Google Trends terms reporting rhinitis and related topics differ in European countries

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Short title: Google Trends in rhinitis in Europe

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Abstract

Google Trends (GT) searches trends of specific queries in Google and reflects the real-life epidemiology of allergic rhinitis. We compared Google Trends terms related to allergy and rhinitis in all European Union countries, Norway and Switzerland from January 1, 2011 to December 20, 2016. The aim was to assess whether the same terms could be used to report the seasonal variations of allergic diseases. Using the Google Trend 5-year graph, an annual and clear seasonality of queries was found in all countries apart from Cyprus, Estonia, Latvia, Lithuania and Malta. Different terms were found to demonstrate seasonality depending on the country - namely: "hay fever"; "allergy"; and "pollen" - showing cultural differences. A single set of terms cannot be used across all European countries, but allergy seasonality can be compared across Europe providing the above three terms are used. Using longitudinal data in different countries and multiple terms, we identified an awareness-related spike of searches (December 2016).

Key words: Allergy, Asthma, Google Trends, Hay fever, Pollen, Rhinitis

Abbreviations

ARIA: Allergic Rhinitis and its Impact on Asthma

GT: Google Trends

MASK: MACVIA-ARIA Sentinel NetworK

MACVIA: *Contre les MAladies Chroniques pour un VIeillissement Actif*

EU: European Union

Forecasting the onset and duration of the pollen season is of vital importance in the management of allergic rhinitis (1, 2). Pollen counts may assess pollen exposure (1-3), but do not necessarily correlate with individual patients. Allergen content in the air can be assessed (4), but this requires sophisticated methods. Meteorological data may be of interest, but more research is needed (5). Combining several sources using advanced data engineering may also be important, but this is not yet available for all pollen species (6).

Since forecasting is still a limited option real-time epidemiological surveillance is an alternative option. Google Trends (GT), a Web-based surveillance tool, uses Google to explore the searching trends of specific queries. It can assess the seasonality of allergic diseases (7-10) and reflects the real-world epidemiology of symptomatic allergic rhinitis (11). However, cultural differences exist between countries and the same search terms may not be used across all countries, making comparisons difficult. MASK (MACVIA-ARIA Sentinel NetworK) (12) proposed to develop a pan-European sentinel network to inform allergy sufferers of the onset of the pollen season (1) and GT may be one of the methods used.

The present study was conceived as a preliminary step to explore the use of GT in the epidemiological surveillance of AR and was aimed at assessing whether there are differences in the Google searches of AR and related topics. We analyzed multiple time series of GT search data on rhinitis, allergy and asthma in the 28 European Union (EU) countries, Norway and Switzerland from 2011 to 2016. The aims were: (i) to assess whether GT could report rhinitis and related topics accurately in all the countries; (ii) to assess the seasonality of queries; and (iii) to determine whether terms differed between countries.

Methods

The following terms were used: “rhinitis”, “allergic rhinitis”, “hay fever”, “asthma”, “pollen”, “allergy”, “conjunctivitis” (disease, topic and term). However, only the following five terms were analyzed: “allergy” as a disease, “hay fever” as a topic, “asthma” as a disease, “conjunctivitis” as a disease and “pollen” as a topic since “rhinitis” as a term or “allergic rhinitis” as a disease were labelled as “hay fever” as a topic. Only “diseases” and “topics” were automatically translated by GT whereas “terms” were not translated. In the present study, we did not control for the translations of terms in the different languages since we wanted a real life assessment of GT. “Rhinitis” as a term was not translated manually since certain countries are multilingual (e.g. Belgium and Switzerland).

Google Trends is based on Google Search and shows 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.

We examined GT queries from January 1, 2011 to December 20, 2016 (using the standard 5-year analytic window of GT) for all 28 EU countries, Norway and Switzerland. We established visually (JB) patterns of countries according to the seasonality of terms (Table 1). We then compared the country patterns (based on seasons) with the mean 5-year terms provided by GT.

We did not compare the results of the 5-year trend with those of one-year or less, since the goal of the paper was not to define whether GT can be used as sentinel, but to assess whether there are differences between terms in European countries.

Results

Using the GT 5-year graph, an annual and clear seasonality of queries was found in all countries apart from Cyprus, Estonia, Latvia, Lithuania, and Malta (Figure 2 online). In these countries, some trends in seasonality were observed but they were not as clear as in the other countries.

Five patterns of country patterns were identified (Table 1). In 16 countries, a spike of queries was observed in the last week of December 2016. Figure 1 shows one example of each cluster, whereas all countries are presented in Figure 1 online.

Country patterns were defined according to seasonality of terms. However, this classification fits with the mean levels of queries over five years. In Cluster A countries, “allergy” queries were reported at a lower level than “hay fever” and did not show any clear seasonal pattern. In Patterns B, C and D countries, “allergy” queries were higher than the other terms and showed a seasonal pattern. When all countries with a seasonal pattern were examined, the peak of queries was the same for “allergy” and “hay fever” (Cluster B) or “allergy” and “pollen” (Cluster C). Moreover, in Patterns A, B, C and D, the seasonal patterns were similar between countries for the five years (Figure 1 and Figure 1 online).

