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Rhinitis, Sinusitis and Upper Airway Disease



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Google Trends and pollen concentrations in allergy and airway diseases in France

Jean Bousquet^{1,2,3,4,5,6} | Gabrielle L. Onorato¹ | Gilles Oliver⁷ | Xavier Basagana^{8,9,10} |
 Isabella Annesi-Maesano¹¹ | Sylvie Arnavielhe¹² | Jean-Pierre Besancenot⁷ |
 Isabelle Bosse¹³ | Philippe J. Bousquet¹⁴ | Denis André Charpin¹⁵ | D. Caillaud¹⁶ |
 Pascal Demoly¹⁷ | Philippe Devillier¹⁸  | Eve Mathieu-Dupas¹² |
 Jean-François M. Fontaine¹⁹ | Jocelyne Just²⁰ | Josep M. Anto^{8,9,10,21} |
 João Fonseca^{22,23} | Uwe Berger²⁴ | Michel Thibaudon⁷

¹MACVIA-France, Fondation partenariale FMC VIA-LR, Montpellier, France

²INSERM U 1168, VIMA: Ageing and Chronic Diseases Epidemiological and Public Health Approaches, Villejuif, France

³UMR-S 1168, Université Versailles St-Quentin-en-Yvelines, Montigny le Bretonneux, France

⁴Euforea, Brussels, Belgium

⁵Comprehensive Allergy Center, Department of Dermatology and Allergy, Charité – Universitätsmedizin Berlin, Berlin, Germany

⁶Corporate Member of Freie Universität Berlin, Humboldt-Universität zu Berlin, Berlin Institute of Health, Berlin, Germany

⁷RNSA (Réseau National de Surveillance Aérobiologique), Brussieu, France

⁸ISGlobal, Centre for Research in Environmental Epidemiology (CREAL), Barcelona, Spain

⁹CIBER Epidemiología y Salud Pública (CIBERESP), Barcelona, Spain

¹⁰Universitat Pompeu Fabra (UPF), Barcelona, Spain

¹¹Epidemiology of Allergic and Respiratory Diseases, Department Institute Pierre Louis of Epidemiology and Public Health, INSERM and Sorbonne Université, Medical School Saint Antoine, Paris, France

¹²KYomed INNOV, Montpellier, France

¹³Allergist, La Rochelle, France

¹⁴EPAR U707 INSERM, Paris and EPAR UMR-S UPMC, Paris VI, Paris, France

¹⁵Clinique des bronches, allergie et sommeil, Hôpital Nord, Marseille, France

¹⁶Service de pneumologie, CHU et université d'Auvergne, Clermont-Ferrand, France

¹⁷Department of Respiratory Diseases, Montpellier University Hospital, Montpellier, France

¹⁸Laboratoire de Pharmacologie Respiratoire UPRES EA220, Université Versailles Saint-Quentin, Université Paris Saclay, Hôpital Foch, Suresnes, France

¹⁹Allergist, Reims, France

²⁰Allergology Department, Centre de l'Asthme et des Allergies Hôpital d'Enfants Armand-Trousseau (APHP), Paris, France

²¹IMIM (Hospital del Mar Research Institute), Barcelona, Spain

²²CINTESIS, Center for Research in Health Technology and Information Systems, Faculdade de Medicina da Universidade do Porto, Porto, Portugal

²³MEDIDA, Lda, Porto, Portugal

²⁴Department of Oto-Rhino-Laryngology, Aerobiology and Pollen Information Research Unit, Medical University of Vienna, Vienna, Austria

Correspondence

Jean Bousquet, CHU Arnaud de Villeneuve,
Montpellier, France.

Email: jean.bousquet@orange.fr

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Abstract

Background: Google Trends (GTs) is a web-based surveillance tool that explores the searching trends of specific queries via Google. This tool proposes to reflect the real-life epidemiology of allergic rhinitis and asthma. However, the validation of GTs against pollen concentrations is missing at the country level.

Objectives: In the present study, we used GTs (a) to compare the terms related to allergy in France, (b) to assess seasonal variations across the country for 5 years and (c) to compare GTs and pollen concentrations for 2016.

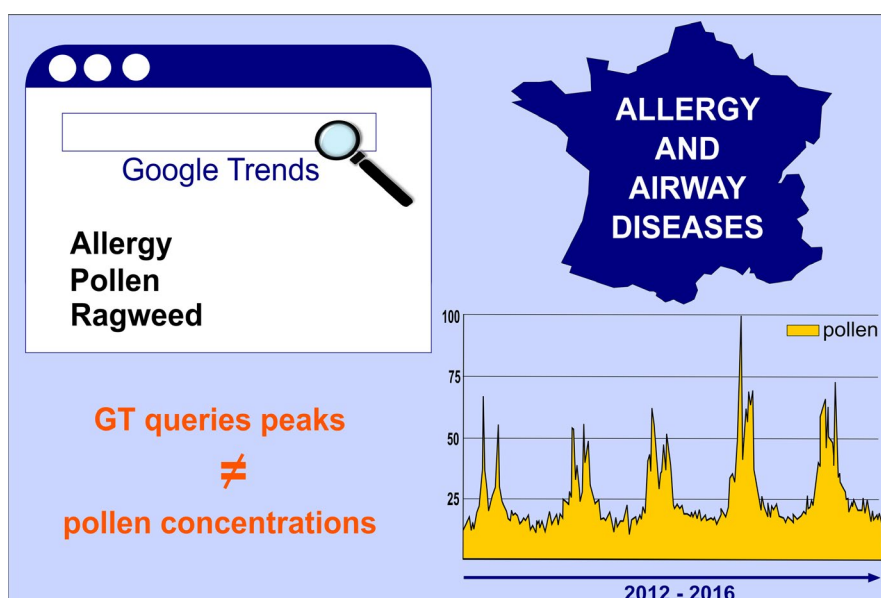
Methods: Google Trends queries were initially searched to investigate the terms reflecting pollen and allergic diseases. 13- and 5-year GTs were used in France. Then, 5-year GTs were assessed in all metropolitan French regions to assess the seasonality of GTs. Finally, GTs were compared with pollen concentrations (*Réseau National de Surveillance en Aerobiology*) for 2016 in seven regions (GTs) and corresponding cities (pollen concentrations).

Results: The combination of searches for “allergy” as a disease, “pollen” as a disease cause and “ragweed” as a plant was needed to fully assess the pollen season in France. “Asthma” did not show any seasonality. Using the 5-year GTs, an annual and clear seasonality of queries was found in all regions depending on the predicted pollen exposure for spring and a summer peak but not for winter peaks. The agreement between GT queries and pollen concentrations is usually poor except for spring trees and grasses. Moreover, cypress pollens are insufficiently reported by GTs.

Conclusions: Google Trends cannot predict the pollen season in France.

KEYWORDS

allergy, asthma, google trends, pollen, rhinitis

**GRAPHICAL ABSTRACT**

Google Trends (GTs) is a web-based tool that explores searching trends. This tool was used to search the terms related to allergy in France, to assess 5-year seasonal variations across the country and to compare GTs with the pollen concentrations for 2016. The combination of terms “allergy,” “pollen” and “ragweed” was needed to fully assess the pollen season in France. GTs cannot predict the pollen season in France.

1 | INTRODUCTION

For patients who are allergic to pollen, knowledge regarding the onset and duration of the pollen season is of great importance.¹⁻⁴ It is therefore essential to be able to forecast the onset of the pollen season as well as to characterize seasons in different places using sentinel networks.⁵⁻⁷ Pollen concentrations can assess the exposure of pollen-allergic patients.⁸ The assessment of allergen content in the air is feasible⁹ but requires sophisticated methods that may not account for all of the pollen species in the ambient air. Furthermore, individual measurements are not feasible. Meteorological data may, in the future, be of interest for predicting the onset of the season, but more data are required.¹⁰ Combining several sources using advanced data engineering may also be important but these data are still complex and, in many different areas, not yet available for all pollen species.^{5,6,11}

Google Trends (GTs) is a web-based surveillance tool that uses Google to explore the searching trends of specific queries. Recent studies have suggested the utility of GTs for assessing the seasonality of allergic diseases.¹²⁻¹⁴ GTs closely reflect the real-world epidemiology of allergic rhinitis and could potentially be used as a monitoring tool for allergic rhinitis.^{13,15} However, there are cultural differences between countries, and, therefore, the same terms might not be used similarly in all countries.¹³ Moreover, for the development of a pan-European sentinel network, these terms should be clearly defined.

France is a country with several climates (Figure S1), and the major allergenic pollen species can be found with different levels depending on the climate (Cypress, Birch, Grass and Ragweed). It is therefore an interesting country to study. The present study was conceived to explore the use of GTs in the epidemiological surveillance of AR in conjunction with pollen concentrations. In the present study, we analysed multiple time series of Google search data on rhinitis, allergy and asthma in France from 2004 to 20 December 2016. We compared RNSA (*Réseau National de Surveillance en Aerobiologie*) pollen concentrations in some French regions with GTs for 2016. The aim was (a) to assess whether GT queries could provide an accurate report on seasonality of rhinitis, asthma or pollen, and (b) to determine whether GTs differ from pollen concentrations.^{3,16,17}

2 | METHODS

2.1 | Google Trends

Google Trends are based on Google Search and show how often a particular search term is entered relative to the total search volume across various regions of the world and in various languages. The horizontal axis of the main graph represents time (starting from 2004), and the vertical axis shows how often a term is searched relative to the total number of searches globally. Google Trends are one of the world's largest real-time data sets with trillions of searches

every year. Examining GTs provides a unique perspective on what people are currently interested in and curious about. Increases in GTs therefore occur during an outbreak of a disease^{18,19} or when a big news story is reported (awareness peak).²⁰

According to Google (<https://support.google.com/trends/answer/4365533?hl=en>), search results are proportionate to the time and location of a query. Each data point is divided by the total searches of the geography and time range it represents, in order to compare relative popularity. Otherwise, places with the greatest search volume would always have the highest ranking. The resulting numbers are then scaled on a range of 0 to 100 based on a topic's proportion to all searches on all topics. Different regions that show the same number of searches for a term may not have the same total search volumes.

