Journal of Public Health (2023) 31:1673–1680
https://doi.org/10.1007/s10389-022-01731-1

ORIGINAL ARTICLE

Influence of the COVID-19 pandemic measures on incidence and representation of other infectious diseases in Germany: a lesson to be learnt

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Received: 13 April 2022 / Accepted: 27 June 2022 / Published online: 9 July 2022

Abstract

Aim The COVID-19 pandemic resulted in a wide range of serious health, social and economic consequences. To counteract the pandemic, various measures and restrictions such as lockdowns, closures, social distancing, hygiene, and protective measures such as wearing face masks have been enforced. Apart from the COVID-19 pandemic, these measures also had effects on other transmittable diseases. This study therefore determined the impact on case numbers and interest for other infectious diseases as well.

Subject and methods Anonymized data on reported case numbers from the German Robert Koch Institute and data from Google Trends about the search interest have been used in this study to track courses of infectious diseases before and during the coronavirus pandemic in Germany.

Results The results of this analysis clearly demonstrated that the case numbers of influenza, whooping cough, measles, mumps, scarlet fever and chicken pox decreased in the pandemic years, most probably due to anti-pandemic measures in Germany. Additionally, the Google Trends analysis demonstrated public awareness, documented by a corresponding search interest, for the new topic COVID-19 and for other infectious diseases.

Conclusion Online available data provided valuable sources for research purposes in infodemiology or infoveillance.

Highlights

- **COVID-19 dominated public search interest for infectious diseases during the pandemic.**
- **Reduction in case numbers of influenza, whooping cough, measles, mumps, scarlet fever and chicken pox was shown for pandemic years.**
- **Google Trends was shown as a functional tool, well suited for demonstrating the population's awareness of certain infectious diseases.**

Keywords COVID-19 · SARS-CoV-2 · Search engine data · Infodemiology · Infoveillance · Representation index

Introduction

SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) has spread worldwide since December 2019 as the COVID-19 (coronavirus disease 2019) pandemic with far-reaching and long-term health, social and economic consequences.

To counteract the pandemic, various measures and restrictions such as lockdowns, closures, social distancing, hygiene, and protective measures such as wearing face masks were also taken in Germany (Müller et al. 2020; Wilder-Smith and Freedman 2020).

Positive effects for reducing other transmittable diseases such as influenza have already been shown. The resulting further consequences for the population have been widely discussed (Sanz-Muñoz et al. 2021)

'Infodemiology' and 'infoveillance' as defined by Gunther Eysenbach are information epidemiology and

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surveillance, respectively, and have already been used to track and investigate infectious diseases with search engine data such as Google Trends data (Mavragani and Ochoa 2019; Eysenbach 2009; Springer et al. 2021). Google Trends data have proven to be valuable and meaningful, provided that they are studied appropriately.

The aim of this study was to evaluate the impact of the COVID-19 pandemic on other infectious diseases in Germany, given that measures to contain the pandemic have also had an impact on other transmittable diseases. In addition, the representation of these diseases in the awareness and in the search interest before and during the pandemic in Germany should be examined by analysis of available Google Trends data.

The relevance of the study lies in the presentation of presumed effects of the COVID-19 pandemic or pandemic containment measures on the case numbers of other infectious diseases using the example of Germany, as well as in the combination of search interest of the Internet-using population and case numbers in the representation index. The study thus provides a basis for future research into epidemic data and information in search engines.

Methods

Study design

In this study, anonymized data on reported case numbers from the German Robert Koch Institute and open access data from Google Trends were used.

Google Trends data

Google Trends (Google LLC, Mountain View, CA, USA) provides data that have been widely used for tracking COVID-19 pandemic (e.g. Strzelecki 2020; Springer et al. 2021). Google Trends data allow comparison of up to five search terms or topics. All values are further related to the maximum peak value (value is set to 100 by Google Trends for this peak). This means that different search queries that contain the same reference term (e.g. topic 'measles') can also be related to one another.

