Assessment of the impact of media coverage in coronavirus-related Google Trends: Infodemiology study

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Abstract

Background: The influence of media coverage in online searches may hamper the role of Google Trends (GT) for Covid-19 monitoring.

Objective: To assess whether Covid-19-related GT – particularly on ageusia and anosmia – were primarily related to media coverage or with epidemic trends.

Methods: We retrieved GT data for searches on “coronavirus”, “cough”, “anosmia” and “ageusia”, plotting them for a period of 5 years. In addition, we analysed the trends of those queries for 17 countries throughout the year of 2020, particularly concerning rises and peaks of searches. For anosmia and ageusia, we assessed whether the respective GT correlated with Covid-19 infections and deaths both throughout 2020 and specifically before March 16, 2020 (i.e., the date when the media started reporting that those symptoms could be associated with Covid-19).

Results: Over the last five years, peaks of “coronavirus” GT were only observed during the Winter of 2020. Rises and peaks in “coronavirus” searches were similar in time in the 17 different assessed countries, irrespectively of their epidemic situation. In 15 of these countries, rises in “anosmia” and “ageusia” GT occurred in the same week or one week after they were identified in the media as symptoms of Covid-19. Analysing data prior to March 16, 2020, anosmia/ageusia GT were found to have variable correlation with Covid-19 infections and deaths in the different countries.

Conclusions: Covid-19-related GT is more related to media coverage than with epidemic trends.

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Abstract

Background: The influence of media coverage in online searches may hamper the role of Google Trends (GT) for Covid-19 monitoring.
Objective: To assess whether Covid-19-related GT – particularly on ageusia and anosmia – were primarily related to media coverage or with epidemic trends.
Methods: We retrieved GT data for searches on “coronavirus”, “cough”, “anosmia” and “ageusia”, plotting them for a period of 5 years. In addition, we analysed the trends of those queries for 17 countries throughout the year of 2020, particularly concerning rises and peaks of searches. For anosmia and ageusia, we assessed whether the respective GT correlated with Covid-19 cases and deaths both throughout 2020 and specifically before March 16, 2020 (i.e., the date when the media started reporting that those symptoms could be associated with Covid-19).
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Conclusions: Covid-19-related GT is more related to media coverage than with epidemic trends.
Keywords: Covid-19; Google Trends; Media coverage

Introduction

Infodemiology is defined as “the science of distribution and determinants of information in an electronic medium, specifically the Internet, or in a population, with the ultimate aim to inform public health and public policy” [1,2]. Such field comprises both “supply-based” and “demand-based” infodemiology, with the latter assessing individuals’ health seeking behaviour (e.g., through online searches) [2]. Over the years, infodemiological studies have become increasingly popular,

focusing on such different fields as chronic diseases, risk behaviours, and infectious diseases [3,4]. Regarding the latter, the use of search query data to predict or monitor infectious outbreaks can be traced to back to the 2002 Severe Acute Respiratory Syndrome epidemic [5]. Subsequent studies have been conducted on influenza and other infectious diseases, with Google Trends (GTs) being one of the most use data sources albeit with mixed results. In fact, despite the initial optimism of GT for flu prediction [6] and despite their strong correlation with influenza-related emergency department visits [7], the unsatisfactory performance of Google Flu Trends has led to its discontinuation [8].
In the context of the Covid-19 pandemic, there has been interest on GTs (or other data on online activity), particularly concerning their potential role for defining the proper timing and location for practicing appropriate risk communication strategies to the affected populations [9]. In Europe, significant correlations were observed between Covid-19 cases and deaths and online interest on this topic [10]. In addition, GTs were found to predict Covid-19 incidence in Iran [11]. By contrast, as the number of Covid-19 cases increased, US population interest in telehealth and telemedicine did not correlate with the proportion of hospitals providing telehealth services [12].
Two difficulties in using GTs for SARS-CoV-2 infection concern (i) an information demand that may be disproportionate to the country epidemiologic situation on account of media coverage (as described in other contexts [5]), and (ii) the low specificity of Covid-19 main symptoms. However, regarding the latter, while, cough, fever and dyspnea can also occur in several other diseases, some more specific manifestations have also been described. Two symptoms that appear to be more specific include anosmia and ageusia [13]. Such was not widely known to the general public before an interview of Hendrik Streeck to the Frankfurter Allgemeine Zeitung (FAZ) dated of March 16 [14], which was then cited by the media throughout the world. The identification of these more specific symptoms raised interest on whether GTs for these manifestations could better correlate with Covid-19 incidence/deaths than GT for less specific symptoms. While strong correlations between searches for smell-related information and the number of Covid-19 cases and deaths have been described in several countries [15], the role of media coverage in motivating smell-related searches cannot be discarded.
Therefore, we aimed to assess whether “anosmia” and “ageusia” searches were primarily related to media release or with Covid-19 epidemic trends.

Methods

This is a GT-based infodemiology study, complying with the methodological framework by Mavragani and Ochoa [16].