We attempted to search for all possible terms or combinations. However, the following terms were used:

- "rhinitis," "allergic rhinitis," "hay fever," "asthma," "allergy," "conjunctivitis" (disease and/or medical condition or research term),
- "pollen" (disease cause or research term),
- "birch," "cypress," "grass," "*Parietaria*," "ragweed," "*Ambrosia*," ash (plant or research term). The terms are those proposed by GTs (eg Poaceae for grass, birch for *Betula*).
- "antihistamine," "salbutamol," "seretide," "symbicort," "terbutaline" (drug or medication or research term), "cetirizine," "desloratadine," "fexofenadine," "loratadine," "levocetirizine" (antihistamine or medication or treatment or drug or research term). The terms were selected using the generic names except for combinations ("seretide" and "symbicort"). "Innovair" was not retrieved.
- RNSA (research term).

We did not analyse intranasal or inhaled corticosteroids since these formulations cannot be distinguished. Moreover, there were very few queries with "fluticasone" or "mometasone."

Only the terms associated with "disease," "plant," "medication" and "subject" are translated by GTs in all languages. Those associated with "research terms" are not translated. Moreover, "research terms" queries were similar and always identical to the other terms. We did not therefore consider "research terms" in the study.

Some terms cannot be used to assess pollens with GTs (eg olive or mugwort) because they refer to terms not related to pollens (eg olive oil).

Searches were conducted in French but for an international journal we used the English translations.

2.2 | Outcomes

We first focussed on the terms used in the GT queries from 2004 to 2016 and compared the terms for 13 years, 5 years and the past 12 months. We then selected the time frame and the terms to be studied.

We examined the GT queries in France and in the 22 Mainland French Regions. Mainland France (*métropolitaine*) was divided into 22 regions before 2016 (Figure S1: climates of France). GTs were examined by visual inspection as the seasonality of GTs was sufficiently clear.

2.3 | Pollen concentrations

We used pollen concentrations provided by the RNSA for 2016 and compared the pollen seasons for the major allergenic taxa of the area with GTs. We selected seven French regions depending on their climate and pollen seasons (Ile-de-France, Limousin, Lorraine, Midi-Pyrénées, Nord-Pas-de-Calais, Pays de la Loire, Provence-Alpes-Côte d'Azur and Rhône-Alpes) and one representative city where the pollen concentrations were available (Paris, Limoges, Metz, Toulouse, Lille, Cholet, Aix-en-Provence and Lyon (Figure S1). The major allergenic pollen taxa are represented in these regions (Cupressaceae, Birch, Ash, Grass and Ragweed). Moreover, the total number of taxa was reported to reflect the entire pollen content of the air pollen rain. Pollen concentrations were performed in each centre individually and for a period of 31 to 39 weeks.^{16,17,21}

2.4 | Agreement between pollen concentrations and GT

There are many ways of assessing agreements between two measurements. Agreement between methods with multiple observations can be used but the method proposed by Bland and Altman²²

does not appear to be possible for the present study since the levels of pollen concentrations vary widely between species (eg very large concentrations for cypress pollen by comparison to others).

We used two different methods to quantify the agreement between GTs and pollen concentrations. In the first analysis, we calculated the Spearman correlations between the GT measurements and the pollen concentrations for each region. High correlations (close to one) indicate that the two series co-vary in a similar way, while values close to zero indicate that the two series vary independently.

In the second analysis, we quantified the agreement between the annual peak of pollen and the annual peak of GT queries. Peaks were defined using two cut-offs, the 75th and the 95th percentiles. Agreement in occurrence of peaks was assessed using Cohen's kappa statistic. Values of <0 indicate no agreement, while often, values below 0.40 are considered as poor agreement, 0.40-0.75 as fair to good agreement and over 0.75 as excellent agreement.²³ The medians, 75 and 95 percentiles, were computed for each measure (pollen concentrations and GT measurements). For pollen concentrations, there are periods with zero levels and we only computed periods with over 1 pollen/m³. On the other hand, for GTs, there are queries all year round and we computed all of the year's data. We used two classical cut-offs: 75th percentile for the pollen season or significant GT queries and 95th percentile for the peak of the pollen season or peak of GT queries. In the kappa test, we calculated the average time of the seasons and of the peaks of seasons for the five pollen taxa (Cypress, Birch, Ash, Grass and Ragweed) as well as the three GT measurements (allergy, pollen and ragweed).

TABLE 1 Mean GT queries for three periods of survey in France

	GT query GT term	Number of queries (GT search)			Selected term for further analyses
		13 y	5 y	Past year	
Allergy	"Disease"	52	52	67	Yes
Allergy	"Research term"	38	40	51	No ("research term" follows "disease" but at a lower level)
Hay fever ^a	"Disease"	3	3	3	Yes
Rhinitis	"Research term"	4	4	5	Yes
Asthma	"Disease"	14	12	14	No seasonal pattern
Conjunctivitis	"Disease"	9	10	14	No seasonal pattern
Pollen	"Disease cause"	12	12	16	Yes
Ragweed	"Plant"	4	4	4	Yes
Birch		8	8	11	Yes
Poaceae ^b	"Plant"	4	4	5	No seasonal pattern
Ash	"Research term"	1	1	1	No seasonal pattern
Cypress	"Plant"	1	1	1	No seasonal pattern
<i>Parietaria</i>	"Plant"	0	0	0	No
Antihistamines	"Treatment"	3	4	6	Yes
RNSA	"Research term"	0	0	0	No

^aGeneric term used for allergic rhinitis or rhinitis.

^bGeneric term for grass.

3 | RESULTS

3.1 | Selection of the GT terms

We analysed the selected terms for 13 years, 5 years and the past 12 months (Table 1 and Figure S1). The same trends were observed for the three time periods, and we selected the 5-year GTs for the selection of terms and future analyses since this allows weekly assessments.

It was found that “allergy” as a disease was the most commonly searched term. We used “allergy” as a disease rather than the research term since there were parallel GTs. “Allergic rhinitis,” “rhinitis” and “hay fever” were all reported under the term “hay fever”

as a disease or a medical condition as proposed by GT. “Asthma” or “conjunctivitis” as a disease did not show any discernable seasonal patterns in the 13- and 5-year or past-year GT graphs and this was considered no further. “Hay fever,” “Pollen,” “birch” and “ragweed” have clear seasonality. Grass pollen shows a small bump during the expected season. “Cypress” or “Cupressaceae” and “*Parietaria*” are almost never detectable.

3.2 | Diseases and pollens

Using the GT 5-year graph and the terms selected from Table 1, an annual and clear seasonality of queries for “allergy” was found in France and in most French regions (Figure 1).

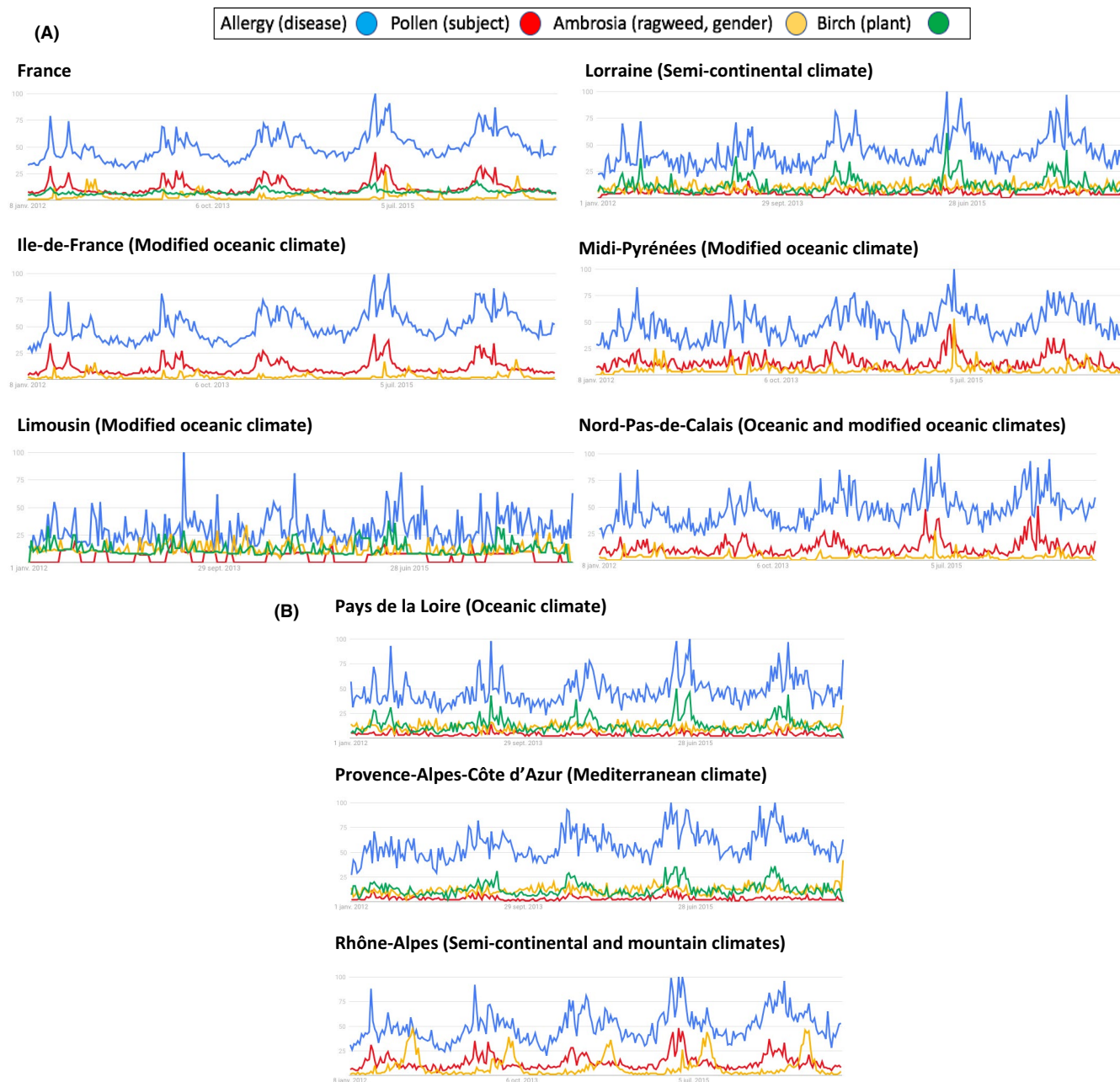


FIGURE 1 Google Trends in France and selected regions for 5 y (2012-2016)

The GT queries for “allergy” showed similar patterns all over France. Only one of the 22 regions could not be analysed due to an insufficient number of queries (Corsica). Although there are differences in magnitude, two peaks of queries attributed to “allergy” occurred in all regions and every year for the 5-year survey: the first one in early spring and the second one in spring. In Languedoc-Roussillon and Provence-Alpes-Côte d’Azur (PACA), an earlier trend (winter) was found. In Rhône-Alpes and, to a lesser extent, in some neighbouring regions, a summer peak was observed for many years.