In this study, data were collected with the following settings in Google Trends (https://trends.google.com/trends). The period was set from January 2013 to December 2021 with a monthly resolution, for which reports of disease cases to the German Robert Koch Institute according to the Protection against Infection Act (German: Infektionsschutzgesetz, IfSG) were also available. Only completed years were taken into account.

Data were accessed in February 2022 for the region Germany. The category was set as all categories and web search was selected. In this study, search topics were used instead of search terms for better covering. The search topics were selected according to diseases, for which data from Robert Koch Institute were available.

Average relative monthly search interest M_y for each year y of the examined period was calculated. Subsequently, the average relative monthly search interests of the years before the pandemic 2013–2019 and of the pandemic years 2020-2021 were averaged and evaluated.

Case data and incidences

In this study, online available data from German Robert Koch Institute's database of notifiable diseases and confirmed pathogens (Robert Koch Institute: SurvStat@RKI 2.0, https://survstat.rki.de, data accessed: 04.02.2022) were used to evaluate case numbers and incidences for Germany. Incidences were provided by the online portal SurvStat@RKI as the number of cases per 100,000 inhabitants. The incidences of each year before the pandemic (2013–2019) and of the pandemic years (2020–2021) were averaged and evaluated. Means and standard deviation were calculated.

Representation index

According to Holmes et al. (2022), a representation index can indicate the ratio of search interest, and thus information need, to a selected real total. In this study, therefore, average relative monthly search interest was related to disease cases that occurred. This showed the representation of search interest related to the actual disease cases that occurred. The representation indices of the different diseases were then compared.

An annual representation index RI_y that relates the average relative monthly search interest M_y in each year y to the number of cases N_y of the respective disease was calculated as follows:

$$\mathbf{RI_y = M_y / N_y}$$

For relative monthly search interest in disease-related search topics the topic measles was used as reference. Subsequently, the RI_y values of the years before the pandemic 2013–2019 and the pandemic years 2020–2021 were averaged and compared. Means and standard deviations were calculated.

Results

As shown in Fig. 1, the case numbers of COVID-19 dominated the reported infectious diseases in Germany since 2020. During the pandemic years 2020 and 2021, many of

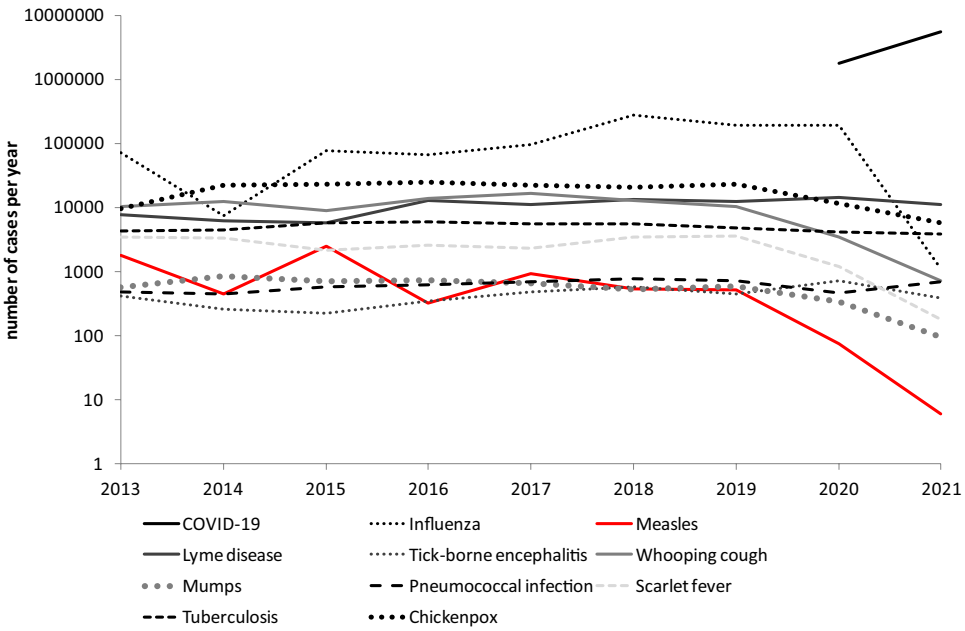

Fig. 1 Case numbers for infectious diseases as indicated according to the German Robert Koch Institute (Robert Koch Institute: SurvStat@RKI 2.0, https://survstat.rki.de, data accessed: 04.02.2022)

