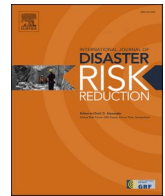




Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Coronavirus (Covid-19) pandemic: How may communication strategies influence our behaviours?

Mario Muselli^{*}, Vincenza Cofini, Giovambattista Desideri, Stefano Necozone

Department of Life, Health and Environmental Science, University of L'Aquila, Viale S. Salvatore, Delta 6 Medicina, 67100, L'Aquila, Italy

ARTICLE INFO

Keywords:

Coronavirus
Covid-19
Infectious disease
Mortality
Public opinion

ABSTRACT

A novel Corona virus (SARS-CoV-2), started in Wuhan China, caused an outbreak of viral pneumonia to subsequently spread throughout the world. Italy has been one of the most affected countries in the world and the increasing number of cases and deaths has created strong emotional reactions in people. This study has aimed at evaluating public attention to this emerging disease through the use of Google Trends. Public attention, measured as the volume of internet search activity, was correlated with Health Communication Strategies and official COVID-19 data. At the moment of the study analysis, Italy was by far the first country in terms of search volume for "coronavirus" and the highest peak of searches was reached on February 23, 2020. We have found that there was a correlation between public attention to coronavirus disease and communications from Public Health policies: we observed spikes in search volumes on the days of Presidential Decree publications. Furthermore, this attention was also correlated with Case Fatality Rate (CFR). Even if CFR data are continuously updated and can be affected by patient histories, the correlation found suggests that the increase in mortality has generated growing interest in the disease and its risk perception. This study shows that tracking searches through Google Trends as a public focus indicator is a useful tool for decision-makers in guiding communication strategies and should as well stimulate a more transparent media and policy making reporting.

1. Introduction

The ongoing outbreak of the novel coronavirus (SARS-CoV-2) has been affecting Italy since February 2020. The first cases were found on January 30, when two Chinese tourists in Rome tested positive for Covid-19 [1]. The first local case was later confirmed, an Italian man who had repatriated from the city of Wuhan, China [2]. On February 22, a cluster of 60 cases and the first deaths were reported in the Lombardy Region [3]. The following day a Presidential Decree imposed quarantine to 11 municipalities in Northern Italy. From then on, the number of positive cases and deaths continued to rise dramatically, exceeding those in China [4]. Similarly, the mortality rate progressively increased pushing the Government to implement measures. On March 8, the whole Lombardy Region and fourteen northern provinces were placed on lockdown. On March 9, the Italian Government expanded the quarantine lockdown to all of Italy, placing more than 60 million people in quarantine [5,6]. On March 11, the Government tightened the quarantine and ordered the nationwide closure of all commercial activities

except for supermarkets and pharmacies, in order to contain the coronavirus outbreak [7]. The Ministry of Health promptly activated a continuously updated and freely accessible monitoring system online of new cases, treatments, and deaths. The availability of such data has allowed research teams to estimate the key parameters of the epidemic and its evolution, and enabled media to disseminate it widely to the whole population [8]. In this context, the population has quickly had access to a large amount of data to satisfy growing interest. The increase of Internet availability and use has made internet-based research an important source for health information for people from all social backgrounds. Also, several useful data about disease and outbreaks were available for public health purposes [9].

The use of data that has not been generated for the primary purpose of epidemiological studies is the basis of digital epidemiology. Several studies showed that the volume of some Internet metrics such as web searches is a useful corollary for public health events [10,11]. Digital epidemiology can be broadly defined as epidemiology that uses digital methods from data collection to data analysis [12]. Examples of such

^{*} Corresponding author. University of L'Aquila, Department of Life, Health and Environmental Sciences, Viale S. Salvatore, delta 6 Medicina, 67100, Coppito, L'Aquila, Italy.

E-mail addresses: mario.muselli@graduate.univaq.it (M. Muselli), vincenza.cofini@univaq.it (V. Cofini), giovambattista.desideri@univaq.it (G. Desideri), stefano.necozone@univaq.it (S. Necozone).

<https://doi.org/10.1016/j.ijdr.2020.101982>

Received 14 May 2020; Received in revised form 18 November 2020; Accepted 19 November 2020

Available online 24 November 2020

2212-4209/© 2020 Elsevier Ltd. All rights reserved.

data include search queries, social media posts, webpage access logs, mobile phone network data, data generated by sensors, and data collected in call centers [13]. Google Trends proved to be a useful tool to track how often search terms and topics are queried over time. It has already been used to explore various health phenomena, including public health surveillance of disease outbreaks [14,15] and allows investigating phenomena on a large scale from a large amount of data.