The GT queries for “hay fever” were low by comparison to those for “pollen” but followed similar patterns.

The peaks for “Pollens” followed trends similar to “allergy” (Figure 2). “Cypress” or “Cupressaceae” did not show any seasonal trend in Languedoc-Roussillon and Provence-Alpes-Côte d’Azur and were not specifically searched in other regions. “Birch” pollen queries were found to a lesser extent than “pollen” in the regions where patients are exposed to the pollen species and at the time of pollination. “Grass” pollen queries were modestly increased during the pollen season in France and in some regions only. “Ragweed” pollen queries were high in Rhône-Alpes (the region with the highest exposure to this pollen) and in some other regions during the expected pollen season.

Summer trends for “ragweed pollen” were seldom associated with those of “pollen” or “allergy” whereas early spring and spring trends for “pollen” were associated with those of “allergy.”

There were some peaks of queries for ragweed pollen in May–June, particularly in 2015. Another peak occurred in April 2012. These peaks occurred across France without any geographical distribution. A last peak of queries occurred in December 2016 in many regions.

Twenty-one regions could be studied. However, searches in Corsica were too low to make any study possible. The background variability of searches was low in France, Ile-de-France and Rhône-Alpes corresponding to the population number of these areas. It was high or very high in less populated regions.

The early and late spring peaks of queries were consistently found in all regions and were variable between years (Table 2). The summer peak was found consistently in Rhône-Alpes, Franche-Comté, Ile-de-France, PACA and Poitou-Charentes. However, only in Rhône-Alpes were the peaks high. In many other regions, the peak was low and inconsistent between years. A “ragweed” peak occurred in

many regions for 2012 only. In the Mediterranean area (Languedoc-Roussillon and PACA), an earlier winter peak was detectable.

3.3 | Medications

The GT queries for “antihistamines” and some of the medications of the same class were very low when “allergy” was searched (Figure 1) but followed patterns similar to “allergy,” “pollen” or “ragweed” (Figure 2). Trends were higher for “antihistamines” and “cetirizine” than for other antihistamines (Figure S3).

3.4 | Agreement between pollen concentrations and GTs for 2016

Using the Spearman rank test, correlations between total taxons and the GT searches for “allergy” and “pollen” were moderate, indicating some co-variation between pollen and GTs, except in the Limousin region (Table S1). This was not the case for “Ambrosia” searches, with much smaller correlations. When looking at each pollen separately, correlations were in general lower (Tables S2A–C). Still, we found moderate correlations for cypress (the major contributor to total taxons), grass, ash and birch, with variations by region.

The ragweed pollen season is far larger with GTs than with RNSA and does not correspond to the symptomatic ragweed pollen season. Thus, Cohen’s kappa test did not take into account the ragweed RNSA pollen season and GTs for “ragweed” (Figure 3). Agreement between pollen concentrations and GTs is presented in Figures S3 and S4 as well as in Table 3. Although there are some similarities between pollen concentrations and GTs, there are major differences in time of the pollen season and pollen species. The differences between GT concentrations are relatively small,^{1–4} whereas pollen seasons are well defined with RNSA.

Cohen’s kappa test ranges from 0.21 to 0.72 between RNSA and GTs for a cut-off of 75 percentile (estimated to be the pollen season) and from 0.18 to 0.57 for a cut-off of 95 percentile (estimated to be the peak of the pollen season).

The early spring tree pollen season and the grass pollen season are relatively well identified with GTs. On the other hand, overall, the Cupressaceae pollen season is poorly detected by GTs, whereas the peaks of pollens are enormous and at least 10-fold higher than those of other pollen species (Figure S5). The ragweed pollen season is far

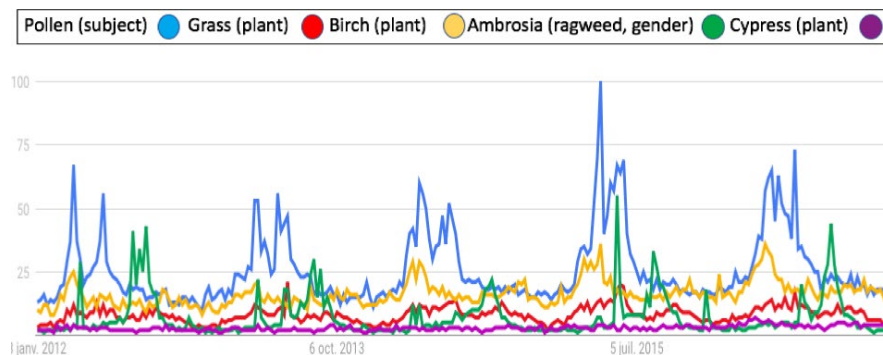


FIGURE 2 Google Trends in France for “pollens” for 5 y (2012–2016)

TABLE 2 Peaks of queries for the 5 past years in French regions

	Background variability	Early spring ^a		Late spring ^a		Summer ^b	
		Level	Number of years/5 y	Level	Number of years/5 y	Level	Number of years/5 y
Alsace	Medium	High	5	High	5	Low	4
Aquitaine	Medium	Variable	5	High	5	Low	2
Auvergne	Medium	Variable	5	Variable	5	Medium	5
Basse-Normandie	High	Variable	5	Low	5	Low	3
Bourgogne	Medium	High	5	Variable	5	Variable	3
Bretagne	High	Variable	5	Variable	5	Low	2
Centre-Val de Loire	Medium	High	5	High	5	Variable	2
Corse	Impossible to assess any value						
Champagne-Ardenne	High	Variable	5	Variable	5	Medium	1
Franche-Comté	Medium	Variable	5	Variable	5	Variable	5
Haute Normandie	Medium	High	5	High	5		
Ile-de-France	Low	High	5	High	5	Low	5
Languedoc-Roussillon	High	Variable	5	Variable	5	Low	2
Limousin	Very high	Variable	5	Variable	5	Medium	1
Lorraine	Medium	High	5	High	5	Low	2
Midi-Pyrénées	High	High	5	High	5	Low	3
Nord-Pas-de-Calais	Medium	High	5	High	5	Low	3
Pays de la Loire	Medium	High	5	High	5	Low	3
Picardie	High	High	5	High	5	Low	2
Poitou-Charentes	Very high	Variable	5	Variable	5	Variable	5
PACA	Very high	Variable	5	Variable	5	Low	5
Rhône-Alpes	Low	High	5	High	5	High	5

^aGTs based on “allergy” and/or “pollen.”^bGTs based on “ragweed.”

larger with GTs than with pollen concentrations but the peak of the ragweed pollen season is well identified with GTs.

4 | DISCUSSION

In the present study, the combination of searches for “allergy” as a disease, “pollen” as a disease cause and “ragweed” as a plant was needed to fully assess the pollen season in France. “Hay fever” was rarely reported and did not show a clear seasonality. Asthma did not show any seasonality. Using the GT 5-year graph, an annual and clear seasonality of queries was found in France (early and late spring and, for some regions, a summer peak). However, the relationship between peaks of GT queries and pollen concentrations is usually insufficient.

4.1 | Limitations and strengths

France is an optimal country for comparing GTs and RNSA due to the varied climates. This is perfectly assessed by pollen concentrations, but GTs do not account for some of the extremely important pollens (eg Cupressaceae). We did not compare pollen concentrations and

GTs across different years but it is clear that Cupressaceae pollens are not better identified by GTs in areas where they are prevalent (Languedoc-Roussillon).

We compared GTs for a French region with pollen concentrations of a single city of the region, and there may be regional differences. However, they would not have accounted for the lack of agreement found in the present study.

We assessed all possible terms related to pollen allergy and found that four are sufficient for reporting GTs (allergy, hay fever, pollen and ragweed). However, the same exercise should be done in every country since there are cultural differences.¹³ Furthermore, the translation of some of the terms (eg ragweed) should be made.