Asthma and conjunctivitis did not show any seasonal pattern using the 5-year approach (data not shown for conjunctivitis).

There was a spike of queries in Austria, Belgium, Bulgaria, Croatia, Czech Republic, Estonia, Finland, Hungary, Ireland, Italy, Malta, Norway, Portugal, Romania, Spain and Switzerland at the end of December 2016 (Figure 1, Figure 1 online, and Table 1 online). These queries appeared within a week in all of the countries and were unrelated to the seasons in previous years. The shape of the spike was steeper than during allergen seasons. Moreover, two new patterns were found (F: peak of “allergy” and “asthma” and G: peak of “asthma”). The change in country patterns occurred in 10 (66.7%) of the countries.

Discussion

GT reflects the proportion of specific queries in relation to all queries. Although terms were translated into the different languages using the automatic Google translator, the reporting of GT differs widely between countries. There are country-specific trends towards a different awareness of allergy terms. Different terms account for seasonality ("allergic rhinitis" or "hay fever" as a topic, "allergy" as a disease, "pollen" as a topic). A single set of terms cannot be used across all countries, but allergy seasonality can be compared across Europe providing the three terms are used. Moreover, longitudinal data in different countries and multiple terms enabled a spike of terms to be identified, apparently unrelated to allergen exposure. The study in Europe is generalizable to other countries and the same clustering approach may be used.

GT does not provide a uniform, unbiased geographical sample. The data pool is skewed towards high-income countries with a higher access to computers and internet. These problems are unlikely to be of importance in the European countries we studied. Moreover, GT does not allow a direct access to absolute numbers.

Significant spikes in the Google search were found with increased awareness of a disease. Examples include the death of a celebrity (13) and the heart transplantation in the month when Vice President Cheney underwent the respective procedure (14). It is likely that the December 2016 spikes were associated with the awareness of thunderstorm asthma (15). Two severe episodes occurred in Australia and Kuwait in the past month and were largely publicised in the media. However, using multiple terms, a 5-year follow up and multiple countries, we were able to identify the awareness-related spikes.

The clustering approach based on seasonality was apparently sound since the mean levels of terms over the five years differed between patterns according to the seasonal patterns. Moreover, the patterns group countries as expected: Ireland and the UK in Cluster A (with Netherlands), German speaking countries in Cluster B and three Nordic countries in Cluster C. These patterns may be related to the understanding of the terms in different languages or to cultural differences. However, combing the three terms, we could assess seasonal changes in most countries. It is interesting to note that the seasons occur at a similar time (with some small differences due to climate) across Europe in particular for the birch, grass and ragweed pollen seasons. The clustering approach has improved our knowledge on the apparent awareness spikes of December 2016.

In this study, we did not assess anti-histamine queries or the different pollen species (e.g. birch, grass, *Parietaria* or ragweed) since the aim was to assess terminology. Moreover, we did not study yearly queries which may indicate some seasonality for asthma and a more precise seasonality in the five countries of Cluster E.

This study has several potential impacts (Table 2).

The results of the current study will be used in the development of the MASK sentinel network (1). MASK (MACVIA (*Contre les MAladies Chroniques pour un VIeillissement Actif*)-ARIA Sentinel NetworK) uses mobile technology to develop care pathways for the management of rhinitis and asthma by a multi-disciplinary group or by patients themselves (16). An App (Android and iOS) is available in 20 countries and 15 languages. It uses a visual analogue scale to assess symptom control

and work productivity as well as a clinical decision support system. The scaling up strategy uses the recommendations of the European Innovation Partnership on Active and Healthy Ageing (17).

More data are required to investigate the importance of GT in a sentinel network, but it is clear that a combination of three terms over a period of observation are needed across Europe to establish baseline and to assess spikes.

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Table 1: Patterns of countries

Cluster	Characteristics	Countries	Average means over 5 years			
			Allergy	Hay fever	Pollen	Asthma
A	Peak of "hay fever" higher than "allergy"	Ireland	45	12	13	24
		Netherlands	21	9	2	7
		UK	36	14	12	21
B	Peak of "hay fever" lower than "allergy" and higher than "asthma"	Austria	38	5	4	9
		Belgium	49	6	7	10
		Denmark	39	3	7	14
		Germany	53	11	5	16
		Luxembourg	28	8	6	8
		Switzerland	51	11	10	14
C	Peak of "pollen" only and higher than "asthma"	Finland	53	1	8	22
		France	51	3	11	11
		Norway	51	1	7	16
		Sweden	43	1	8	13