Keyword selection

In this study, we retrieved GT data on the keywords “coronavirus” (as virus and search term), “cough” (as topic), “anosmia” (as disease) and “ageusia” (as topic).
With the exception of “coronavirus”, no other non-topic/non-disease search terms were used. In fact, we tested the search terms “loss of smell”, “hyposmia”, “olfaction”, “dysgeusia” and “loss of taste” [8] using the translations of the terms in native languages (with double quotes used when searching for more than one-word keyword) but these queries did not retrieve consistent or quality-sufficient data.

Region and period selection

We always obtained country-level GT data (except for a worldwide analysis of the last five years). We retrieved GT data for the following different time periods:

- A time frame of the last five years (up to the week of April 5-11, 2020): This time frame

allowed us to assess worldwide search spikes on selected keywords on a long-term period.

- A time frame comprising the year of 2020 (i.e., period ranging from the week of January 5-11 to the week of April 5-11, 2020): This time frame allowed us to identify the search trends on selected keywords throughout the year of 2020, in 17 Western countries (those where searches for "anosmia" were sufficient to perform an analysis). Such GT data was plotted (without performing formal correlations) alongside data on Covid-19 cases in different countries. Of note, for this time frame, we retrieved data starting in January 5 (and not on the date that the first Covid-19 case was registered in each country), not only to allow between-country comparison, but also because (i) in the Western world, news coverage on SARS-CoV-2 infection started before the first confirmed cases were identified, and (ii) it is possible that there have been Covid-19 cases in the West prior to the first identified cases (and that could have reflected on symptom web searches).
- A time frame ranging from the date of the first confirmed Covid-19 case in each country until March 15: This time frame allowed a closer analysis of search trends before the media started reporting that anosmia and ageusia could be symptoms of Covid-19. To assess the impact of such media coverage, we analyzed eight different countries, and correlated web searches with the respective data on Covid-19 cases for that period. Correlations with the daily number of deaths were also performed (in this case, using a time frame ranging from the date of the first death in each country until March 15).

Search categories

Categories and subcategories were not selected when searching for keywords.

Data analysis

After plotting worldwide GT data on selected keywords for the last 5 years, we retrieved GT for the year of 2020, assessing the trends of those queries in 17 countries where searches for anosmia were sufficient to perform an analysis.

To further assess the impact of media coverage on Covid-19-related GT, and in order to assess whether GT correlated with Covid-19 cases, we focused on eight countries in different stages of Covid-19 pandemic – France, Germany, Italy, Portugal, Spain, United Kingdom (UK), Brazil, and United States of America (USA). For each country, we plotted the weekly GT data on selected keywords, together with weekly data on new Covid-19 cases (numbers retrieved from official sources).

Subsequently, we performed an analysis restricted to the time period prior to March 16, the date that the media started reporting that anosmia/ageusia could be symptoms of Covid-19. In fact, from that date onwards, GT data could largely reflect interest in media coverage, rather than searches for symptoms that patients have. Therefore, for each country, and between the date of the first confirmed Covid-19 case and March 15, we assessed the correlation (by means of Pearson correlation coefficients – r) between the daily average of GT on "anosmia" and "ageusia" (herein, reported as "anosmia"/"ageusia"), and daily data on new Covid-19 cases. Similar analyses were performed for new Covid-19 deaths (with the time frame being that between the date of the first Covid-19 death and March 15).

In order to facilitate plot reading, we plotted normalized weekly data on Covid-19 cases and deaths. That is, we plotted the total number of new Covid-19 cases and deaths as percentages of the respective maximum weekly values observed during the defined time period.

Results

On a worldwide scale, GTs of different countries were similar in time, with peaks for "coronavirus" being higher than for other searches (Figure 1). Throughout five years, such peaks were only found in the winter of 2020. Queries for "coronavirus" as a virus and as a search term peaked at the same

time. The second highest peaks were for “cough” with two peaks coinciding with those of “coronavirus”. “Anosmia” and “ageusia” had a slightly delayed identical peak that was not identified when “cough” or “coronavirus” terms were searched.
We analysed search trends in 17 countries where the “anosmia” peak was clearly identifiable (in two of these countries, “ageusia” did not show any peak, and in other two no peak was observed for “cough”). In particular, we started by observing the week when searches for each topic started to rise (Table 1). The first rise in “coronavirus” searches started by late January, 2020, while the second peak of “coronavirus” started February 16-22 in one country (Italy), and by February 23-29 in the remaining countries. “Cough” queries started in the same week in 3 countries, one week later in 4, two weeks later in 2, and later in 6 countries.