4.2 | Overall results

Five patterns were identified in European countries depending on searches in “allergy,” “pollen” and “hay fever.” France belongs to pattern C (“allergy” and “pollen” queries are similarly searched and “hay fever” queries are seldom searched).¹³ All French regions have a similar pattern indicating that there is no difference in searching across France. As in many countries, searches for “ragweed” as a plant were

Time of the analysis of the data ● ≥75th percentile ● ≥95th percentile ●

Weekly pollen counts (Metz)										Weekly pollen c RNSA Lyon										Weekly pollen counts (Toulouse)									
Amb	Birch	Cypress	Ash	Grass	Allergy	Pollen	Amb			Amb	Birch	Cypress	Ash	Grass	Allergy	Pollen	Amb			Amb	Birch	Cypress	Ash	Grass	Allergy	Pollen	Amb		
ND	ND	ND	ND	ND	45	6	1			ND	ND	ND	ND	ND	30	8	1			ND	ND	ND	ND	ND	53	6	2		
ND	ND	ND	ND	ND	44	8	1			ND	ND	ND	ND	ND	38	6	1			ND	ND	ND	ND	ND	31	6	2		
ND	ND	ND	ND	ND	30	13	1			ND	ND	ND	ND	ND	35	12	1			ND	ND	ND	ND	ND	45	11	3		
ND	ND	ND	ND	ND	46	12	1			ND	ND	ND	ND	ND	37	8	1			ND	ND	ND	ND	ND	48	10	3		
ND	ND	ND	ND	ND	37	13	1			ND	ND	ND	ND	ND	45	6	1			0	0	353.97	73.8	0	50	10	2		
ND	ND	ND	ND	ND	43	5	1			0.97	0.00	3.88	0.00	0.00	42	9	1			0	0	175.26	187	0	65	9	6		
ND	ND	ND	ND	ND	30	8	1			0.00	0.00	600.91	9.90	0.00	38	6	1			0	0	170.43	79.4	2.07	62	10	2		
ND	ND	ND	ND	ND	34	5	1			0.99	0.00	338.58	11.88	0.00	39	10	1			0	0	185.61	86.3	1.38	56	16	2		
ND	ND	ND	ND	ND	52	10	1			0.00	0.00	113.85	15.84	0.99	49	12	1			0	0	109.71	40	4.14	44	11	2		
0	0	255.2	0	0	47	9	2			0.00	0.00	1097.91	28.71	0.99	64	11	1			0	0	113.86	24.2	5.52	47	12	2		
0	4.4	125.5	1.1	0	63	10	2			0.00	0.00	3252.43	148.32	2.93	65	16	1			0	1.38	228.39	25.5	2.76	61	14	2		
0	6.6	250.8	19.8	0	55	9	2			0.00	0.99	1191.43	639.47	0.00	51	14	2			0	4.14	93.15	56.6	6.9	68	15	3		
0	7.7	47.3	18.7	0	64	17	3			0.00	0.00	229.61	912.25	0.00	62	14	3			0.69	34.2	131.1	77.3	5.52	79	22	4		
0	382.8	114.4	133	0	72	22	2			0.00	14.55	367.63	338.60	7.76	66	26	4			0	32.4	87.63	46.9	4.14	79	22	3		
0	1081	160.6	235	0	92	34	2			0.00	275.48	172.66	655.72	10.67	88	36	4			0	0	0	0	0	90	40	5		
0	1399	19.8	82.5	6.6	83	39	2			0.00	577.15	69.84	640.20	57.23	81	39	3			0	48.3	97.98	53.1	32.43	70	23	2		
0	114.4	12.1	11	12	65	20	1			0.00	263.84	127.07	516.04	268.69	51	17	4			0	34.5	67.62	2.76	83.49	69	26	2		
0	121	38.5	5.5	59	66	31	2			0.00	18.43	66.93	58.20	314.28	73	20	4			0	40	74.52	6.21	160.8	77	27	6		
0	3.3	4.4	2.2	99	63	34	2			0.00	11.64	105.73	43.65	321.07	100	53	3			0	12.4	30.36	2.07	114.5	74	20	2		
0	6.6	70.4	0	417	61	24	1			0.00	5.82	87.30	6.79	653.78	59	34	6			0	18.6	71.07	0.69	171.1	75	22	4		
0	0	31.9	0	419	33	12	2			0.97	1.94	8.73	1.94	816.74	87	43	26			0	7.59	33.81	0	149	89	26	6		
0	0	31.9	0	290	43	15	1			0.00	0.97	32.98	0.00	1575.28	76	31	7			0	0.69	33.12	0.69	211.8	65	26	5		
0	0	19.8	0	872	100	37	2			0.00	0.00	28.13	0.00	1020.44	67	20	5			0	1.38	31.74	0	389.9	67	36	3		
0	0	22	0	361	60	25	2			0.00	0.00	15.52	0.00	316.22	49	13	7			0	0	9.66	0	76.59	61	15	2		
0	0	47.3	0	323	71	25	6			0.00	0.00	30.07	0.00	273.54	49	13	9			0	0.69	41.4	0	258.1	64	21	14		
0	0	15.4	0	249	52	8	5			0.97	0.00	30.07	0.00	293.91	49	17	5			0	0	15.18	0	469.9	75	20	7		
0	0	3.3	0	220	60	17	3			0.00	0.00	46.56	0.00	341.44	47	13	10			0	0	3.45	0	547.2	63	21	7		
0	0	6.6	0	84	57	17	2			0.00	0.00	8.73	0.00	118.34	48	11	9			0	0	8.97	0	241.5	68	11	4		
0	0	3.3	0	61	56	11	3			0.97	0.00	5.82	0.00	48.50	45	11	10			0	0	4.83	0	57.96	73	15	3		
0	0	4.4	0	34	58	14	4			0.97	0.00	4.85	0.00	26.19	54	12	15			0	0	0	0	0	59	15	8		
0	0	6.6	0	53	54	10	5			0.97	0.97	3.88	0.00	21.34	50	10	14			0	0	0	0	0	51	10	4		
1.1	0	2.2	0	25	75	9	9			360.00	0.00	14.55	0.97	25.22	46	12	28			0	0	0	0	0	75	15	6		
0	0	0	0	24	34	13	10			100.00	0.00	8.73	0.00	16.49	45	13	34			0	0	0	0	0	57	9	9		
1.3	0	1.1	0	12	29	3	17			3160.00	0.97	10.67	0.00	5.82	60	10	39			7.59	0	2.07	0	24.15	74	21	26		
6.6	0	2.2	0	14	47	8	6			6400.00	0.00	1.94	0.00	22.31	49	13	34			29.67	0	0	0	22.08	63	17	15		
ND	ND	ND	ND	ND	51	11	5			460.00	0.00	5.82	0.00	6.79	52	12	31			32.43	0	0	0	17.25	65	20	3		
ND	ND	ND	ND	ND	44	11	3			1400.00	0.00	1.94	0.00	27.16	49	10	22			3.45	0	2.07	0	14.49	57	13	6		
ND	ND	ND	ND	ND	33	6	3			737.00	0.00	1.94	0.00	1.94	49	13	13			ND	ND	ND	ND	ND	64	9	3		
ND	ND	ND	ND	ND	40	8	3			40.00	0.00	6.79	0.00	1.94	47	10	5			ND	ND	ND	ND	ND	55	13	11		
ND	ND	ND	ND	ND	33	12	2			2.05	0.00	13.38	0.00	2.05	39	14	3			ND	ND	ND	ND	ND	48	13	9		
ND	ND	ND	ND	ND	47	12	1			2.16	0.00	7.98	0.00	4.96	29	11	1			ND	ND	ND	ND	ND	57	13	4		
ND	ND	ND	ND	ND	37	11	1			0.97	0.00	2.91	0.00	0.97	47	8	2			ND	ND	ND	ND	ND	45	15	6		
ND	ND	ND	ND	ND	38	10	1			ND	ND	ND	ND	ND	4	10	4			ND	ND	ND	ND	ND	50	12	9		
ND	ND	ND	ND	ND	30	10	1			ND	ND	ND	ND	ND	33	8	2			ND	ND	ND	ND	ND	58	8	9		
ND	ND	ND	ND	ND	64	9	1			ND	ND	ND	ND	ND	35	10	1			ND	ND	ND	ND	ND	41	8	3		
ND	ND	ND	ND	ND	55	10	1			ND	ND	ND	ND	ND	34	7	4			ND	ND	ND	ND	ND	57	5	3		
ND	ND	ND	ND	ND	35	3	1			ND	ND	ND	ND	ND	29	9	3			ND	ND	ND	ND	ND	59	10	3		
ND	ND	ND	ND	ND	43	9	1			ND	ND	ND	ND	ND	41	7	6			ND	ND	ND	ND	ND	49	10	3		
ND	ND	ND	ND	ND	47	5	1			ND	ND	ND	ND	ND	36	8	3			ND	ND	ND	ND	ND	43	8	5		
ND	ND	ND	ND	ND	33	14	1			ND	ND	ND	ND	ND	41	13	2			ND	ND	ND	ND	ND	47	10	3		
ND	ND	ND	ND	ND	38	9	1			ND	ND	ND	ND	ND	42	4	1			ND	ND	ND	ND	ND	42	7	4		
										ND	ND	ND	ND	ND	42	8	2			ND	ND	ND	ND	ND	57	4	6		

FIGURE 3 Agreement between GTs and pollen concentrations in three French Regions (2016)

not always associated with searches for “allergy” and never associated with searches for “pollen” as a disease cause (Bousquet et al, in revision). This finding is interesting since in the spring, “pollen” and “allergy” were associated but “ragweed” is never associated with “pollen” and rarely with “allergy.” Thus, the three terms are needed to account for allergic rhinitis in France.

The May-June “ragweed” peaks detected in many French regions represent awareness peaks since ragweed does not pollinate during these months. In particular, the 2015 May peak, is associated with a paper on ragweed pollen and climate change. This paper was published the same month and attracted a large media dissemination.²⁴ It is therefore important to correlate GTs for “ragweed” with the expected pollen season.

