Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Maximum generable interest: A universal standard for Google Trends search queries

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ABSTRACT

The coronavirus or COVID-19 pandemic represents a health event with far-reaching global consequences, triggering a strong search interest in related topics on the Internet worldwide. The use of search engine data has become commonplace in research, but a universal standard for comparing different works is desirable to simplify the comparison. The coronavirus pandemic's enormous impact and media coverage have triggered an exceptionally high search interest. Consequently, the maximum generable interest (MGI) on coronavirus is proposed as a universal reference for objectifying and comparing relative search interest in the future. This search interest can be explored with search engine data such as Google Trends data. Additional standards for medium and low search volumes can also be used to reflect the search interest of topics at different levels. Size standards, such as reference to MGI, may help make research more comparable and better evaluate relative search volumes. This study presents a framework for this purpose using the example of stroke.

1. Introduction

Since December 2019, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) spread globally, causing multiple waves of a disease now known as coronavirus disease 2019 (COVID-19). The global pandemic has far-reaching consequences, on health, societies, and economies [1]. The global consequences and media coverage of this extraordinary pandemic have also attracted public interest worldwide. In our information societies, this led to a worldwide internet search, depending on availability, for example via Google's search engine. Thereby, the interest for COVID-19-related topics reached highest interest values [2]. We therefore postulate that the Google Trends disease-related topic "coronavirus" is the topic that shows the maximum search interest worldwide in Google that can be generated for a single (health) event or topic [3,4].

Gunther Eysenbach defined the foundations of information epidemiology and surveillance as "infodemiology" and "infoveillance" [5,6]. Infodemiology is the study of the distribution and determinants of health information in populations, and the use of this information for public health decision-making. Infoveillance is the systematic collection and analysis of health information for the purpose of detecting, monitoring, and responding to public health threats. Both infodemiology and infoveillance are important tools for public health surveillance, which is the ongoing, systematic collection, analysis, interpretation, and dissemination of data on health events and trends. Surveillance is used to identify and investigate health threats, and to track the progress of public health interventions [7].

Infodemiology studies can help to identify where health information is being shared and accessed, and how this information is being used. This information can be used to design public health interventions that are more likely to be successful [8]. For example, if infodemiology studies show that people are more likely to search for health information online than in traditional media, then public health campaigns that focus on online outreach are more likely to be successful [9]. Infoveillance can help to identify potential health threats early, before they spread. By monitoring health information, infoveillance can detect patterns that may indicate a developing health threat. For example, an increase in the number of people reporting symptoms of a disease may indicate an outbreak. Infoveillance can also be used to monitor the progress of public health interventions, and to identify any potential problems [10]. Both infodemiology and infoveillance have their limitations. For example, infodemiology studies can be biased if the surveyed people are not representative of the general population. Infoveillance can also be limited by the quality and availability of health information. However, when used together, these two tools can provide a powerful tool for public health surveillance.

Data from search engines have been widely used to track and study infectious diseases [11,12]. For example, attempts have been to use Google Flu Trends to make predictions about influenza [13]. Google Flu Trends used search data to estimate flu activity, but lacked

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transparency and predictive accuracy [14]. It was discontinued in 2015, but its experience advanced infodemiology and inspired other research in digital data sources for monitoring disease outbreaks. Especially during the COVID-19 pandemic, the principles defined by Eysenbach were frequently applied [15]. Beyond healthcare research, there are many applications for Google Trends data (https://trends.google.com/trends), for example in science, research, politics, business, economics, nature conservation, and education [16–22]. But even in these fields, the pandemic, with its influence on many areas of life, is an extraordinary and formative topic [19,23,24]. The aim of this study was to evaluate worldwide public search interest on "coronavirus" as universal standard. It should also be investigated whether other popular topics could be used as graded and comparable search interest standard ladder.

2. Methods

2.1. Google trends data

Google Trends is a public web facility provided by Google. It enables users to see how often particular terms are searched for on the Internet. The service can be used to compare the relative popularity (based on data from Google) of different search terms and topics. Google Trends data have been widely used for infodemiology or infoveillance [7,22]. Google Trends provides anonymous data without personal user information and offers comparisons of up to five search keywords or topics [25]. In this study, the following settings in Google Trends were used: the period "past 5 years" (i.e., weekly data: November 2017–November 2022) and the region "worldwide" were selected and "all categories" and "web search" were set. In this study, search topics were used. For this study, search topics were selected to provide examples of the application of the proposed approach that are also of particular relevance to public health. In addition to the topics that were relevant during the COVID-19 pandemic [2,23,26], these include widespread cardiovascular, metabolic, and neoplastic diseases [27–29]. For these health topics, Google Trends also provides corresponding search topics under generally understandable names. The following search topics were selected : "coronavirus", "coronavirus disease 2019", "COVID-19 vaccine", "heart attack", "stroke", "diabetes", "breast cancer".