Some authors have investigated the importance of perception of an emerging hazard and the role of the Internet to communicate Information during a public health emergency [16–19]. This study aims to investigate public attention to this emerging disease, correlating it with Public Health strategies, and the official reported COVID-19 data. We analyzed the data relating to the onset of the coronavirus pandemic in Italy to assess the perception of the risk of an emerging disease and to better understand the online dynamics of health communications in outbreak scenarios.

2. Materials and methods

The study period was from December 1, 2019, to March 16, 2020. The outbreak was first identified in Wuhan, Hubei, China, in December 2019, but the first laboratory-confirmed patients in Italy were identified on December 30, 2020 [1]. To assess the perception of an emerging hazard and risk among Italian population at the inception of the coronavirus pandemic four COVID-19-associated keywords were selected, based on expectations regarding public interest in this topic. These four keywords were “coronavirus”, “coronavirus symptoms (in Italian)”, “coronavirus news (in Italian)”, and “coronavirus Italy (in Italian)”. In this study, we first included the essential keyword, “coronavirus”, then included the keywords associated with the basic keyword query on Google Trends.

The keywords were entered into Google Trends to search interest data over the last three months. Google Trends (<https://trends.google.com/trends>), provided by Google Inc., is a free data service that shows the relative number of searches globally or within a particular region for a specific search term. For every search term, Google Trends generates a scatterplot graph: the horizontal axis of the scatterplot graphs represents time (days), and the vertical axis shows how often the key search term is searched relative to the total number of searches. Therefore, Google Trends does not show absolute search volume number for terms. Instead, the numbers are normalized and scaled from 0 to 100; 0 represents a lack of interest in the search query (or insufficient data to analyze), 100 represents the highest level of interest in the search query.

We ran a worldwide search on Google Trends on the final search terms related to coronavirus over the three-month study period. We used it to contextualize Italy and worldwide trends data. Finally, we investigated variations in Italian government policies (surrounding public health) to explore any associations with subsequent public search interest.

Since the first days of the coronavirus outbreak, the Ministry of Health has published official data [8] and subsequently, a dashboard [20]; this data includes daily tallies of new cases, hospitalizations, and deaths. The data are updated daily. For this analysis, we calculated crude estimates of the case-fatality risk, as the proportion of deaths compared to the total number of people diagnosed with the disease every day. The fatality rates were correlated to the volume of research, using Spearman’s correlation.

Trend analyses were performed using Microsoft Excel. Statistical analyses were conducted using the statistical software STATA, version 15.

Final searches on Google Trends were performed on March 16, 2020.

3. Results

The overall trends obtained via Google Trends, including all the representative keywords, showed a similar trend. From the end of

December, the Italian community reacted significantly to the news of the ongoing outbreak of Covid-19.

By comparison, the keyword that generated the highest volume of research was “coronavirus” (Fig. 1). During December and January, the search volume was very low; during this period, the disease was only present in China. Based on trend lines, we observed the first peak on January 31, 2020, the day after the first cases in Italy were confirmed. The keyword “coronavirus” reached a volume of searches 28 times higher than the mean of the previous period and 12 times higher than the mean of the other keywords. However, the highest peak of searches in the period taken into consideration was reached on February 23, 2020: this was 4.6 times higher than the peak reached in January. After this peak, interest gradually decreased, but two weeks later there was a further increase in the volume of research, reaching another peak on March 9, 2020, when the Italian Government expanded the quarantine to all of Italy.

Lombardy was the Italian Region with the highest number of cases and showed the highest volume of research for information on “coronavirus”, closely followed by Piemonte, Emilia-Romagna, Valle d’Aosta, and Umbria Regions.

At the moment of the study analysis, Italy was by far the first country to search volume for “coronavirus”. The second country, Spain, showed a search volume lower than the Italian one (almost half of that). However, these data do not consider the searches done in China.

We observed a different trend all over the world: a first peak was observed on January 31 with a subsequent decrease (as observed in Italy). Since February 20, there has been a gradual increase in the volume of searches still underway (Fig. 2).

In addition, we explored whether communications from Public Health policies to prevent the spread of the disease, influenced search interests in coronavirus in Italy. Based on the scatterplots and polynomial trend lines of all search terms, we observed spikes in search volumes on the days of Presidential Decrees publication (Fig. 3).

Lastly, we found similar trends for case-fatality rate and search volume of the keyword “coronavirus” (Fig. 4) with a significant correlation between these variables (r Spearman’s Rho correlation = 0.693, $p < 0.001$).