“Asthma” did not show any seasonality in France or French Regions. This finding is not surprising as peaks of asthma were only

found in Australia and Kuwait during the thunderstorm epidemic of November-December 2016.²⁴

The Spearman rank correlation was usually moderate for most but not all correlations. The Cohen's kappa test is usually under 0.50, and the agreement between GTs and RNSA is not satisfactory for the prediction of the pollen season if we consider RNSA to be the gold standard: (a) The term “ragweed” cannot be used. Ragweed GT queries cover a larger period than pollination. It is likely that many patients are aware of “ragweed” and use this term to report symptoms due to other allergen exposure. There are several GT awareness peaks without apparent allergen exposure. This peak was also found in other countries (Bousquet, in revision). In France, other peaks are found in May-June and may possibly be related to the information on Ragweed International Day, usually largely publicized. It is therefore of importance to correlate GTs for “ragweed” with the expected pollen

TABLE 3 Inter-rater agreement between pollen concentrations and GTs for 7 French regions

Region	PACA	Ile-de-France	Nord-Pas-de-Calais	Alsace-Lorraine	Rhône-Alpes	Midi-Pyrénées	Pays de la Loire	Limousin
City	Aix-en-Provence	Paris	Lille	Metz	Lyon	Toulouse	Cholet	Limoges
Time of collection (weeks)	1-39	6-38	8-38	10-36	6-42	5-37	2-37	7-39
Kappa test	0.46	0.21	0.53	0.63	0.52	0.22	0.26	0.72
95% percentile	0.20	0.41	0.33	0.57	0.51	0.18	0.22	0.57

season. There was another apparent awareness peak in December 2016.¹³ This peak is also found in many other countries and appears to be related to the Australia asthma death outbreak of late November 2016.¹⁴ (b) Excluding "ragweed," the overall prediction of the pollen season does not appear to be sufficient using GTs since there is a high background across all regions, and differences between low and high levels of queries are small. (c) The coverage of GTs is large in a region where different types of vegetation may be encountered (eg alpine and semi-continental in Rhône-Alpes). (d) Cupressaceae pollens are not sufficiently recognized by GTs, whereas they represent a large population of allergy sufferers in some parts of France.²⁵ The term "cypress" is not identified by GTs, and allergy sufferers do not necessarily recognize that their symptoms are associated with allergy. This represents a major problem in GTs.

On the other hand, GTs may be of interest as a complement to pollen concentrations as (a) they represent patient information, whereas pollens may not always represent symptoms; (b) when there is an overlap of pollen seasons, it may be important to examine GTs; (c) since pollen concentrations are not assessed during the entire year in France, GTs may identify some periods of allergen exposure; and (d) pollen concentrations are available for a reduced area but may not cover the entire region, and there may be gaps in coverage. It may therefore be of interest to combine pollen concentrations and GTs.

4.3 | Generalization and conclusions

The terms of Google Trends differ between countries, and the results obtained in this study need to be confirmed in other countries since there are cultural differences between European countries¹³ and the translation of terms is of great importance.²⁶ The goal of influenza-like illness surveillance was to determine the timing, location and magnitude of outbreaks by monitoring the frequency and progression of clinical case incidence using electronic data. GTs were thought to be extremely useful but were found inadequate in some analyses and their interest declined.²⁷⁻²⁹ The results of the present study are similar to the flu data. Current Internet search query data using GTs are no substitute for pollen concentrations. However, new generation surveillance systems including GTs, pollen concentrations and patients' data such as those obtained in MASK should incorporate the use of near real-time electronic health data and computational methods for continued model fitting and ongoing evaluation and improvement.²⁸

The results of the current study will be used in the development of the MASK sentinel network¹ and predictive medicine.³⁰ MASK (Mobile Airways Sentinel network) uses mobile technology to develop care pathways for the management of rhinitis and asthma by a multidisciplinary group and by patients themselves.³² The scaling up strategy uses the recommendations of the European Innovation Partnership on Active and Healthy Ageing.^{33,34}

CONFLICT OF INTEREST

J Bousquet reports personal fees and other from Chiesi, Cipla, Hikma, Menarini, Mundipharma, Mylan, Novartis, Sanofi-Aventis,

Takeda, Teva, Uriach, other from Kyomed, outside the submitted work. The other authors have no COI to declare.

ORCID

Philippe Devillier  <https://orcid.org/0000-0003-4107-8317>

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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Supplementary Table 1. Spearman correlation coefficients between total taxons and GT searches for the different regions.

Region	PACA	Ile-de-France	Nord-Pas De Calais	Alsace-Lorraine	Rhône-Alpes	Midi-Pyrénées	Pays de La Loire	Limousin
City	Aix-en-Provence	Paris	Lille	Metz	Lyon	Toulouse	Cholet	Limoges
"Allergy"	0.65	0.69	0.56	0.58	0.70	0.51	0.55	0.30
"Pollen"	0.68	0.73	0.60	0.62	0.69	0.62	0.61	0.26
"Ambrosia"	0.05	0.35	0.32	0.31	0.31	0.03	0.23	0.43

Supplementary Table 2a. Spearman correlation coefficients between Betula (birch) taxons and GT searches for the different regions.

	Region							
GT	PACA	Ile-de-France	Nord-Pas De Calais	Alsace-Lorraine	Rhône-Alpes	Midi-Pyrénées	Pays de La Loire	Limousin
“Allergy”	0.38	0.48	0.36	0.40	0.51	0.41	0.29	0.28
“Pollen”	0.56	0.7	0.51	0.50	0.58	0.61	0.44	0.30
“Ambrosia”	0.04	0.00	0.03	-0.03	-0.01	-0.10	0.01	0.20

Supplementary Table 2b. Spearman correlation coefficients between Cypres taxons and GT searches for the different regions.

	Region							
GT	PACA	Ile-de-France	Nord-Pas De Calais	Alsace-Lorraine	Rhône-Alpes	Midi-Pyrénées	Pays de La Loire	Limousin
“Allergy”	0.57	0.56	0.53	0.51	0.5	0.42	0.44	0.32
“Pollen”	0.63	0.73	0.56	0.54	0.57	0.55	0.58	0.17
“Ambrosia”	-0.03	0.12	0.15	0.21	0.07	-0.10	-0.01	0.26

Supplementary Table 2c. Spearman correlation coefficients between Fraxinus (ash) taxons and GT searches for the different regions.

	Region							
GT	PACA	Ile-de-France	Nord-Pas De Calais	Alsace-Lorraine	Rhône-Alpes	Midi-Pyrénées	Pays de La Loire	Limousin
“Allergy”	0.5	0.44	0.41	0.33	0.36	0.24	0.20	0.27
“Pollen”	0.63	0.64	0.57	0.47	0.50	0.43	0.38	0.13
“Ambrosia”	-0.16	-0.10	0.06	-0.11	-0.24	-0.27	-0.19	-0.09

Supplementary Table 2d. Spearman correlation coefficients between Gramineae (grass) taxons and GT searches for the different regions.

	Region							
GT	PACA	Ile-de-France	Nord-Pas De Calais	Alsace-Lorraine	Rhône-Alpes	Midi-Pyrénées	Pays de La Loire	Limousin
“Allergy”	0.44	0.63	0.49	0.42	0.67	0.58	0.53	0.27
“Pollen”	0.27	0.61	0.46	0.32	0.62	0.58	0.55	0.28
“Ambrosia”	0.41	0.53	0.40	0.48	0.61	0.26	0.38	0.56

Figure 1 online: France climates and Regions (2015)

<http://www.cartesfrance.fr/geographie/cartes-france-climat/carte-france-climat.html>

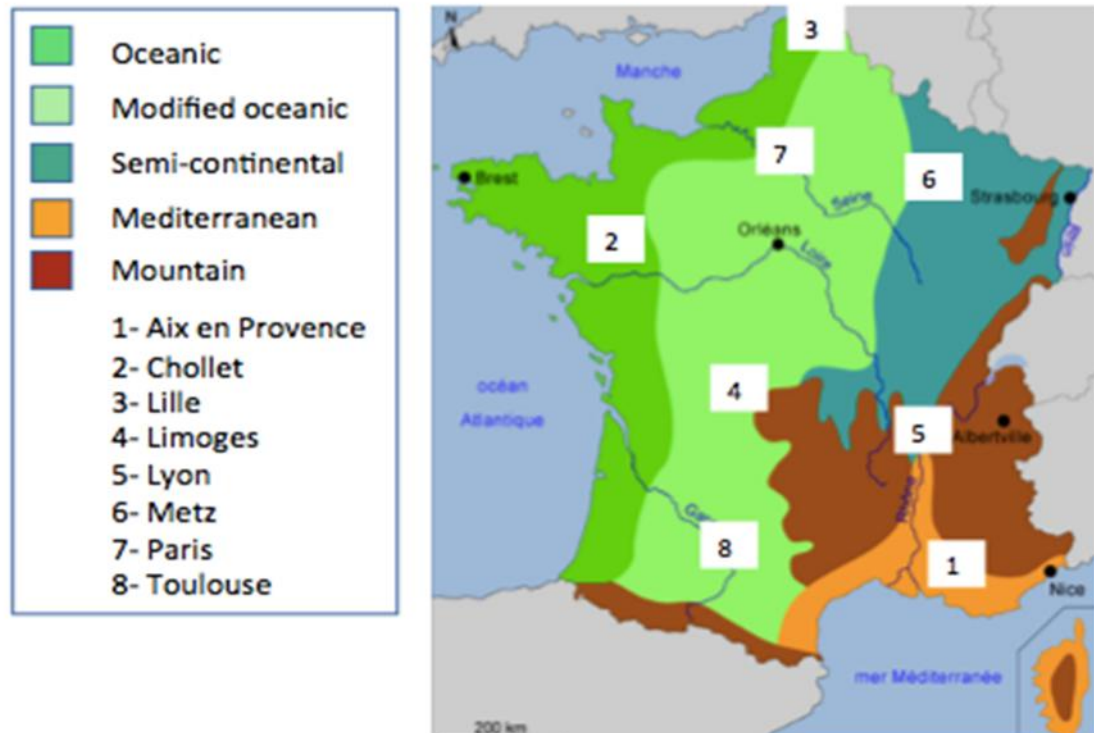
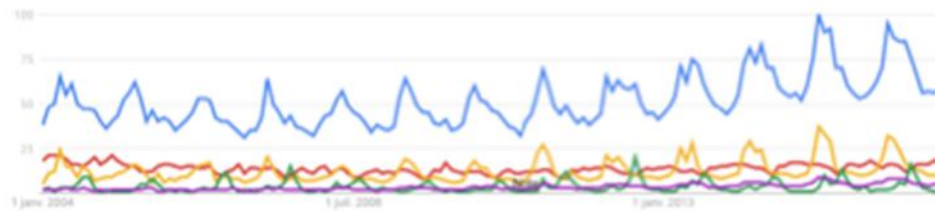