Table 1. Week of onset Google Trends (GT) peaks in 17 countries

Country	GT on “coronavirus” (as virus)		GT on “anosmia” (as disease)	GT on “ageusia” (as topic)	GT on “cough” (as topic)
	Peak 1[a]	Peak 2[a]			
Argentina	19-25 Jan	23-29 Feb	22-28 Mar[b]		8-14- Mar
Australia	19-25 Jan	23-29 Feb	22-28 Mar[c]	15-21 Mar[c]	16-22 Feb
Belgium	19-25 Jan	23-29 Feb	15-21 Mar[c]	15-21 Mar[c]	16-22 Feb
Brazil	19-25 Jan	23-29 Feb	15-21 Mar[c]	15-21 Mar[c]	16-22 Feb
Canada	19-25 Jan	23-29 Feb	15-21 Mar[c]	22-28 Mar[c]	8-14 Mar
Chile	19-25 Jan	23-29 Feb	22-28 Mar[b]	22-28 Mar[b]	23-29 Feb
France	19-25 Jan	23-29 Feb	15-21 Mar[c]	15-21 Mar[c]	1-7 Mar
Germany	19-25 Jan	23-29 Feb	15-21 Mar[c]	15-21 Mar[c]	23-29 Feb
Italy	19-25 Jan	16-22 Feb	1-7 Mar[c]	8-14 Mar[c]	23-29 Feb
Portugal	19-25 Jan	23-29 Feb	15-21 Mar[c]	15-21 Mar[c]	8-14 Mar
Russia	19-25 Jan	23-29 Feb	22-28 Mar[c]		
Spain	19-25 Jan	23-29 Feb	15-21 Mar[c]	8-14 Mar[c]	8-14 Mar
Sweden	19-25 Jan	23-29 Feb	15-21 Mar[c]	22-28 Mar[c]	
Switzerland	19-25 Jan	23-29 Feb	8-14 Mar[c]	15-21 Mar[c]	1-7 Mar
The Netherlands	19-25 Jan	23-29 Feb	15-21 Mar[c]	22-28 Mar[c]	23-29 Feb
UK	19-25 Jan	23-29 Feb	15-21 Mar[c]	15-21 Mar[c]	8-14 Mar
USA	19-25 Jan	23-29 Feb	22-28 Mar[c]	15-21 Mar[c]	8-14 Mar

Jan: January 2020; Feb: February 2020; Mar: March 2020; Apr: April 2020; UK: United Kingdom; USA: United States of America.
[a] There were consistently two GT peaks on “coronavirus” – “peak 1” was a minor peak by late January, and “peak 2” was the largest GT peak.
[b] GT peak at the week of 5-11 April. [c] GT peak at the week of 15-21 March.

We observed that the onset of “anosmia” queries occurred in March 15-21 in 10 countries (corresponding to the week of Hendrik Streeck interview to the FAZ), and in March 22-28 in 5 other countries (only in Italy and Switzerland they started before March 15-21). The weeks of onset for “ageusia” and “anosmia” queries were the same in 7 of 15 countries. Regarding the GT peaks for “anosmia” and “ageusia”, they were observed in March 22-28, 2020 for all countries except Argentina and Chile (one week after the interview).
Subsequently, we analysed eight countries plotting the average GT on “anosmia” and “ageusia”

along with Covid-19 cases. We observed that the GT peak coincided with the maximum weekly number of new Covid-19 cases in Italy, but not in the remaining countries (Figure 2). For all countries (except Italy and Germany), GT peaks were followed by sharp decreases.
Analysing data between the first confirmed case of Covid-19 until March 16, we observed that, in countries with higher Covid-19 infection or death rates, there were moderate-good correlations between GT on "anosmia"/"ageusia" and Covid-19 new cases or deaths (Table 2 and Figure 3). By contrast, poor correlations were observed in countries with lower Covid-19 rates by March 15. The only exception was the United Kingdom, in which we observed strong correlations between GT searches on anosmia/ageusia and new Covid-19 cases (r=0.739) and deaths (r=0.668), despite the low Covid-19 infection and death rate (0.3 deaths per million inhabitants).

Table 2. Correlation coefficients between Google Trends (GT) on "anosmia"/"ageusia" and frequency of Covid-19 new Covid-19 cases and deaths.

Country	Covid-19 cases per million inhabitants (March 15)	Covid-19 deaths per million inhabitants (March 15)	Correlations with average GT on "anosmia" (as disease) and ageusia" (as topic)		Correlations with GT on "anosmia" (as disease)		Correlations with GT on "ageusia" (as topic)	
			Covid-19 cases	Covid-19 deaths	Covid-19 cases	Covid-19 deaths	Covid-19 cases	Covid-19 deaths
Italy	411.1	30.0[b]	0.796[a]	0.776[b]	0.810[a]	0.855[b]	0.646[a]	0.621[b]
Spain	169.6	6.24	0.568[a]	0.755[b]	0.460[a]	0.531[b]	0.506[a]	0.632[b]
France	80.8	1.89	0.552[a]	0.761[b]	0.434[a]	0.575[b]	0.438[a]	0.647[b]
UK	20.9	0.32	0.739[a]	0.668[b]	0.663[a]	0.745[b]	0.457[a]	0.500[b]
Germany	58.2	0.14	-0.005[a]	-	0.104[a]	-	-0.099[a]	-
USA	10.6	0.19	-0.081[a]	-0.141[b]	0.015[a]	-0.545[b]	-0.115[a]	0.331[b]
Portugal	23.8	0	-0.312[a]	-	-0.229[a]	-	-0.182[a]	-
Brazil	0.95	0	-0.014[a]	-	-0.031[a]	-	0.003[a]	-

UK: United Kingdom; USA: United States of America.
[a] Analysis time frame: From the date of the first confirmed Covid-19 case in the respective country and March 15. [b] Analysis time frame: From the date of the first confirmed Covid-19 death in the respective country and March 15.