In addition, the popular topics "YouTube" (video sharing company) and "WhatsApp" (mobile application) [30] were chosen as topics with a medium relative interest level in this setting, also to show that the application of the references does not have to be limited to medical topics. The area under the interest curve did not play a role in the selection of the topics. Data were collected in November 2022.

2.2. Universal standard reference & graded search interest standard

Google Trends disease topic "coronavirus" was postulated to be the topic that shows worldwide the maximum interest that can be generated for a single (health- or disease-related) event or topic. Accordingly, the "maximum generable interest" (MGI) was introduced as a universal standard for Google Trends search queries. This describes the maximum worldwide peak for "coronavirus" in 2020. Graded search interest standard was constructed with examples of medium and low relative search interest.

2.3. Conversion to the universal standard

The graded search interest standard can be used to investigate a specific topic in more detail depending on the level of relative search interest and then still be able to relate it to the universal standard "coronavirus". Rovetta and Castaldo have already proposed a corresponding approach to improve the accuracy of Google Trends for low volume search terms [16]. In our study, a conversion of the relative (weekly) search interest $SI(topic\ x)_{reference\ y}$ for a topic x, which was collected with a reference y other than "coronavirus", to the universal standard reference "coronavirus" is necessary. This was done with the help of the following conversion factor F:

$$F = pSI(reference\ y)_{reference\ \text{“}coronavirus\text{”}}/100$$

Here $pSI(reference\ y)_{reference\ \text{“}coronavirus\text{”}}$ is the peak SI of the reference y as topic if the universal reference is used in the Google trends query. The conversion for queries with a low reference can be done analogously, first to a medium reference and then to the universal reference.

3. Results

As Fig. 1 A shows, the topic of "coronavirus" has such a high peak interest worldwide in March 2020 that other search topic areas such as diabetes, stroke or heart attack have only a very low relative interest. In the worldwide search interest, the peak for topic "coronavirus" is higher than the peaks for topics of COVID-19 or the COVID-19 vaccine, for example. As the pandemic progresses, the topic of COVID-19 replaces the topic of coronavirus and the focus of search interest shifts (Fig. 1A). Public interest was now more focused on the WHO's proposed name for the disease, COVID-19 [16,31]. Fig. 1A also shows examples of suitable reference topics with high, medium, and low relative peak search interest: "coronavirus" (high), "YouTube" (medium), "diabetes" (low). The area under the curve does not play a role here and was not taken into account in the considerations.

However, with a high reference, such as "coronavirus", the relative search interest for topics of lesser interest, such as "stroke", may only be inadequately represented. Possible interesting peaks may be obscured (Fig. 1B). In addition, Google Trends only provides integer values (between 0 and 100) or, in the case of correspondingly low relative search interest, the indication "<1". If a topic is examined with correspondingly suitable references adapted to the level of search interest, a better approximation to the curve progression of the individual query (without additional reference) is possible (Fig. 1B). As an example of the application of the graded search interest standard, the topic "stroke" was used and queried with the reference "diabetes" adjusted to the level of relative search interest (Figs. 1B, 2). The results were converted to references "YouTube" and "coronavirus" as shown in Fig. 2. It should be noted that if a search topic varies greatly in search intensity over the selected time window, e.g., from values <1 to close to the range of the selected reference (100), better resolution for the low values can hardly be achieved. Even with a single query, the values would spread over the selected time period from the range around 1 to the peak of 100. A possible solution would be to change the time period in which the low values are examined separately, as described by Rovetta and Castaldo, and then recalibrated [16].

4. Discussion

The use of search engine data as an instrument for research has become established in recent years, not only in health care or medicine [32,33]. Many studies use individual search topics that are compared with each other in a way that is appropriate for this specific field of research [34,35]. However, a uniform, universal standard would be desirable to simplify the comparison of different works. Comparability with other research work or publications is particularly important for research in the field of public health, to be able to better classify the different magnitudes of the search volumes. Infodemiology and infoveillance could benefit greatly from this comparability of the results. A better weighting of the relevance of individual search topics would be possible. In addition, the limited resources for informing the population, for example, could be used and addressed in a more targeted manner. Accordingly, the "maximum generable interest" (MGI) is proposed as a universal standard for Google Trends search queries. The maximum peak of interest in the topic "coronavirus" is postulated