Figure 2 online: Selection of terms and time of study (GT results for France)

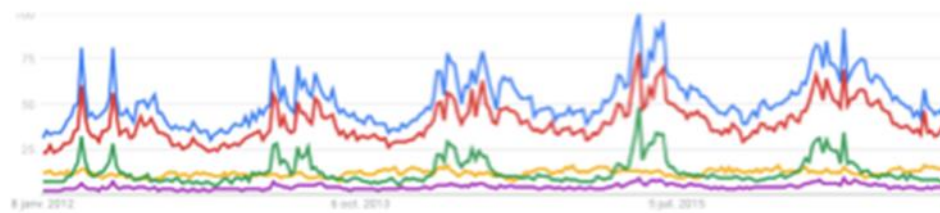
13 years

Allergy (disease) Asthma (disease) Pollen(subject) Ambrosia (ragweed, gender) Anti-histamine



5 years

Allergy (disease) Asthma (research term) Asthma (disease) Pollen (subject) Anti-histamine (drug)



Birch (plant) Poaceae (plant) Pollen (subject) Ambrosia (ragweed, gender)

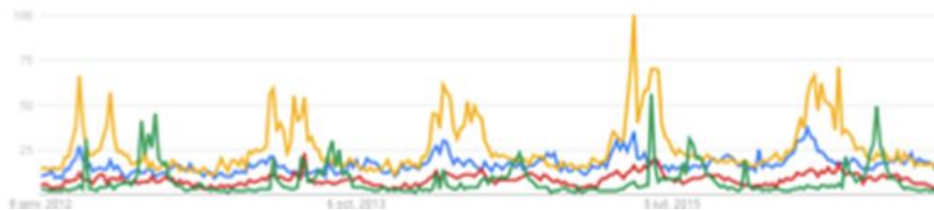
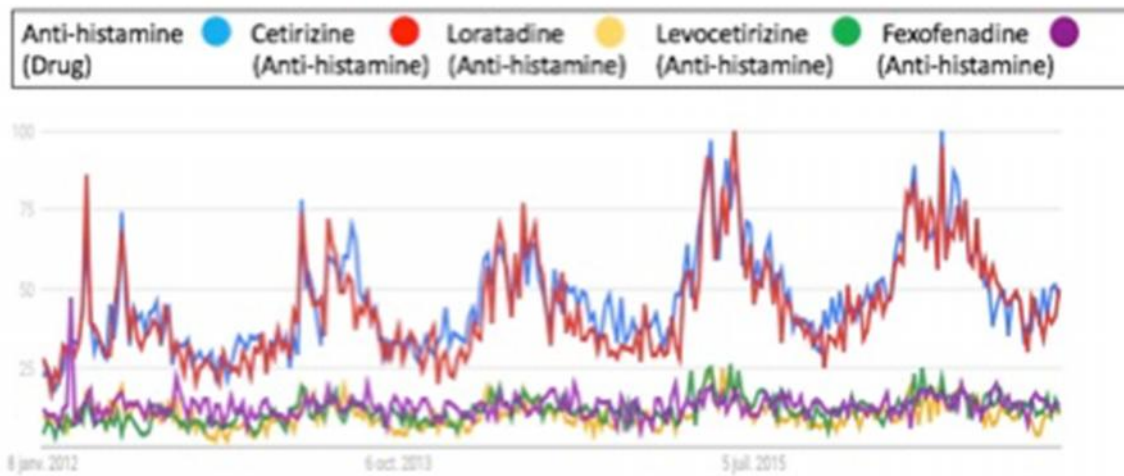


Figure 3 online: Trends in France for anti-rhinitis medications



Time of the analysis of data  $\geq 75\%$ percentile  $\geq 95\%$ percentile 

Weekly pollen counts (Aix en Provence)						weekly GT PACA				Weekly pollen counts (Paris)					Weekly GT (Ile de France)			Weekly pollen counts (Lille)					Weekly GT (Nord)			
Week	Amb	Birch	Cypress	Ash	Grass		Allergy	Pollen	Amb	Amb	Birch	Cypress	Ash	Grass	Allergy	Pollen	Amb	Amb	Birch	Cypress	Ash	Grass	Allergy	Pollen	Amb	
S1	0	0	0,97	536,41	219,22	2,91	62	43	15	3	ND	ND	ND	ND	ND	49	8	1	0	ND	ND	ND	ND	47	14	2
S2	0	0	0	1013,7	189,15	0	48	57	10	3	ND	ND	ND	ND	ND	44	7	1	0	ND	ND	ND	ND	40	11	2
S3	0	0	0	656,69	85,36	0,97	31	51	7	3	ND	ND	ND	ND	ND	46	9	1	0	ND	ND	ND	ND	44	8	2
S4	0	0	0	6024,7	208,55	0	216	57	10	3	ND	ND	ND	ND	ND	47	7	1	0	ND	ND	ND	ND	37	7	2
S5	0	0	0	10842	388	0	382	71	19	3	ND	ND	ND	ND	ND	47	9	1	0	ND	ND	ND	ND	39	7	2
S6	0	0	0	103,79	52,38	0	26	58	16	1	0	0	39	3,64	0,52	43	9	1	0	ND	ND	ND	ND	42	7	2
S7	0	0	0	12885	115,43	2,91	389	50	9	1	0	0	795,08	6,76	0,52	52	8	1	0	ND	ND	ND	ND	39	5	2
S8	0	0,97	7494,2	79,54	0,97	751	77	16	1	0	0	0	352,56	6,24	0,52	56	8	1	0	0	66	0	0	54	7	2
S9	0,97	0	13664	72,75	16,49	918	71	13	1	0	0	0	575,64	2,6	0,52	52	11	1	0	3,3	236,5	0	0	47	8	2
S10	0	0,97	8175,2	50,44	9,7	502	78	20	1	0	0	1,04	577,2	6,76	0	50	12	2	0	7,7	664,4	1,1	0	45	10	2
S11	0	1,94	5053,7	88,27	6,79	634	70	25	1	0	0	2,6	378,56	1,56	0	59	13	2	0	9,9	576,4	0	0	54	18	2
S12	0	0	0	3095,3	99,91	5,82	1567	62	25	1	0	4,16	379,6	23,92	1,56	55	19	2	0	4,4	391,6	6,6	0	55	14	2
S13	0	68,87	862,93	158,11	21,34	5990	70	24	1	0	0	42,12	122,72	45,24	0	57	18	3	0	63,8	133,1	27,5	0	63	8	2
S14	0	71,78	323,98	262,87	22,31	5333	74	22	2	0	817,96	224,64	191,4	2,6	85	33	2	0	883	738,1	97,9	0	49	21	2	
S15	0	9,7	138,71	104,76	13,58	3661	75	26	2	0	1446,1	185,12	289,1	0,52	81	25	2	0	3443	500,5	305	8,8	83	22	2	
S16	0	86,1	265,78	99,91	97	4888	80	28	4	0,52	2041,5	186,16	204,4	8,84	84	31	2	0	1725	121	79,2	7,7	80	35	2	
S17	0	53,35	80,51	58,2	91,18	1321	71	23	3	0	371,28	49,4	36,92	6,24	65	19	1	0	362	19,8	52,8	6,6	57	15	2	
S18	0,97	154,23	215,34	36,86	145,5	2575	59	24	3	0	552,76	204,36	55,12	65	82	30	2	0	818	199,1	46,2	39,6	67	35	2	
S19	0	21,34	160,05	15,52	194	2367	72	22	3	0	30,16	37,44	4,16	27,04	69	23	2	0	64,9	94,6	17,6	51,7	100	40	2	
S20	0,97	14,55	169,75	11,64	181,39	1644	84	27	1	0	15,6	69,16	0,52	71,24	62	20	1	0	7,7	30,8	3,3	89,1	50	19	2	
S21	1,94	4,85	100,88	179,45	151,32	2153	68	14	2	0	1,04	35,36	1,04	150,28	64	17	2	0	1,1	74,8	2,2	147,4	38	14	2	
S22	0	1,94	106,7	73,72	134,83	1417	47	11	3	0	2,08	7,8	0	73,32	54	13	1	0	2,2	14,3	2,2	405,9	66	15	2	
S23	0	0,97	136,77	17,46	420,01	1676	58	12	1	0	0	22,88	2,08	304,72	90	38	2	0	0	36,3	2,2	778,6	86	45	2	
S24	0	0	95,06	1,94	139,68	909	56	12	3	0	1,04	13	1,56	397,8	57	16	2	0	1,1	11	0	377,3	48	29	3	
S25	0	0	96,03	0	147,44	634	50	10	5	0	0	24,96	6,76	355,16	60	15	6	0	0	15,4	0	413,6	67	17	4	
S26	0	0	100,88	3,88	204,67	882	67	11	7	0	0,52	19,76	1,56	489,8	63	17	5	0	0	11	0	380,6	59	20	2	
S27	0	0	61,11	1,94	259,96	1238	62	15	7	0,52	0,52	19,24	3,64	589,92	74	14	3	0	0	27,5	0	798,4	63	28	5	
S28	0	0,97	91,18	6,79	109,61	794	66	11	4	0	0	15,08	0	205,92	77	16	2	0	0	9,9	0	232,1	73	14	3	
S29	0	0	24,25	0	52,38	206	67	9	4	0	0,52	13,52	0,52	143,52	69	13	3	0	0	40,7	0	217,8	80	12	3	
S30	0,97	0	42,68	3,88	32,01	357	55	8	2	0	0	19,76	0,52	87,36	70	11	4	0	0	23,1	0	85,8	58	10	3	
S31	0,97	0	19,4	0,97	11,64	305	53	8	4	0	0	7,28	0	58,24	59	9	5	0	0	17,6	0	61,6	52	12	3	
S32	21,34	0	26,19	0	50,44	419	60	13	6	0,52	3,64	0	50,44	64	10	9	0	0	0	11	0	44	67	8	3	
S33	38,8	0	25,22	0,97	9,7	140	67	8	7	0	0	4,16	0	34,32	63	9	10	1,1	2,2	16,5	0	41,8	79	15	4	
S34	36,86	0	2,91	0,97	11,64	431	56	8	21	0,52	0	5,2	0	34,32	57	9	17	3,1	2,2	16,5	0	39,6	62	13	13	
S35	33,95	0	2,91	0	20,37	63	52	7	10	0,52	0	3,12	0	14,56	59	9	16	0	0	0	0	26,4	37	10	4	
S36	35,89	0	16,49	0	32,98	65	55	5	7	0,52	0	1,56	0	9,36	55	8	6	0	1,1	3,3	0	1,1	43	6	2	
S37	5,82	0	1,94	0	7,76	42	58	4	6	0	0	0	0	7,28	52	8	5	3,1	0	2,2	0	14,3	46	8	2	
S38	4,85	0,97	5,82	0	2,91	57	47	13	2	0	0	1,04	0	2,08	49	10	3	0	1,1	4,4	0	1,1	47	11	2	
S39	0,97	0	0,97	0	3,88	1	53	50	4	ND	ND	ND	ND	ND	49	8	3	ND	ND	ND	ND	ND	36	11	7	
S40	ND	ND	ND	ND	ND	ND	47	14	2	ND	ND	ND	ND	ND	47	7	3	ND	ND	ND	ND	ND	38	14	2	
S41	ND	ND	ND	ND	ND	ND	48	9	2	ND	ND	ND	ND	ND	44	7	2	ND	ND	ND	ND	ND	49	13	2	
S42	ND	ND	ND	ND	ND	ND	56	17	2	ND	ND	ND	ND	ND	48	10	1	ND	ND	ND	ND	ND	38	11	2	
S43	ND	ND	ND	ND	ND	ND	45	8	1	ND	ND	ND	ND	ND	43	7	1	ND	ND	ND	ND	ND	54	11	2	
S44	ND	ND	ND	ND	ND	ND	41	12	1	ND	ND	ND	ND	ND	42	8	1	ND	ND	ND	ND	ND	49	10	2	
S45	ND	ND	ND	ND	ND	ND	35	9	1	ND	ND	ND	ND	ND	41	8	1	ND	ND	ND	ND	ND	46	6	2	
S46	ND	ND	ND	ND	ND	ND	55	13	2	ND	ND	ND	ND	ND	58	8	1	ND	ND	ND	ND	ND	62	5	2	
S47	ND	ND	ND	ND	ND	ND	49	8	2	ND	ND	ND	ND	ND	42	7	1	ND	ND	ND	ND	ND	35	10	2	
S48	ND	ND	ND	ND	ND	ND	45	10	2	ND	ND	ND	ND	ND	44	7	1	ND	ND	ND	ND	ND	33	12	3	
S49	ND	ND	ND	ND	ND	ND	40	8	2	ND	ND	ND	ND	ND	40	9	1	ND	ND	ND	ND	ND	31	9	4	
S50	ND	ND	ND	ND	ND	ND	42	11	2	ND	ND	ND	ND	ND	40	9	1	ND	ND	ND	ND	ND	49	7	2	
S51	ND	ND	ND	ND	ND	ND	55	7	2	ND	ND	ND	ND	ND	46	7	1	ND	ND	ND	ND	ND	59	4	2	
S52	ND	ND	ND	ND	ND	ND	55	9	1	ND	ND	ND	ND	ND	48	7	1	ND	ND	ND	ND	ND	43	8	2	
75%	37	72	843	105	135		68	19	4	3	685	379	55	305	55	16	3	3	818	199	53	377	63	15	2	
95%	39	190	11664	263	260		78	27	7	6	2042	577	249	570	64	31	10	3	3443	664	305	777	83	35	2	