the airborne transmitted viral or bacterial diseases that can be easily transmitted from person to person through droplet infection, such as measles or whooping cough, showed a significant decrease in the number of cases or incidences (Fig. 1, Table 1). In contrast, the number of cases of zoonotic tick-borne diseases, Lyme disease and tick-borne encephalitis remained at about pre-pandemic levels.

As shown in Fig. 2A, the topic of COVID-19 dominated compared to the other topics examined. The search interest for COVID-19 was so high that other search topics provided insufficient data. Other infectious diseases were therefore related to the clear measles peak in 2015 (Fig. 2B). In 2015, a measles outbreak was registered in Germany as also shown in Fig. 11 (Robert Koch Institute: 'Epidemiologisches Bulletin', No. 10, 09. March 2015). It also attracted media attention, e.g. https://www.zeit.de/wissen/gesundheit/2015-02/masern-infektion-ausbruch-berlin-impfung) and may have triggered public search interest.

As shown in Table 2, the mean values of the averaged relative monthly search interest in the pre-pandemic years (2013–2019) and the pandemic years (2020–2021) showed increases, for example, for influenza and measles. In contrast, scarlet fever showed a decreasing trend during the pandemic (Table 2).

Table 3 shows the corresponding values of the annual representation index RI of the years before the pandemic and the years of the pandemic.

A low RI value means that the relative search interest and thus the public need for information for a particular disease is relatively low in relation to the actual number of reported new cases for this disease. High values, on the other hand, represent a high level of attention in relation to the number

Table 1 Means and standard deviations of averaged incidences of the years before the pandemic (2013–2019) and the pandemic years (2020–2021) for the diseases as indicated (incidences as provided by the online portal SurvStat@RKI as the number of cases per 100,000 inhabitants) (* meaningful data only since the onset of the disease)

	Averaged incidences (2013–19)		Averaged incidences (2020–21)	
	Mean	Standard deviation	Mean	Standard deviation
COVID-19	no data*	no data*	4343.8	3109.9
Influenza	135.6	108.6	117.8	164.6
Measles	1.2	1.0	0.0	0.1
Lyme disease	12.0	3.9	15.2	2.7
Tick-borne encephalitis	0.5	0.1	0.7	0.3
Whooping cough	14.9	3.1	2.5	2.3
Mumps	0.8	0.1	0.3	0.2
Pneumococcal infection	0.8	0.1	0.7	0.2
Scarlet fever	3.6	0.8	0.8	0.8
Tuberculosis	6.3	0.8	4.8	0.2
Chickenpox	25.1	6.0	10.2	4.8