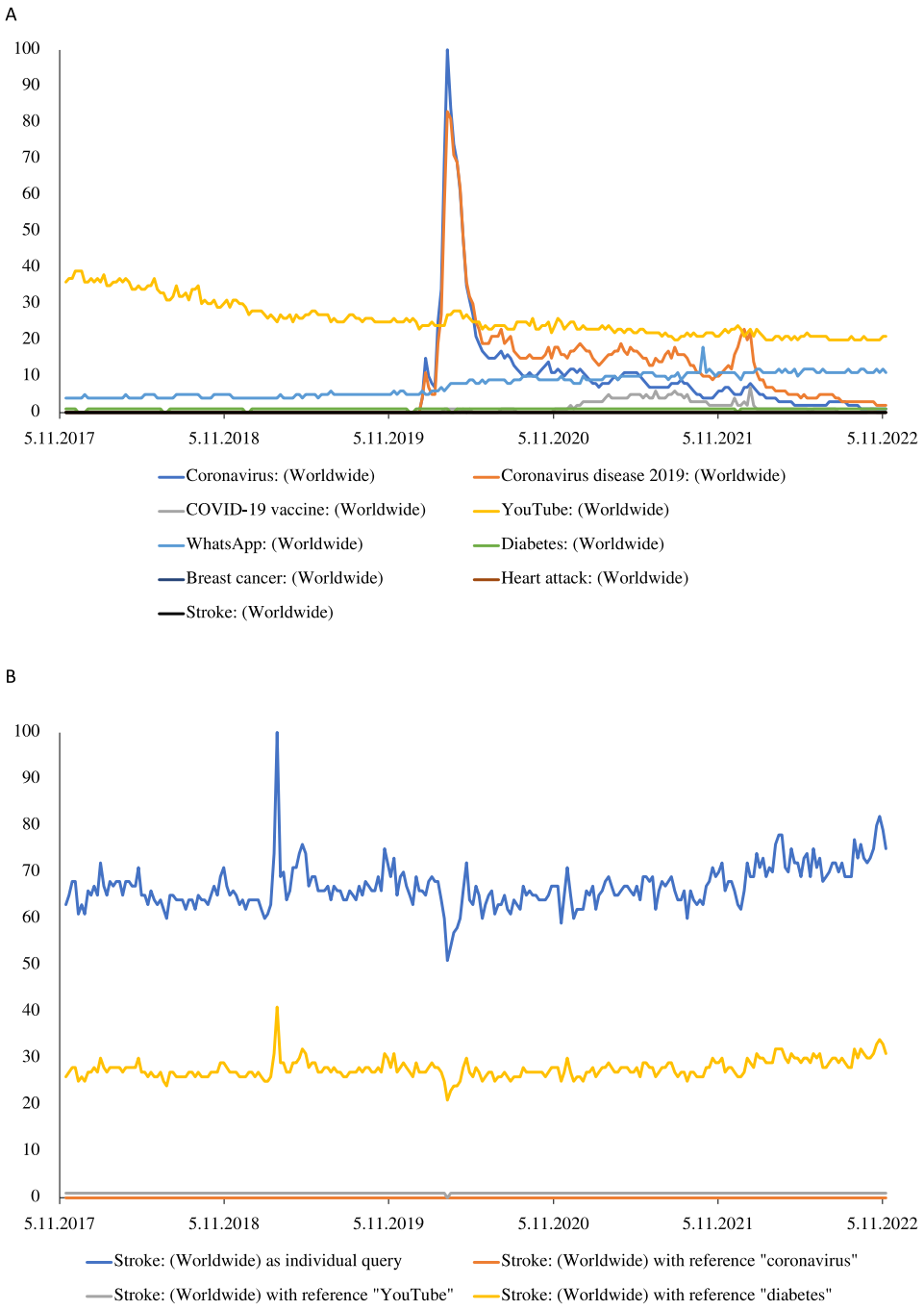

Fig. 1. Relative weekly search interest in search topics worldwide as indicated according to Google Trends data with "coronavirus" (A) as a reference or relative search interest for one topic with different references as indicated (B).

as the relative search volume which corresponds approximately to the maximum possible search interest worldwide for a single (health) topic.

The difficulty with using Google Trends data for infodemiology and infoveillance is that the outcomes from various Google Trends queries are not always easily comparable. The MGI approach has been suggested as a global standard for Google Trends search queries to address this problem. Without regard to the precise keywords used, the MGI approach is a statistical method that enables direct comparison of search volumes across various queries.

The MGI algorithm makes it simpler to compare and aggregate the results from various searches by ensuring that the search volumes for all queries are normalized to a similar scale. Researchers in infodemiology and infoveillance might compare and analyze search volume data across various terms and themes more readily by adopting MGI as a standard for Google Trends queries. In the end, this could contribute to better public health outcomes by increasing the quality and dependability of digital data analyses in these areas.