Weekly pollen counts (Metz)							GT Alsace Lorraine		
Amb	Birch	Cypress	Ash	Grass	Allergy	Pollen	Amb		
ND	ND	ND	ND	ND	45	6	1		
ND	ND	ND	ND	ND	44	8	1		
ND	ND	ND	ND	ND	30	13	1		
ND	ND	ND	ND	ND	46	12	1		
ND	ND	ND	ND	ND	37	13	1		
ND	ND	ND	ND	ND	43	5	1		
ND	ND	ND	ND	ND	30	8	1		
ND	ND	ND	ND	ND	34	5	1		
ND	ND	ND	ND	ND	52	10	1		
0	0	255,2	0	0	47	9	2		
0	4,4	115,5	1,1	0	63	10	2		
0	6,6	250,8	19,8	0	55	9	2		
0	7,7	47,3	18,7	0	64	17	3		
0	382,8	114,4	133	0	72	22	2		
0	1081	160,6	235	0	92	34	2		
0	1399	19,8	82,5	6,6	83	39	2		
0	114,4	12,1	11	12	65	20	1		
0	121	38,5	5,5	59	66	31	2		
0	3,3	4,4	2,2	99	63	34	2		
0	6,6	70,4	0	417	61	24	1		
0	0	31,9	0	419	33	12	2		
0	0	31,9	0	290	43	15	1		
0	0	19,8	0	872	100	37	2		
0	0	22	0	361	60	25	2		
0	0	47,3	0	323	71	25	6		
0	0	15,4	0	249	52	8	5		
0	0	3,3	0	220	60	17	3		
0	0	6,6	0	84	57	17	2		
0	0	3,3	0	61	56	11	3		
0	0	4,4	0	34	58	14	4		
0	0	6,6	0	53	54	10	5		
1,1	0	2,2	0	25	75	9	9		
0	0	0	0	24	34	13	10		
13	0	1,1	0	12	29	3	17		
2,2	0	4,4	0	9,9	53	15	11		
6,6	0	2,2	0	14	47	8	6		
ND	ND	ND	ND	ND	51	11	5		
ND	ND	ND	ND	ND	44	11	3		
ND	ND	ND	ND	ND	33	6	3		
ND	ND	ND	ND	ND	40	8	3		
ND	ND	ND	ND	ND	33	12	2		
ND	ND	ND	ND	ND	47	12	1		
ND	ND	ND	ND	ND	37	11	1		
ND	ND	ND	ND	ND	38	10	1		
ND	ND	ND	ND	ND	30	10	1		
ND	ND	ND	ND	ND	64	9	1		
ND	ND	ND	ND	ND	55	10	1		
ND	ND	ND	ND	ND	35	3	1		
ND	ND	ND	ND	ND	43	9	1		
ND	ND	ND	ND	ND	47	5	1		
ND	ND	ND	ND	ND	33	14	1		
ND	ND	ND	ND	ND	38	9	1		
10	383	47	108	307	61	17	3		
13	1389	231	235	646	83	25	10		

Weekly pollen c RNSA Lyon							GT: Rhone-Alpes		
Amb	Birch	Cypress	Ash	Grass	Allergy	Pollen	Amb		
ND	ND	ND	ND	ND	30	8	1		
ND	ND	ND	ND	ND	38	6	1		
ND	ND	ND	ND	ND	35	12	1		
ND	ND	ND	ND	ND	37	8	1		
ND	ND	ND	ND	ND	45	6	1		
0,97	0,00	3,88	0,00	0,00	42	9	1		
0,00	0,00	600,93	9,90	0,00	38	6	1		
0,99	0,00	338,58	11,88	0,00	39	10	1		
0,00	0,00	113,85	15,84	0,99	49	12	1		
0,00	0,00	1097,91	28,71	0,99	64	11	1		
0,00	0,00	1252,43	148,32	2,93	65	16	1		
0,00	0,99	1191,43	639,47	0,00	51	14	2		
0,00	0,00	229,61	912,25	0,00	62	14	3		
0,00	14,55	367,63	1338,60	7,76	66	26	4		
0,00	275,48	172,66	655,72	10,67	88	36	4		
0,00	577,15	69,84	640,20	57,23	81	39	3		
0,00	263,84	127,07	516,04	268,69	51	17	4		
0,00	18,43	66,93	58,20	314,28	73	20	4		
0,00	11,64	105,73	43,65	321,07	100	51	3		
0,00	5,82	87,30	6,79	653,78	59	34	6		
0,97	1,94	8,73	1,94	816,74	87	43	26		
0,00	0,97	32,98	0,00	1575,28	76	31	7		
0,00	0,00	28,13	0,00	1020,44	67	20	5		
0,00	0,00	15,52	0,00	316,22	49	13	7		
0,00	0,00	30,07	0,00	273,54	49	13	9		
0,97	0,00	30,07	0,00	293,91	49	17	5		
0,00	0,00	46,56	0,00	341,44	47	13	10		
0,00	0,00	8,73	0,00	118,34	48	11	9		
0,97	0,00	5,82	0,00	48,50	45	11	10		
0,97	0,00	4,85	0,00	26,19	54	12	15		
0,97	0,97	3,88	0,00	21,34	50	10	14		
360,00	0,00	14,55	0,97	25,22	46	12	28		
100,00	0,00	8,73	0,00	16,49	45	13	34		
3160,00	0,97	10,67	0,00	5,82	60	10	39		
6400,00	0,00	1,94	0,00	22,31	49	13	34		
460,00	0,00	5,82	0,00	6,79	52	12	31		
1800,00	0,00	1,94	0,00	27,16	49	10	22		
737,00	0,00	1,94	0,00	1,94	49	13	13		
40,00	0,00	6,79	0,00	1,94	47	10	5		
2,05	0,00	13,38	0,00	2,05	39	14	3		
2,16	0,00	7,98	0,00	4,96	29	11	1		
0,97	0,00	2,91	0,00	0,97	47	8	2		
ND	ND	ND	ND	ND	4	10	4		
ND	ND	ND	ND	ND	33	8	2		
ND	ND	ND	ND	ND	35	10	1		
ND	ND	ND	ND	ND	34	7	4		
ND	ND	ND	ND	ND	29	9	3		
ND	ND	ND	ND	ND	41	7	6		
ND	ND	ND	ND	ND	36	8	3		
ND	ND	ND	ND	ND	41	13	2		
ND	ND	ND	ND	ND	42	4	1		
ND	ND	ND	ND	ND	42	8	2		
1400,00	ND	120,00	64,00	316,00					
6400,00	ND	ND	ND	1020,00					