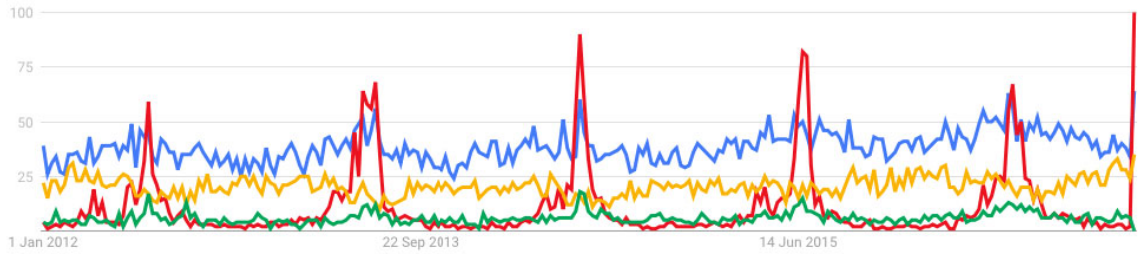
D	Peak of “hay fever” and “pollen” lower than or similar to “asthma” *OR* Peak of “allergy” without peak of “hay fever” or “pollen”	Bulgaria	44	3	2	14
		Croatia	32	1	1	6
		Czech Republic	40	2	2	10
		Greece	50	2	3	16
		Hungary	34	1	3	6
		Italy	46	2	1	7
		Poland	49	1	1	10
		Portugal	48	2	1	10
		Romania	51	1	1	10
		Slovenia	45	1	2	10
		Slovakia	40	4	3	9
		Spain	38	1	1	7
E	No season identified	Cyprus	39	8	8	17
		Estonia	54	3	5	15
		Latvia	58	2	5	16
		Lithuania	49	6	6	10
		Malta	44	15	13	26

Table 2: Potential impact of the study

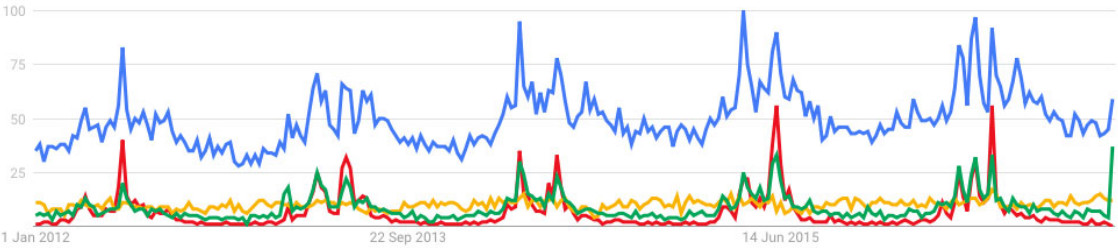
- It is possible to investigate Google search trends across a range of European countries
- Although patients in Europe overall experience the same symptoms of allergic rhinitis induced by pollens which induce an allergic reaction, they use searches which differ between countries. We have found that the searches are similar in different regions of the same country. The clusters we have proposed are in line with cultural differences.
- When GTs are used in allergic rhinitis, patients in most European countries use other search terms.
- There is a need to use multiple searches for a single disease.
- The results call for uniform nomenclature and self management guidelines to improve detection and proactive treatment of seasonal allergy symptoms.
- GT analysis as a tool to improve and tailor our communication to the patients and general public besides building our sentinel network

Figure 1: Examples of patterns

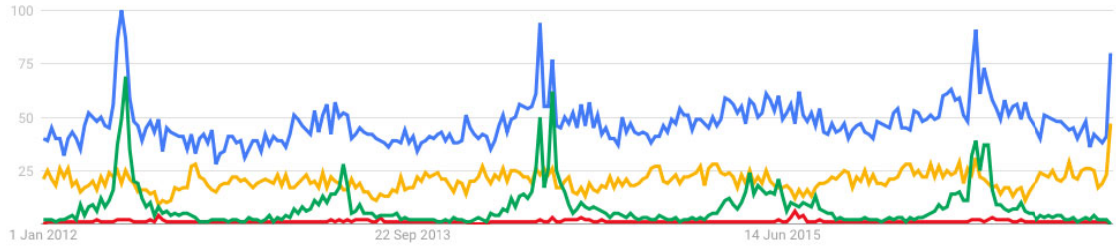
Cluster A: Ireland



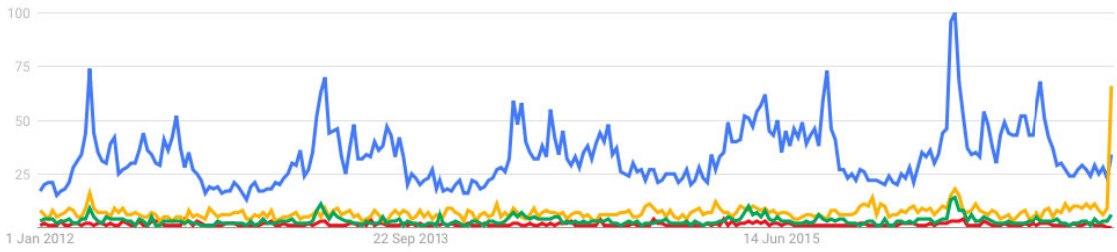
Cluster B: Belgium



Cluster C: Finland



Cluster D: Croatia



Cluster E: Malta