These results are supported by between-countries comparisons (Figure 4) – while prior to March 16, Italy was the country with the largest volume of searches on "anosmia"/"ageusia", it was surpassed by France, the United Kingdom and Spain following extensive media coverage on those symptoms.

Discussion

Principal findings

The results of the present study suggest that Covid-19-related GT queries do not necessarily follow the evolution of the epidemic and, in particular for anosmia and ageusia, are rather more closely related to media coverage.
We carried out a stepwise approach and, based on the 1 and 5-year perspectives, and showed that search peaks for "coronavirus", but also for "anosmia"/"ageusia" are just found in 2020, and there may be a relationship between the two peaks. This is different from "cough" whose searches are detected for all years but with a peak coincident with the "coronavirus" peak.

We then assessed countries with an identifiable “anosmia” peak in 2020 in the Northern and Southern Hemispheres. Surprisingly, in all places, peaks for “coronavirus”, “cough” or “anosmia/ageusia” all occurred simultaneously, irrespectively of the pandemic stage. The simple interpretation is that this is unlikely to be associated to Covid-19 incidence. However, the time of onset differed for “coronavirus” or “cough” versus “anosmia” or “ageusia”, with the latter coinciding with the timing that media news covered the information on these symptoms (Table 3).

Table 3. Media coverage on the identification of “anosmia” and “ageusia” as Covid-19 symptoms

Language	Date	Title of index media news	Source	URL
German (first article)				
	16/03/2020	Virologe Hendrik Streeck : "Wir haben neue Symptome entdeckt"	Frankfurt Allgemeine Zeitung	https://www.faz.net/aktuell/gesellschaft/gesundheit/coronavirus/neue-corona-symptome-entdeckt-virologe-hendrik-streeck-zum-virus-16681450.html
Italian				
	17/03/2020	Coronavirus, tra i sintomi frequenti la perdita totale di gusto e olfatto	Corriere de la Serra	https://www.corriere.it/salute/malattie_infettive/20_marzo_17/coronavirus-sintomi-frequenti-perdita-gusto-olfatto-6d3b0932-6836-11ea-9725-c592292e4a85.shtml
English				
	17/03/2020	Coronavirus symptoms shock: Scientists discover NEW symptoms including lack of taste	Daily Express (UK)	https://www.express.co.uk/news/world/1256433/coronavirus-symptoms-latest-uk-covid-19-coronavirus-taste-smell
	17/03/2020	Coronavirus is most contagious before and during the first week of symptoms	Science News (USA)	https://www.express.co.uk/news/world/1256433/coronavirus-symptoms-latest-uk-covid-19-coronavirus-taste-smell
French				
	17/03/2020	Coronavirus : toux, fièvre, fatigue... quels sont les symptômes du Covid-19 ?	Le Parisien	https://www.sciencenews.org/article/coronavirus-most-contagious-before-during-first-week-symptoms
Spanish				
	18/03/2020	El coronavirus neutraliza los sentidos del olfato	ABC	https://www.abc.es/sociedad/abci-coronavirus-neutraliza-sentidos-olfato-y-gusto-

		y el gusto		202003180214_noticia.html
Portuguese				
	18/03/2020	Virologista alemão revela novos sintomas do coronavírus	Sputinik news (Brazil)	https://br.sputniknews.com/ciencia_tecnologia/2020031815343670-virologista-alemao-revela-novos-sintomas-do-coronavirus/

We subsequently studied the peaks for “coronavirus”, “cough” or “anosmia”/“ageusia”. The peak of “anosmia”/“ageusia” is delayed when compared to “cough”, a major symptom of Covid-19. It was usually short (one week) confirming that most of the queries were driven by media coverage. Prior studies have also pointed out that GTs are highly influenced by media [17, 18] – due to some media coverage, aberrant ragweed pollen peaks were observed during the grass pollen season [19]. In fact, one important limitation of demand-based infodemiological studies concerns the difficulty of distinguishing the effects of a true biological epidemic from what generates interest or apprehension in Internet users [2,5]. In that sense, complementing search data with click data has been suggested as a possible solution to partly overcome this limitation [2].