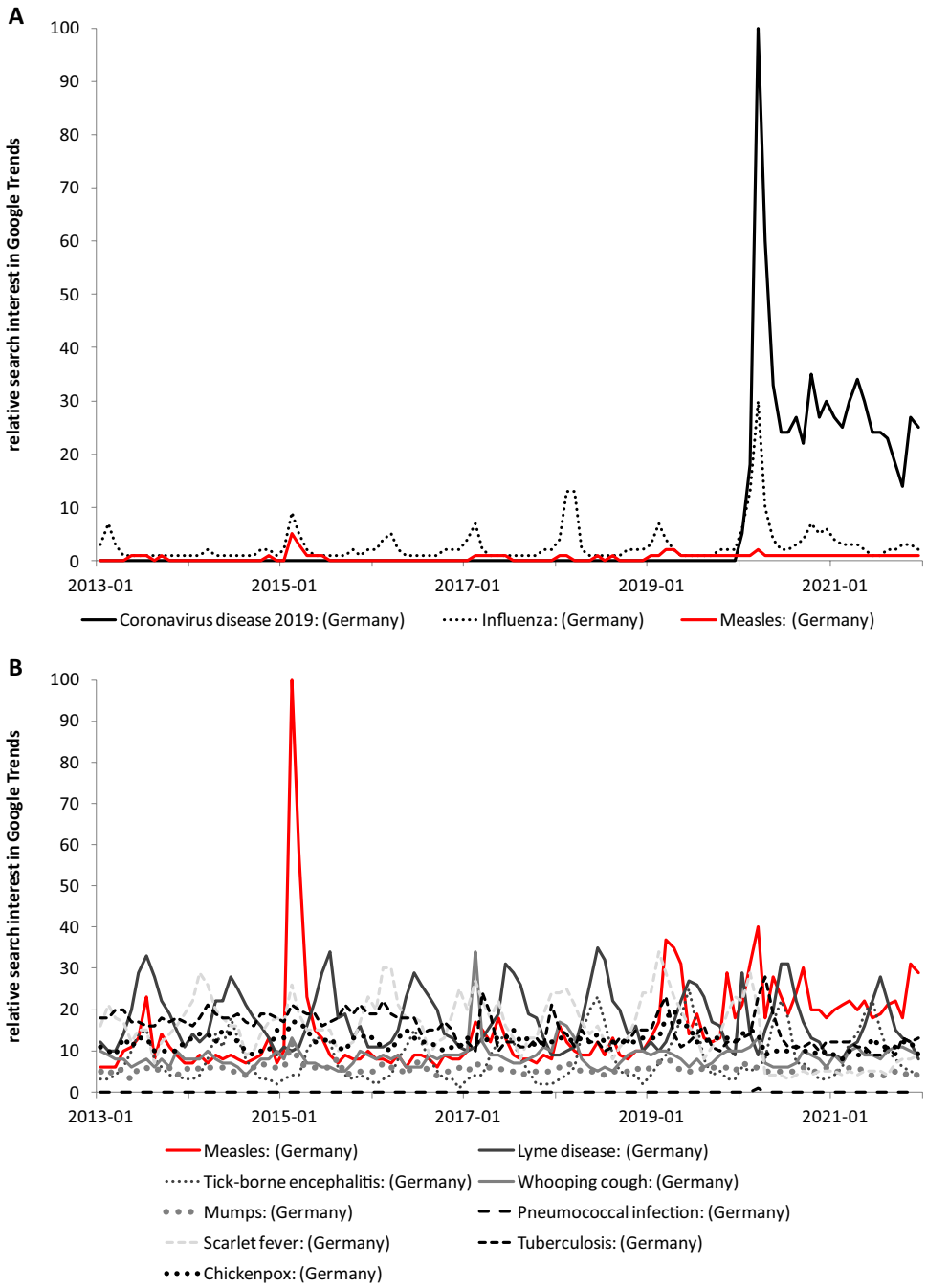

Fig. 2 Relative monthly search interest in disease-related search topics as indicated according to Google Trends data with coronavirus disease 2019 (**A**) and measles (**B**) as reference (Google Trends values <1 were considered 0)

of new cases. Values before and after the pandemic can be compared for one disease. Furthermore, it is also possible to compare the RI values of different diseases.

Since the index was related to the number of cases, the value for COVID-19 was very low due to the high number of cases. In contrast, the topic of measles was very well represented by search interest due to the low number of cases during the pandemic (Table 3).

In order to be able to show the changes in search interest in more detail, the Google Trends queries were carried out again separately for each topic. The results are shown in Fig. 3. For example, a decrease in scarlet fever during the pandemic was shown. Seasonality was shown, for example, for tick-borne diseases (Fig. 3A) or seasonal influenza (Fig. 3B). In contrast, at the beginning of 2020, at the beginning of the COVID-19 pandemic, there was an exceptionally high peak for influenza (Fig. 3B). Comparisons of COVID-19 with influenza may have also played a role here.

