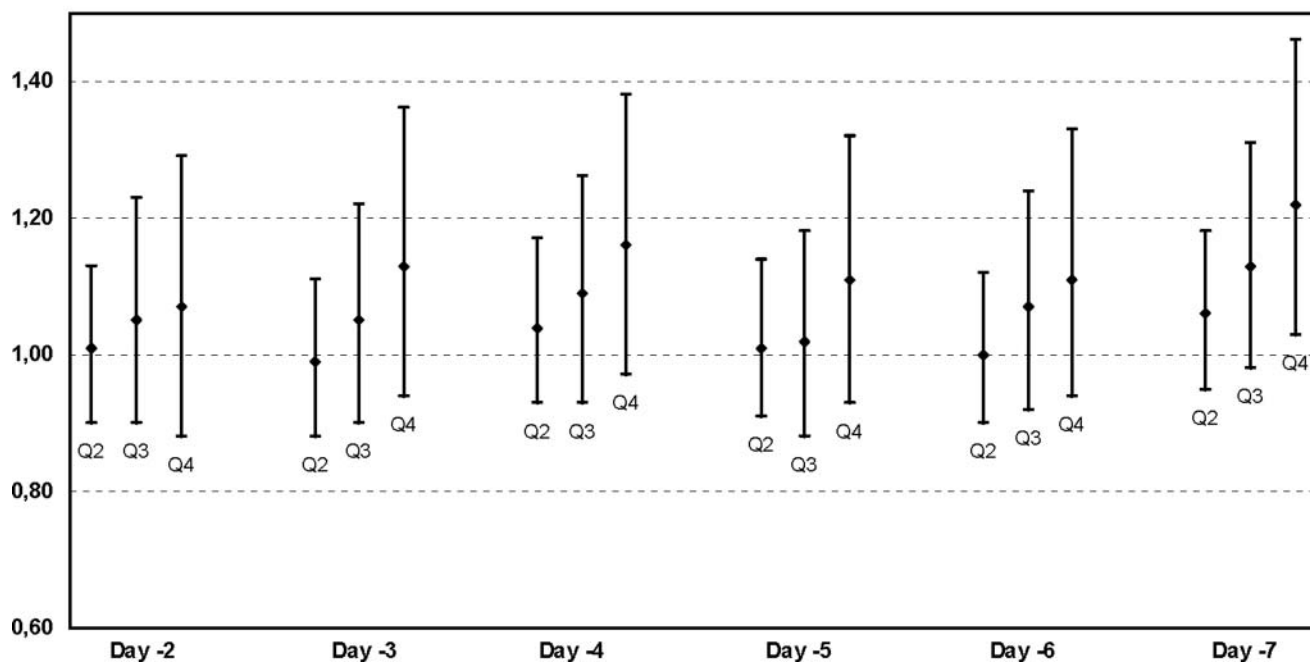


Fig. 2. Relative risks (95% confidence intervals), adjusted for maximum temperature and humidity, of asthma hospital admissions, according to the mean pollen level (in quartiles) several days before outbreak. Q2 = 2nd quartile; Q3 = 3rd quartile; Q4 = 4th quartile.

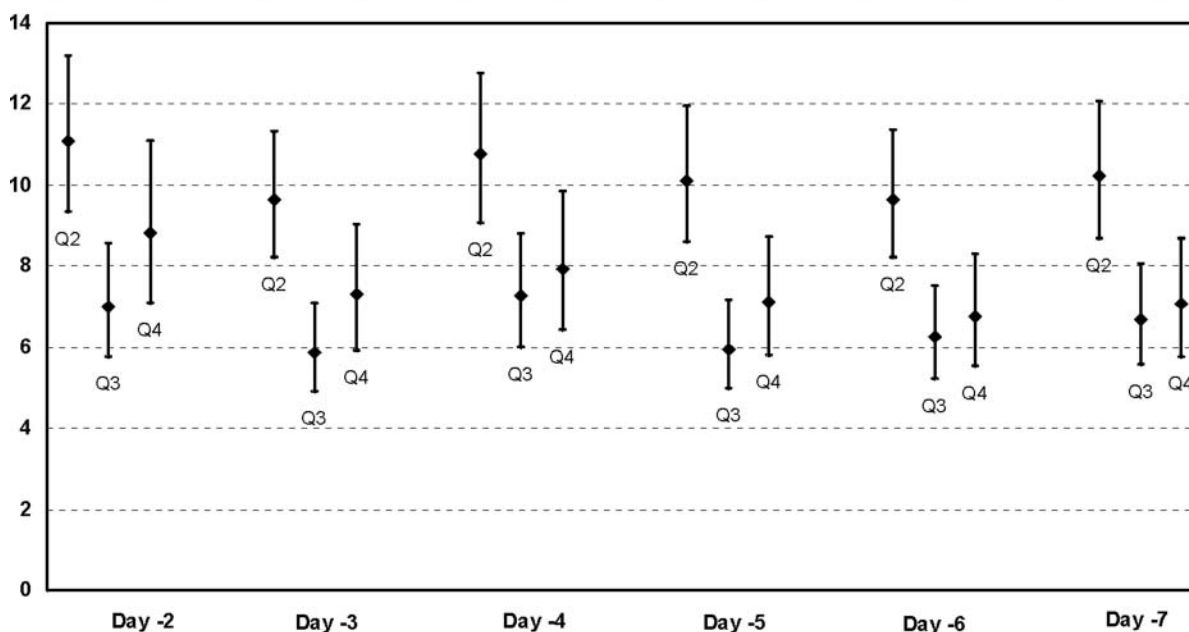


Fig. 3. Relative risks (95% confidence intervals), adjusted for maximum temperature and humidity, of asthma hospital admissions, according to the maximum pollen level (in quartiles) several days before outbreak. Q2 = 2nd quartile; Q3 = 3rd quartile; Q4 = 4th quartile.