The correlation between “anosmia”/“ageusia” and deaths or new cases of Covid-19 varied substantially among countries. Depending on the country, there was a high correlation or no correlation at all. Prior to March 16, in countries with higher Covid-19 infection or death rates, there were moderate-good correlations between queries on “anosmia”/“ageusia” and Covid-19 new cases or deaths. This suggests that, in the absence of substantial changes in media coverage, and in the presence of a sufficiently high Covid-19 incidence, GT might mostly reflect searches for symptoms patients have. Thus, the strong correlations found by Walker et al [15] may reflect the facts that (i) they analysed GT on anosmia/ageusia only up until March 25, 2020 (i.e., until the week before searches on anosmia/ageusia started to decrease); (ii) their analyses on the associations between Covid-19 cases/deaths and pre-mediatic coverage of anosmia GT were restricted to three countries (UK, Spain and Italy); and that (iii) such pre-mediatic coverage was considered by the authors to have occurred until March 20, 2020 (i.e., searches between March 16-19 were misclassified as they had already occurred under potential influence of media coverage).

Limitations

Our study has some potentially relevant limitations. We used data at national levels, which may have not captured within-countries heterogeneity on Covid-19 incidence or GT – different results could have obtained if data were assessed at a more granulated level. Another relevant limitation concerns the fact that, by March 16, the incidence of Covid-19 was still low in most Western countries – with the exception of Italy and Spain, the remaining Western countries had less than 100 confirmed Covid-19 cases per million inhabitants. The possibility of assessing a larger number of countries with higher number of Covid-19 cases would have allowed us to more confidently assess “anosmia” and “ageusia” search patterns (and their association with Covid-19 epidemiology) before and after media coverage on those symptoms.

Another important GT limitation concerns the representativeness of Internet users [20] – Internet use is lowest among the elderly, who constitute the age group with the highest Covid-19 morbidity. Finally, GT is provided in relative rather than absolute numbers, which may limit across-countries comparisons. However, as expected, similar correlation coefficients are obtained when comparing GT with relative or absolute numbers of Covid-19 cases/deaths.

Conclusions

In conclusion, at least in the initial stages of SARS-CoV-2 pandemic, Covid-19-related web searches

may more closely reflect media coverage (and subsequent users' interest or apprehension) than epidemiological trends. The use of GTs has increased dramatically in the last decade, and, whereas in the past the focus had been on surveillance and monitoring, the focus of research has now shifted to forecasting changes [21]. It seems important to link GTs with other source of data to overcome the limitations of using only search information.