Table 2 Means and standard deviations of the averaged relative monthly search interest of the years before the pandemic (2013–2019) and the pandemic years (2020–2021) for the search topics as indicated (topic measles was used as reference (peak value = 100); Google Trends values <1 were considered 0) (* meaningful data only since the onset of the disease)

	Averaged relative monthly search interest (2013–19)		Averaged relative monthly search interest (2020–21)	
	Mean	Standard deviation	Mean	Standard deviation
Coronavirus disease 2019 (Germany)	no data*	no data*	588.3	122.6
Influenza (Germany)	45.3	15.3	109.2	81.3
Measles (Germany)	13.1	6.0	23.1	1.7
Lyme disease (Germany)	17.8	0.6	16.6	2.7
Tick-borne encephalitis (Germany)	7.5	1.4	9.7	1.1
Whooping cough (Germany)	8.6	1.3	8.9	0.9
Mumps (Germany)	5.6	0.4	5.1	0.5
Pneumococcal infection (Germany)	0.0	0.0	0.0	0.1
Scarlet fever (Germany)	17.6	1.6	7.4	2.4
Tuberculosis (Germany)	16.1	2.4	13.0	2.5
Chickenpox (Germany)	12.5	1.0	10.7	0.5

Table 3 Means and standard deviations of annual representation index RI values of the years before the pandemic (2013–2019) and the pandemic years (2020–2021) (topic measles was used as reference (peak value = 100) for Google Trends data) (* meaningful data only since the onset of the disease)

	Annual representation index RI (2013–19)		Annual representation index RI (2020–21)	
	Mean	Standard deviation	Mean	Standard deviation
COVID-19	no data*	no data*	0.000	0.000
Influenza	0.001	0.001	0.023	0.032
Measles	0.019	0.012	1.986	2.357
Lyme disease	0.002	0.001	0.001	0.000
Tick-borne encephalitis	0.020	0.007	0.020	0.010
Whooping cough	0.001	0.000	0.008	0.008
Mumps	0.009	0.001	0.033	0.024
Pneumococcal infection	0.000	0.000	0.000	0.000
Scarlet fever	0.006	0.001	0.020	0.017
Tuberculosis	0.003	0.001	0.003	0.000
Chickenpox	0.001	0.000	0.001	0.001

Discussion

COVID-19 and seasonal influenza are two comparable, transmissible viral diseases that attracted the most public attention of all diseases examined in the study. In the case of the exceptional influenza peak in 2020, this may be due, among other things, to the fact that comparisons between COVID-19 and 'common' influenza were publicly discussed at the beginning of the COVID-19 pandemic, which probably generated above-average interest in this topic (e.g. https://www.tagesschau.de/faktenfinder/coronavirus-faq-angst-berechtigt-101.html, 03. March 2020).

Influenza showed a pronounced seasonal aspect and clear differences between the various years examined. The low number of influenza cases in 2014 was also well reflected in the Google Trends analysis, which also showed very low interest in this topic. While a relatively large number of influenza cases were still recorded for 2020, the case number in 2021 was particularly low in comparison. The measures taken due to the pandemic may have played a role here (Sanz-Muñoz et al. 2021). In the case of COVID-19, the number of cases did not react as desired. Here, aspects such as a naïve population and evolution of new virus mutants also played a major role. The outbreak of pandemic waves in Germany could therefore not be prevented, but the measures taken certainly had an impact on their severity (Lippold et al. 2021; Jung et al. 2020; Leung et al. 2020).

The media also played a role as a trigger that should not be underestimated regarding the awareness of the population shown here on the basis of the search interest. This was also