Weekly pollen counts (Toulouse)							GT: Midi Pyrénées		
Amb	Birch	Cypress	Ash	Grass	Allergy	Pollen	Amb		
ND	ND	ND	ND	ND	53	6	2		
ND	ND	ND	ND	ND	31	6	2		
ND	ND	ND	ND	ND	45	11	3		
ND	ND	ND	ND	ND	48	10	3		
0	0	353,97	73,8	0	50	10	2		
0	0	175,26	187	0	65	9	6		
0	0	170,43	79,4	2,07	62	10	2		
0	0	185,61	86,3	1,38	56	16	2		
0	0	109,71	40	4,14	44	11	2		
0	0	131,86	24,2	5,52	47	12	2		
0	1,38	228,39	25,5	2,76	61	14	2		
0	4,14	93,15	56,6	6,9	68	15	3		
0,69	24,2	131,1	77,3	5,52	79	22	4		
0	32,4	87,63	46,9	4,14	79	22	3		
0	0	0	0	0	90	40	5		
0	48,3	97,98	53,1	32,43	70	21	2		
0	34,5	67,62	2,76	83,49	69	26	2		
0	40	74,52	6,21	160,8	77	27	6		
0	12,4	30,36	2,07	114,5	74	20	2		
0	18,6	71,07	0,69	171,1	75	22	4		
0	7,59	33,81	0	149	89	26	6		
0	0,69	33,12	0,69	211,8	65	26	5		
0	1,38	31,74	0	389,9	67	36	3		
0	0	9,66	0	76,59	61	15	2		
0	0,69	41,4	0	258,1	64	21	14		
0	0	15,18	0	469,9	75	20	7		
0	0	3,45	0	547,2	63	21	7		
0	0	8,97	0	241,5	68	11	4		
0	0	4,83	0	57,96	73	15	3		
0	0	0	0	0	59	15	8		
0	0	0	0	0	51	10	4		
0	0	0	0	0	75	15	6		
0	0	0	0	0	57	9	9		
7,59	0	2,07	0	24,15	74	21	26		
29,67	0	0	0	22,08	63	17	15		
32,43	0	0	0	17,25	65	20	3		
3,45	0	2,07	0	14,49	57	13	6		
ND	ND	ND	ND	ND	64	9	3		
ND	ND	ND	ND	ND	55	13	11		
ND	ND	ND	ND	ND	48	13	9		
ND	ND	ND	ND	ND	57	13	4		
ND	ND	ND	ND	ND	45	15	6		
ND	ND	ND	ND	ND	50	12	9		
ND	ND	ND	ND	ND	58	8	9		
ND	ND	ND	ND	ND	41	8	3		
ND	ND	ND	ND	ND	57	5	3		
ND	ND	ND	ND	ND	59	10	3		
ND	ND	ND	ND	ND	49	10	3		
ND	ND	ND	ND	ND	43	8	5		
ND	ND	ND	ND	ND	47	10	3		
ND	ND	ND	ND	ND	42	7	4		
ND	ND	ND	ND	ND	57	4	6		
32	33	120	77	161	70	21	6		
32	48	186	187	470	87	27	14		

Weekly pollen counts (Cholet)						GT:Pays de la Loire		
Amb	Birch	Cypress	Ash	Grass	Allergy	Pollen	Amb	
ND	ND	ND	ND	ND	42	15	4	
0	0	7,85	4,71	3,14	42	9	2	
0	0	6,28	0	0	45	10	4	
0	0	0	0	0	44	13	2	
0	7,85	47,1	3,14	4,71	54	11	2	
0	0	0	0	0	35	8	2	
0	0	7,85	12,6	0	36	14	2	
0	0	345,4	80,1	6,28	49	9	2	
0	0	664,1	104	6,28	52	10	2	
0	9,42	836,8	83,2	11	35	10	4	
0	4,71	1809	104	20,4	39	9	2	
0	0	386,2	53,4	14,1	53	23	2	
0	25,12	136,6	116	12,6	48	15	2	
0	183,7	125,6	127	14,1	49	13	2	
0	212	218,2	146	42,4	63	25	3	
0	1421	190	168	75,4	69	22	2	
0	114,6	122,5	29,8	67,5	58	18	3	
0	128,7	164,9	15,7	309	67	28	5	
0	21,98	92,63	3,14	204	49	35	6	
0	21,98	193,1	3,14	377	52	19	2	
0	3,14	78,5	7,85	1149	46	16	2	
0	1,57	25,12	0	1064	60	18	2	
0	0	47,1	1,57	2845	90	42	4	
0	0	12,56	1,57	482	66	13	8	
0	0	37,68	0	1178	53	10	12	
0	0	21,98	0	598	44	7	4	
0	0	29,83	0	1568	69	21	5	
0	0	9,42	0	360	62	14	5	
0	0	12,56	0	529	65	14	2	
3,1	0	3,14	0	140	64	8	10	
0	0	7,85	0	137	35	13	5	
0	0	1,57	0	119	62	8	8	
0	0	1,57	0	12,6	63	12	5	
0	0	1,57	0	76,9	36	12	18	
0	0	0	0	20,4	55	3	9	
1,6	0	4,71	0	47,1	32	9	7	
0	0	1,57	0	9,42	55	11	7	
ND	ND	ND	ND	ND	50	13	2	
ND	ND	ND	ND	ND	24	10	2	
ND	ND	ND	ND	ND	41	9	4	
ND	ND	ND	ND	ND	41	10	7	
ND	ND	ND	ND	ND	39	12	2	
ND	ND	ND	ND	ND	30	4	2	
ND	ND	ND	ND	ND	42	7	6	
ND	ND	ND	ND	ND	39	9	2	
ND	ND	ND	ND	ND	52	6	2	
ND	ND	ND	ND	ND	40	6	2	
ND	ND	ND	ND	ND	43	3	2	
ND	ND	ND	ND	ND	41	5	2	
ND	ND	ND	ND	ND	37	12	2	
ND	ND	ND	ND	ND	29	7	2	
ND	ND	ND	ND	ND	52	40	2	
115	165	104	377	55	4	5		
189	837	146	1568	69	28	10		

Weekly pollen counts (Limoges)						GT:Limousin		
Amb	Birch	Cypress	Ash	Grass	Allergy	Pollen	Amb	
ND	ND	ND	ND	ND	33	10	0	
ND	ND	ND	ND	ND	36	9	0	
ND	ND	ND	ND	ND	22	9	0	
ND	ND	ND	ND	ND	27	18	9	
ND	ND	ND	ND	ND	39	10	0	
ND	ND	ND	ND	ND	31	10	0	
0	0	15,12	4,32	0	34	10	0	
0	0	206,61	9,7	0	70	9	0	
0	0	83,42	18,43	1,94	27	9	0	
0	0	507,31	19,4	6,79	43	10	0	
0	0,97	416,13	20,37	1,94	49	10	0	
0	0	201,76	83,42	8,73	30	14	20	
0	101,5	187,92	190,1	2,16	32	19	10	
0	662,5	331,74	304,6	2,91	20	15	10	
0	629,5	294,88	138,7	7,76	45	20	10	
0	1936	151,32	200,8	33,95	51	20	10	
0	285,2	63,05	16,49	24,25	54	29	10	
0	739,1	383,15	41,71	116,4	43	21	10	
0	21,36	79,45	4,87	82,79	39	10	10	
0	1,98	52,47	1,98	265,3	63	16	10	
0	12,61	44,62	0	455,9	50	30	10	
0	0	7,76	0	277,4	39	15	10	
0,97	0	29,1	0	2048	75	64	10	
0	0	5,82	0	143,6	66	0	10	
0	0	31,04	0	725,6	44	0	11	
0	0	7,76	0	432,6	49	0	11	
0	0	3,88	0	1198	17	0	12	
0	0,97	17,46	0	496,6	30	0	12	
0	0	17,46	0	183,3	48	12	12	
0	0	19,4	0	110,6	70	12	12	
0	0	4,85	0	22,31	45	13	13	
2,91	0	19,4	0	39,77	46	13	26	
3,88	0	4,85	0	21,38	51	13	13	
4,95	0	0	0	29,7	31	12	37	
7,76	0	1,94	0	5,82	28	12	11	
0,97	0	3,88	0	4,85	52	12	23	
0,97	0	2,91	0	2,91	33	11	0	
0,97	0	4,85	0	0	23	11	0	
0	0	5,82	0	4,85	27	11	0	
ND	ND	ND	ND	ND	40	23	0	
ND	ND	ND	ND	ND	28	11	0	
ND	ND	ND	ND	ND	62	34	0	
ND	ND	ND	ND	ND	34	11	0	
ND	ND	ND	ND	ND	50	11	0	
ND	ND	ND	ND	ND	32	16	0	
ND	ND	ND	ND	ND	38	21	0	
ND	ND	ND	ND	ND	21	10	0	
ND	ND	ND	ND	ND	73	21	0	
ND	ND	ND	ND	ND	21	27	0	
ND	ND	ND	ND	ND	38	11	11	
ND	ND	ND	ND	ND	22	11	0	
ND	ND	ND	ND	ND	51	11	0	
8	701	170	139	265	50	18	11	
8	1936	416	325	1198	70	30	23	

Figure 5 online: Comparisons between pollen concentrations and GTs for Lyon and Région Rhône-Alpes (2016)

Ambrosia (ragweed), *Betula* (birch), *Cupressus* (cypress), *Fraxinus* (ash)