Conflicts of Interest

None declared

Abbreviations

FAZ: Frankfurter Allgemeine Zeitung; GT: Google Trends

References

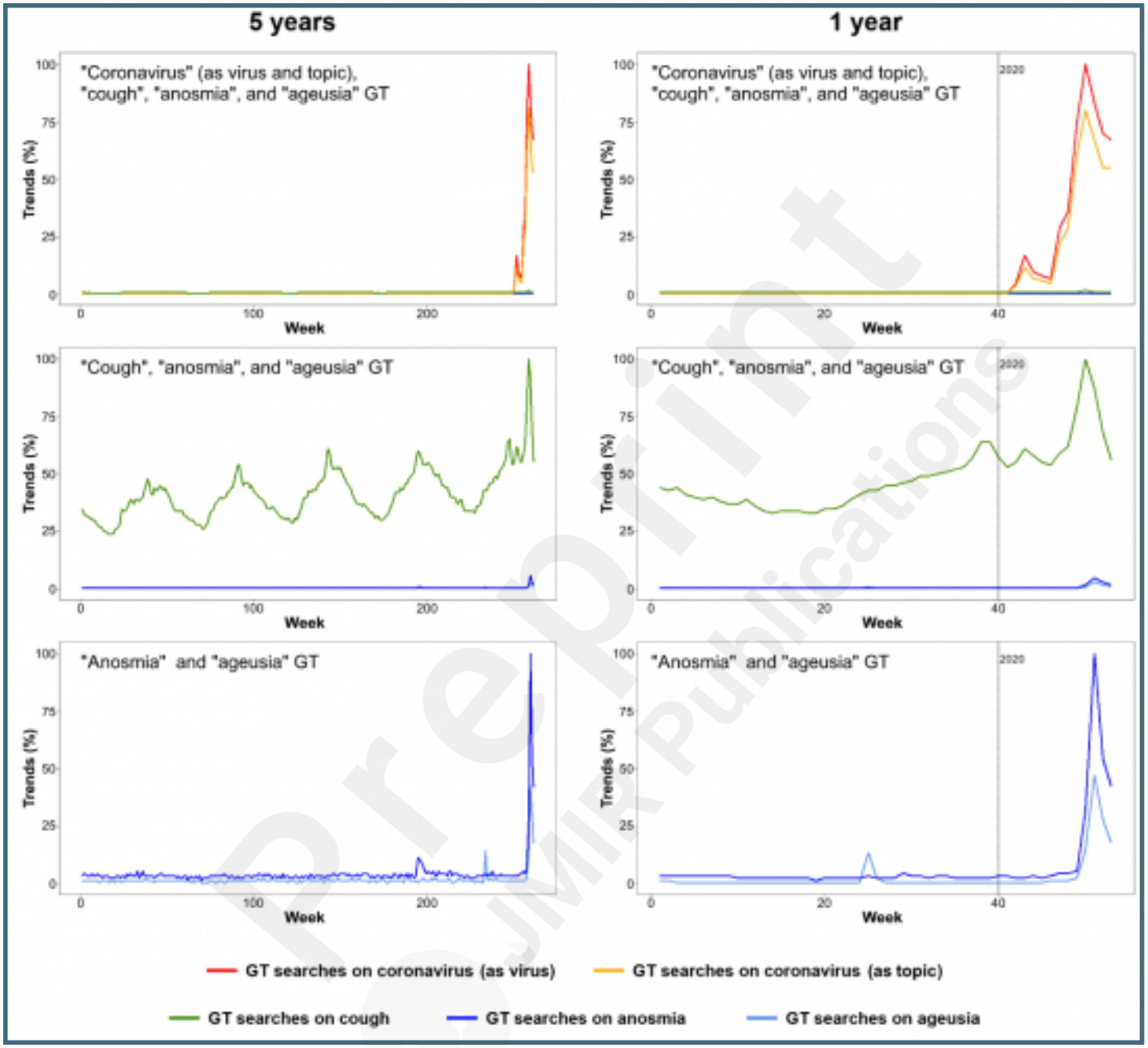
1. Eysenbach G. Infodemiology: the epidemiology of (mis)information. Am J Med; 2002;13(9):763-765.
2. Eysenbach G. Infodemiology and infoveillance: framework for an emerging set of public health informatics methods to analyze search, communication and publication behavior on the Internet. J Med Internet Res; 2009;11(1):e11.
3. Bernardo TM, Rajic A, Young I, Robiadek K, Pham MT, Funk JA. Scoping Review on Search Queries and Social Media for Disease Surveillance: A Chronology of Innovation. J Med Internet Res; 2013;15(7):e147.
4. Mavragani A. Infodemiology and Infoveillance: Scoping Review. J Med Internet Res; 2020;22(4):e16206.
5. Eysenbach G. SARS and Population Health Technology. J Med Internet Res; 2003; 5(2):e14.
6. Ginsberg J, Mohebbi MH, Patel RS, Brammer L, Smolinski MS, Brilliant L. Detecting influenza epidemics using search engine query data. J Med Internet Res; 2009;457:1012-1014.
7. Klembczyk JJ, Jalalpour M, Levin S, Washington RE, Pines JM, Rothman RE, et al. Google Flu Trends Spatial Variability Validated Against Emergency Department Influenza-Related Visits. J Med Internet Res; 2016;18(6):e175.
8. Butler D. When Google got flu wrong. Nature; 2013;494(7436):155-6.
9. Husnayain A, Fuad A, Su EC. Applications of google search trends for risk communication in infectious disease management: A case study of Covid-19 outbreak in Taiwan. Int J Infect Dis; 2020.
10. Mavragani A. Tracking Covid-19 in Europe: An Infodemiology Study. JMIR Public Health Surveill; 2020.
11. Ayyoubzadeh SM, Ayyoubzadeh SM, Zahedi H, Ahmadi M, S RNK. Predicting Covid-19 incidence using Google Trends and data mining techniques: A pilot study in Iran. JMIR Public Health Surveill; 2020.
12. Hong YR, Lawrence J, Williams D, Jr., Mainous Iii A. Population-Level Interest and Telehealth Capacity of US Hospitals in Response to Covid-19: Cross-Sectional Analysis of Google Search and National Hospital Survey Data. JMIR Public Health Surveill; 2020;6(2):e18961.
13. Lechien JR, Chiesa-Estomba CM, De Siati DR, Horoi M, Le Bon SD, Rodriguez A, et al. Olfactory and gustatory dysfunctions as a clinical presentation of mild-to-moderate forms of the coronavirus disease (Covid-19): a multicenter European study. Eur Arch Otorhinolaryngol; 2020.
14. Schmitt P-P. „Wir haben neue Symptome entdeckt". Frankfurter Allgemeine Zeitung. 2020 March 16, 2020.

15. Walker A, Hopkins C, Surda P. The use of google trends to investigate the loss of smell related searches during Covid-19 outbreak. Int Forum Allergy Rhinol; 2020.
16. Mavragani A, Ochoa G. Google Trends in Infodemiology and Infoveillance: Methodology Framework. JMIR Public Health Surveill; 2019;29(5):e13439.
17. Hamaoui-Laguel L, vautard R, Liu L, Solmon F, Viory N, Khvorostyanov D, et al. Effects of climate change and seed dispersal on airborne ragweed pollen loads in Europe. Nat Clim Change; 2015;5:766-71.
18. Pandey A, Abdullah K, Drazner MH. Impact of Vice President Cheney on public interest in left ventricular assist devices and heart transplantation. Am J Cardiol; 2014;113(9):1529-31
19. Bousquet J, Agache I, Berger U, Bergmann KC, Besancenot JP, Bousquet PJ, et al. Differences in Reporting the Ragweed Pollen Season Using Google Trends across 15 Countries. Int Arch Allergy Immunol; 2018;176(3-4):181-8.
20. Eysenbach G. Infodemiology and Infoveillance Tracking Online Health Information and Cyberbehavior for Public Health. Am J Prev Med. 2011;40(5 S2):S154-158.
21. Jun S, Yoo H, Choi S. Ten years of research change using Google Trends: From the perspective of big data utilizations and applications. Technol Forecast Social Change. 2018;130:69-87.