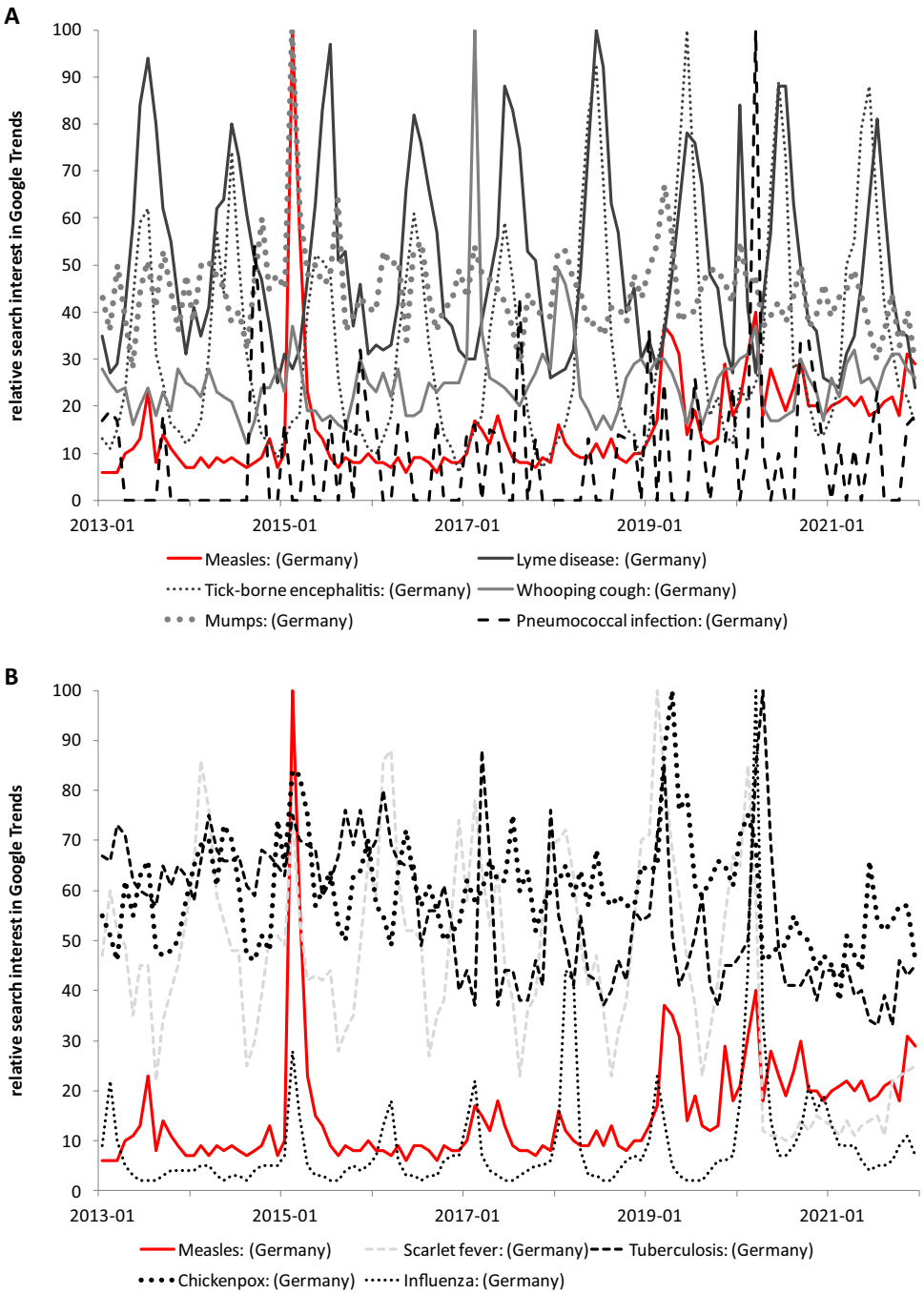

Fig. 3 Relative monthly search interest in disease-related search topics as indicated according to Google Trends data (each topic retrieved individually from Google Trends; Google Trends values <1 were considered 0)

evident in 2015 at the measles peak or in the case of influenza at the beginning of 2020. Although the case numbers on these occasions were relatively high, the resulting interest was nonetheless exceptionally increased.

While zoonotic Lyme disease and tick-borne encephalitis hardly showed any changes caused by the pandemic, the number of cases of other bacterial or viral diseases decreased.

It can be suggested that pandemic countermeasures intended to prevent human-to-human transmissions had also successfully led to the shown reduction in cases of influenza, whooping cough, measles, mumps, scarlet fever and chicken pox.