Table 2.—Relative Risks (95% Confidence Intervals) of Asthma Hospital Admissions, According to the Maximum Pollen Level (in Quartiles) Several Days Before Outbreak

Exposure day	Male			Female		
	Quartile	RR	95% CI	Quartile	RR	95% CI
–2	1st quartile	1		1st quartile	1	
	2nd quartile	11.81	(8.83–15.79)	2nd quartile	10.68	(8.60–13.27)
	3rd quartile	6.95	(4.99–9.68)	3rd quartile	7.04	(5.51–8.99)
	4th quartile	9.18	(6.29–13.40)	4th quartile	8.60	(6.49–11.40)
–3	1st quartile	1		1st quartile	1	
	2nd quartile	11.01	(8.36–14.49)	2nd quartile	8.97	(7.34–10.95)
	3rd quartile	5.86	(4.30–7.98)	3rd quartile	5.91	(4.70–7.43)
	4th quartile	7.45	(5.23–10.60)	4th quartile	7.22	(5.56–9.39)
–4	1st quartile	1		1st quartile	1	
	2nd quartile	11.24	(8.47–14.90)	2nd quartile	10.51	(8.48–13.03)
	3rd quartile	7.29	(5.32–10.00)	3rd quartile	7.28	(5.72–9.26)
	4th quartile	9.16	(6.42–13.06)	4th quartile	7.29	(5.57–9.55)
–5	1st quartile	1		1st quartile	1	
	2nd quartile	10.70	(8.15–14.03)	2nd quartile	9.80	(7.99–12.03)
	3rd quartile	5.83	(4.30–7.91)	3rd quartile	6.06	(4.81–7.63)
	4th quartile	7.18	(5.10–10.10)	4th quartile	7.06	(5.46–9.14)
–6	1st quartile	1		1st quartile	1	
	2nd quartile	10.59	(8.06–13.92)	2nd quartile	9.18	(7.51–11.21)
	3rd quartile	5.71	(4.21–7.75)	3rd quartile	6.65	(5.29–8.34)
	4th quartile	6.63	(4.70–9.33)	4th quartile	6.89	(5.34–8.89)
–7	1st quartile	1		1st quartile	1	
	2nd quartile	10.59	(8.09–13.86)	2nd quartile	10.03	(8.14–12.36)
	3rd quartile	5.53	(4.10–7.46)	3rd quartile	7.54	(5.95–9.55)
	4th quartile	6.33	(4.54–8.83)	4th quartile	7.55	(5.81–9.81)

Note. Relative risks were adjusted for maximum temperature and humidity.

analyzed emergency admissions for asthma,^{10,18} whereas others included hospital admissions at large.^{16,19}

Our data appear to support the nonlinear effect of pollen in asthma exacerbations, given that the maximum effect is observed in the 2nd quartile of the distribution of peak levels of pollen. This finding indicates that there may be a pollen “threshold level” that triggers asthma exacerbations that are sufficiently intense to lead to hospital admission.^{5,16,20} Another possible explanation could be that the increase in hospital admissions occurs mainly among pollen-sensitized patients, and once these are affected, the effect on the nonsensitized population may be lower.¹⁶ The larger effect of pollen exposure in sensitized subjects when compared with the effect among nonsensitized patients is supported in several studies. It is known that, in pollen-sensitized patients, FeNO is higher during the pollen season.²¹ Furthermore, during this season blood eosinophil count increases.²² An increase in the leukocyte profile in bronchial biopsy among asthmatics and an increase in bronchial hyperreactivity were also observed.²³

The case-crossover design is a method for investigating the effects of acute exposure on health.²⁴ This design reduces the confounding effect of variables such as treatment, socioeconomic status, or environmental smoking. However, it may be

vulnerable to problems of selection of the control period. In our study, to avoid this problem, we chose all the days in the previous week as control and thus could compare the effects throughout a wide period of exposure.

Our work has some limitations. The use of an administrative database to identify patients admitted for asthma does not enable the diagnosis of asthma to be confirmed with certainty. However, it has been shown that asthma diagnosis based on coding is generally accurate. According to Campbell et al, the accuracy rate for diagnoses based on coding is about 80%.²⁵ For well-recognized acute conditions, such as asthma, the agreement is even higher.²⁶

Nevertheless, the cause-effect relationship must be interpreted with caution. There are some important variables that could not be assessed in this study. Smoking, comorbidities, indoor allergen exposure, adherence to treatment, and level of asthma control are a few of them. However, their potential confounding effect is not real, as these variables are unlikely to be different for the same patient between the admission day and at most 1 week before the admission day. Other variables such as nitrogen dioxide, sulfur dioxide, ozone, and particulates may confound the relation observed. This information was not available; also, we were unable to gather information on the type of pollen.

In conclusion, in view of these findings, it would be justified to encourage asthma patients to increase their preventive treatment on days with pollen levels higher than the identified trigger level.

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