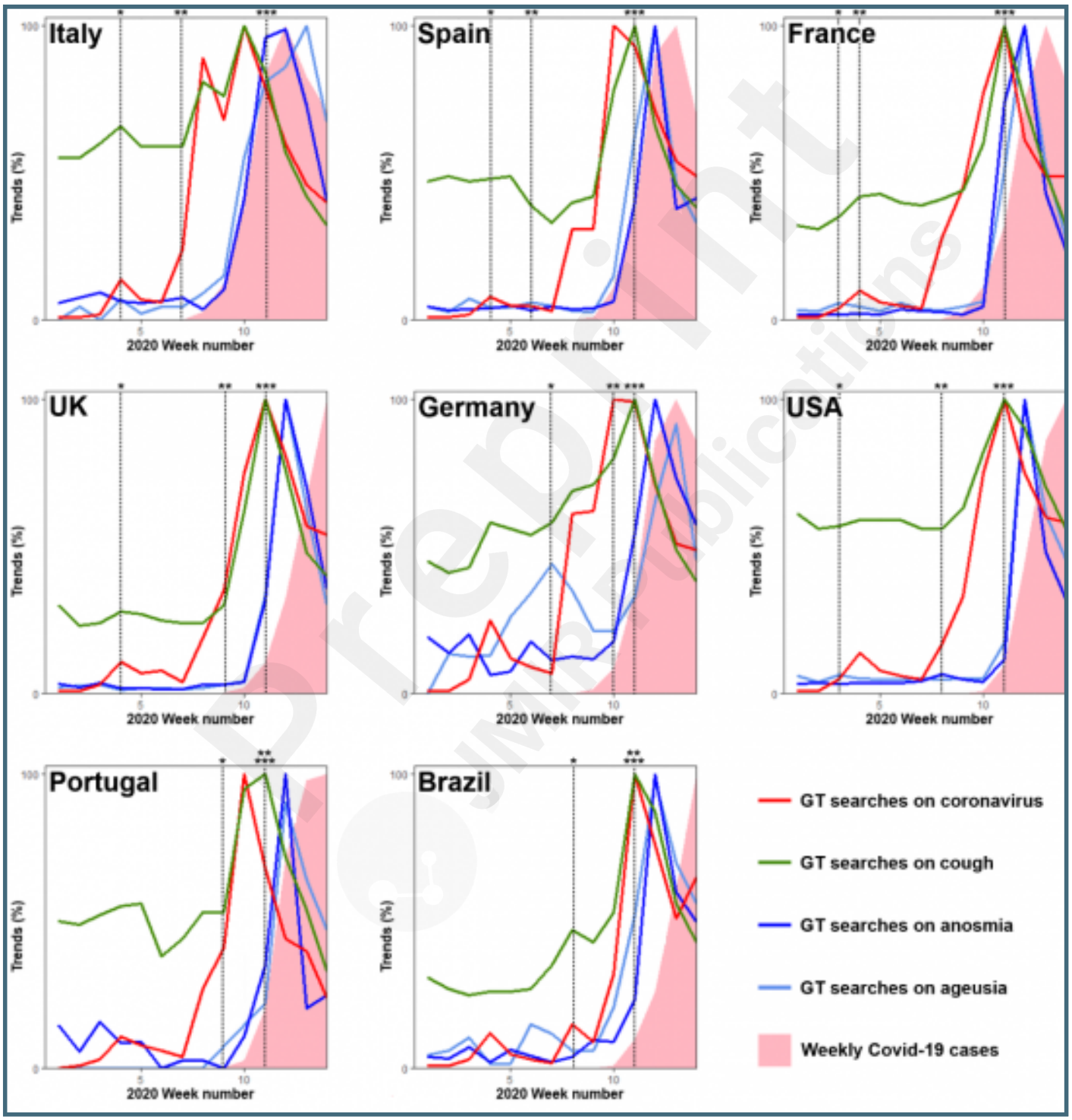
Supplementary Files

Figures

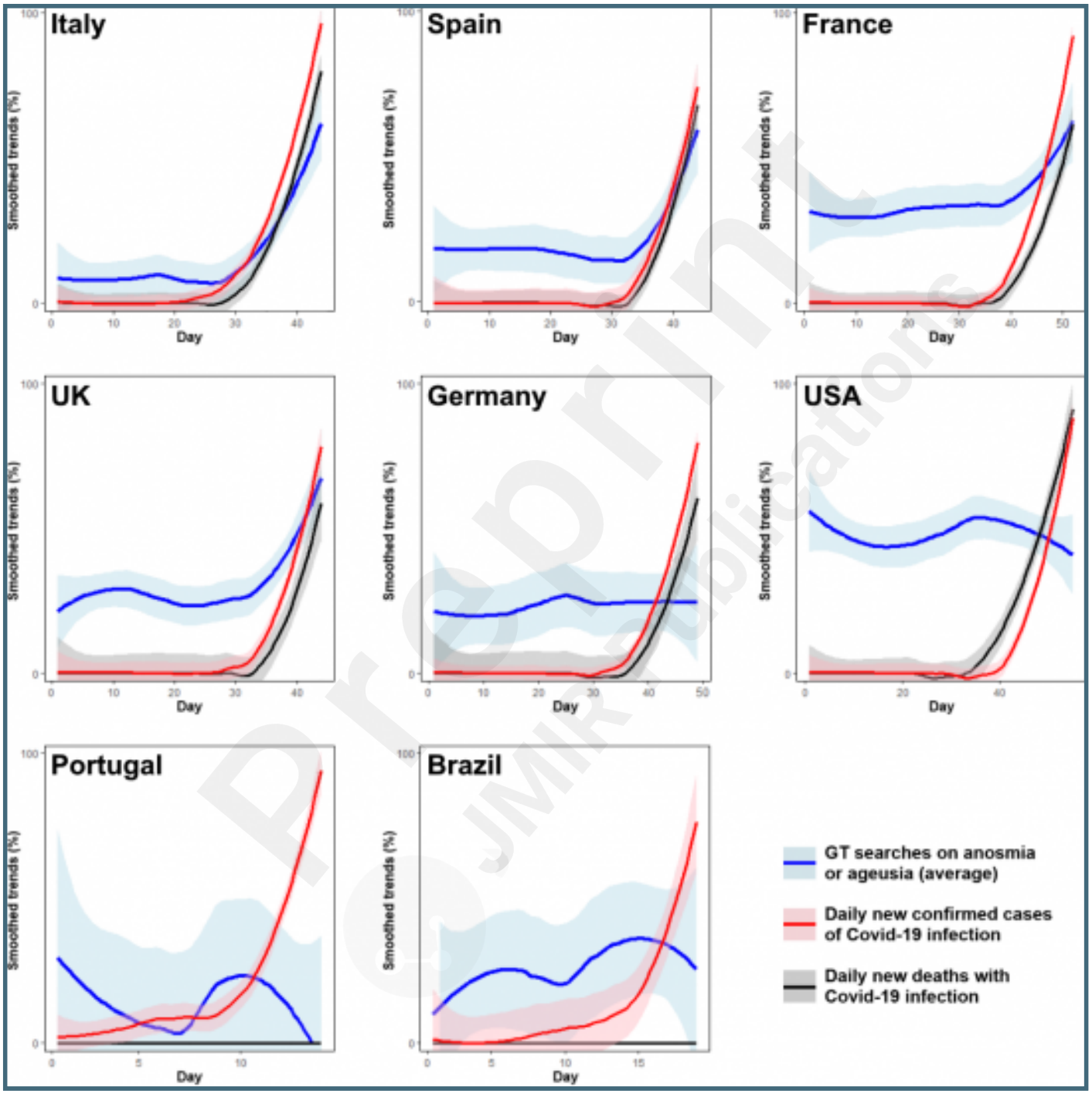
Global Google Trends (GT) on "coronavirus", "cough", "anosmia", and "ageusia". Data are presented as a percentage of the maximum value and on a weekly basis, for a period of 5 years and 1 year up to the week of April 5-11, 2020.



Google Trends (GT) on "coronavirus", "cough", "anosmia" and "ageusia", and relative frequency of new Covid-19 infections. Data are presented as a percentage of the maximum value and on a weekly basis, from the week of January 5-11 to the week of April 5-11, 2020. * First confirmed case of Covid-19 case. ** First confirmed death due to Covid-19. *** Hendrik Streeck interview to the Frankfurter Allgemeine Zeitung, reporting that anosmia and ageusia could be Covid-19 symptoms.



Average of Google Trends (GT) on "anosmia" and "ageusia", and relative frequency of new Covid-19 infections and deaths. Data are presented as Loess-smoothed percentages of the maximum value (smoothed trends) and on a daily basis, from February 1 to March 15, 2020 (before the media publicized that anosmia and ageusia could be symptoms of Covid-19). Lines were smoothed to display trends more clearly.



Average of Google Trends (GT) on "anosmia" and "ageusia" before the media publicized that those could be symptoms of Covid-19 (February 1-March 15, 2020), and in the two weeks before and after such media release (marked with a grey dashed line) (March 1-31, 2020). Data are presented on a daily basis, as Loess-smoothed percentage of the maximum value and adjusted for the population.