For tuberculosis and pneumococcal infections, hardly any effects on case numbers or incidences were observed. Many uncertainties remain regarding the effects of the pandemic on the transmission of *Mycobacterium tuberculosis* (McQuaid et al. 2021). As discussed by McQuaid et al. (2021), in addition to the increased vulnerability to tuberculosis through a decrease in health care access, an

increase in contact at home (e.g. during lockdowns) may have promoted infections, while the reduction in contacts and masks use may have reduced transmission. Brueggemann et al. (2021) also discussed incidence reductions for *Streptococcus pneumonia*. In this study, on the other hand, no relevant reductions in reported cases could be demonstrated. This may also have had something to do with the possibility of co-infections during COVID-19 (Pal et al. 2020).

This study has some limitations. For example, Google Trends uses subsamples in the evaluation. By using different subsamples, multiple queries to Google Trends could result in different values regarding the search volume for a search topic. Problems with data collection and the general overload of the healthcare system due to the pandemic as well as unreported cases may have also affected the database (e.g. https://www.spiegel.de/wissenschaft/medizin/corona-infektionen-aus-niedersachsen-fehlen-bei-aktuellen-rki-zahlen-a-d4ed9e3f-917c-4859-8c66-4c0c994b5e91, 13 December 2021).

Google Trends data clearly showed that the population was aware of infectious diseases. In particular, the unsurprisingly high level of awareness of the COVID-19 pandemic, which had a decisive impact on personal and social life in 2020 and 2021, could be demonstrated. In addition, other infectious diseases such as influenza, measles, whooping cough, mumps and scarlet fever were also very present in public interest during the pandemic years in relation to the number of cases, as could be shown using the representation index. For example, relative search interest for the topic measles increased in pandemic years and case numbers decreased, resulting in RI being higher during the pandemic than before. For influenza, measles, whooping cough, mumps and scarlet fever an increased RI compared to pre-pandemic times could be shown in this study. An increasing representation index represents a higher level of attention in relation to the number of cases that occurred.

The causes of rising RI are complex. In addition to, for example, a reduction in the number of cases during the pandemic, the relative increase in search interest can cause an increase. Identifying the exact causes for such an increase in relative search interest on Google is difficult. However, in the case of influenza, the public comparison of COVID-19 with influenza could be suspected as a trigger. A search interest in the topic of measles might have been motivated by the public discussion and the introduction of a measles protection law in Germany (German: 'Masernschutzgesetz'), which prescribes mandatory vaccination protection for certain groups of people and came into force in March 2020 (Küpke et al. 2020).

The results of this Google Trends analysis clearly demonstrated the public interest, documented by a corresponding search volume, for the new topic COVID-19 and other infectious diseases. The temporal course of search interest was shown using data from Google Trends.

Conclusions

Despite the limitations of the study, analysis of the available data showed a clear trend. A reduction in case numbers of influenza, whooping cough, measles, mumps, scarlet fever and chicken pox was shown for pandemic years. It could be learnt from this that this was most likely due to the measures taken to combat the pandemic and thus represents a positive side effect of these measures. In addition, however, the negative effects of these measures must not be neglected (e.g. Benke et al. 2020).

Google Trends data provided a functional tool that demonstrated the representation in awareness of the population.

Acknowledgements We thank the Editor-in-Chief Joachim Kugler and the anonymous reviewers, who made it possible for us to significantly improve our research with their valuable suggestions.

Authors' contributions Martin Kaatz: writing, visualization, investigation, validation, review & editing, supervision
Steffen Springer: writing, visualization, investigation, validation
Michael Zieger: conceptualization, methodology, writing, visualization, investigation, review & editing, supervision

Funding This research did not receive any specific funding.

Availability of data and material (data transparency) Not applicable

Code availability (software application or custom code) Not applicable

Declarations

Ethical approval Not required. No human participants were involved in this research. Only anonymized data from the German Robert Koch Institute and open access data from Google Trends were used.

Consent to participate Not applicable.

Consent for publication Not applicable.

Conflicts of interest The authors declare no conflicts of interest.

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