This study has some difficulties and limitations. One difficulty consists in the adaptation for individual countries, for example with different search volumes or different popularity of Google as a search engine [36]. In addition, another difficulty also consists in finding a suitable consensus for the diverse setting options of Google Trends (category, time frame, region etc.). We propose the standard "coronavirus" as a universal standard for worldwide research and as a starting point for further foundational work to bring Google Trends research into a more comparable framework. Adaptable additional standards can cover the range of medium and low search interest volumes. A conversion to the universal standard is possible to also take into account important details

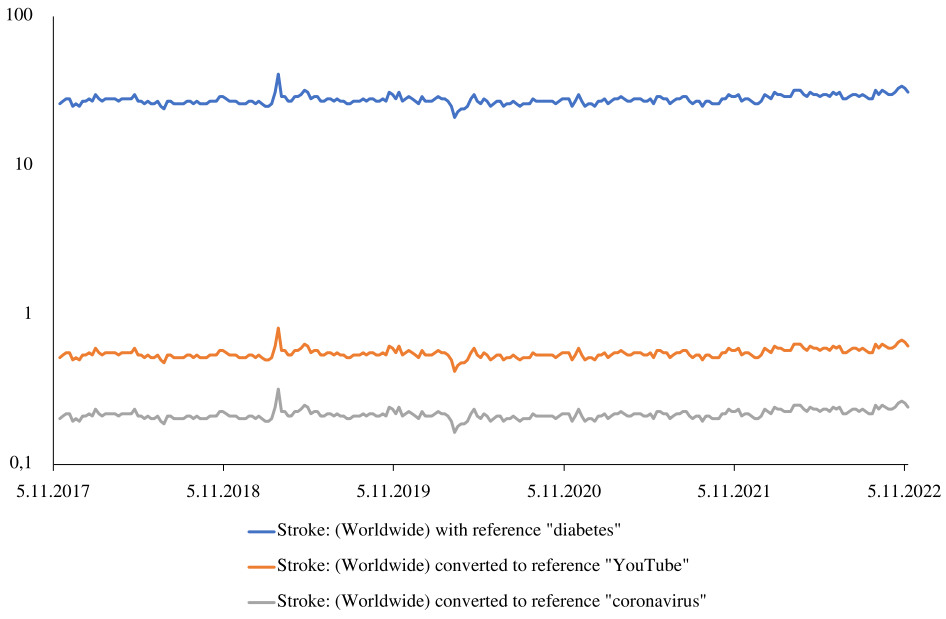

Fig. 2. Topic "stroke" as example of relative weekly search interest in search topics worldwide according to Google Trends data with reference "diabetes" adapted to level of relative search interest in "stroke" and converted to references "YouTube" and "coronavirus" as indicated.

of the lower search volumes, as shown in the medical example "stroke" in the study.

There are several described limitations in the use of search engine data, such as Google Trends data, which include the different geographical availability of Internet, the popularity of Google, the output of relative data instead of absolute values, and the use of subsamples by Google Trends [2,4,37].

In particular, the reliability of Google Trends data strongly depends on the stability of the search data received, which is subject to fluctuations due to the method of collection by subsampling [16,38]. To increase the reliability of the data collected, it is therefore recommended to conduct surveys on different days [16,38,39]. In addition, the changes and improvements made by Google from time to time, which are inadequately documented, may mean that the results of data collections before and after such changes are no longer fully comparable [40,41].

5. Conclusions

The study found that the topic of "coronavirus" has such a high peak interest worldwide in March 2020 that other search topic areas such as diabetes, stroke or heart attack have only a very low relative interest. In the worldwide search interest, the peak for topic "coronavirus" is higher than the peaks for topics of COVID-19 or the COVID-19 vaccine. The study also found that with a high reference, such as "coronavirus", the relative search interest for topics of lesser interest, such as "stroke", may only be inadequately represented. Google Trends only provides integer values (between 0 and 100) or, in the case of correspondingly low relative search interest, the indication "<1". The study concludes that if a topic is examined with correspondingly suitable references adapted to the level of search interest, a better approximation to the curve progression of the individual query (without additional reference) is possible. A subsequent conversion to the universal standard can be made. Google Trends is a widely used research tool. Size standards, such as reference to MGI, may help make research more comparable and better evaluate relative search volumes. Infodemiology and infoveillance could benefit greatly from this comparability of the results and weight research results better.

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Steffen Springer: Methodology, Investigation, Validation, Visualization, Writing – original draft, Writing – review & editing. **Artur Strzelecki:** Investigation, Formal analysis, Validation, Visualization, Supervision, Writing – review & editing. **Michael Zieger:** Idea, Conceptualization, Methodology, Investigation, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Only data from publicly available sources was used.

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