4. Discussion and conclusion

The infection caused by COVID-19 represents a significant global public health challenge, as witnessed by recent WHO communications [21], and Italy has been one of the most affected countries [22]. The present study examined the variation of public attention to the emerging Covid-19 disease, by using Google Internet search data. Nowadays, it is the first attempt in estimating how much the new coronavirus infection has captured the attention of the population involved. Overall, our results show that there has been a significant increase in coronavirus searches in the last few days. This increase was expected, given the rapid progression of the virus in the country. The interest from Italian public opinion exploded within the first days of the first cases of Coronavirus Disease 2019 reported in Italy [1]. This event aroused an immediate interest in the population, recording the first peak on January 31. In fact, within three days, the volume of searches more than quadrupled. However, the interest in coronavirus soon declined rapidly. It declined until February 21, 2020, when the Minister of Health announced the first Italian victim of coronavirus. The peak of searches was reached on February 24, when the Italian Government announced the first containment measures with a special Presidential Decrees. Although there was a dramatic increase in new cases of coronavirus, the subsequent peaks in the volume of searches were observed in correspondence to subsequent Presidential Decrees, on March 4 and 8.

This trend in the volume of searches does not reflect the real epidemiological situation; instead, it appears that official communications and government activity influence public interest more. In fact, although the disease was already in circulating in 2019, we only

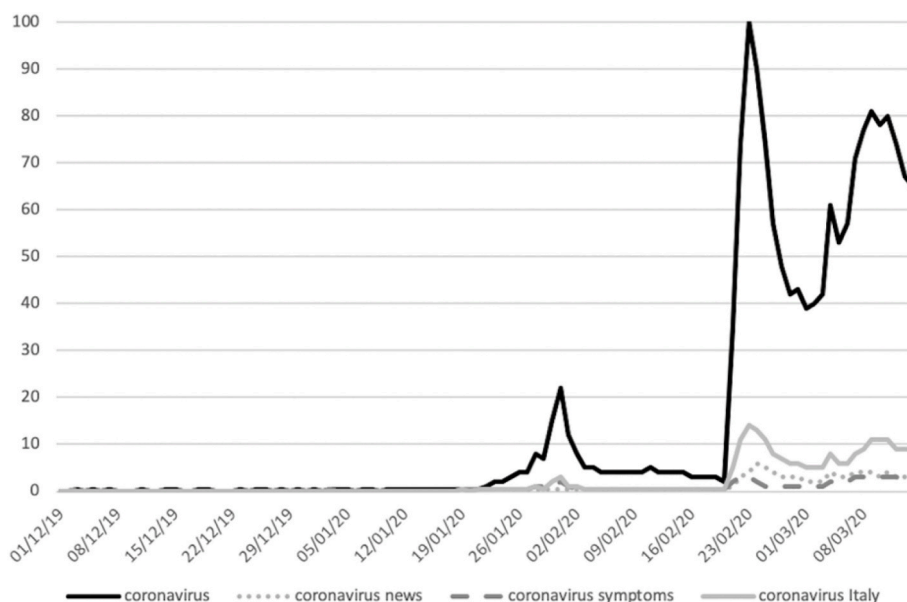


Fig. 1. Search volume comparison for the four keywords selected on Covid-19. Source: Google Trends.

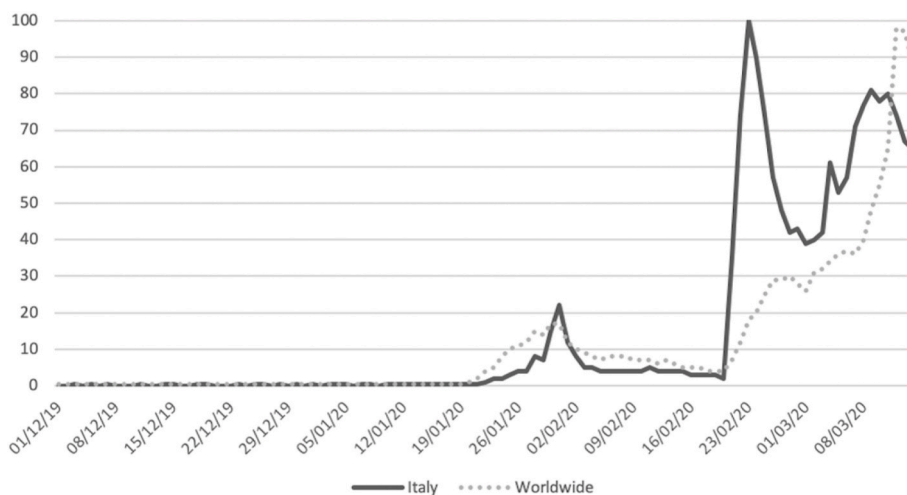


Fig. 2. Coronavirus query interest in Italy and Worldwide. Source: Google Trends.

observed an increase in research volumes after the European public authorities revealed the nature of the disease.

Our observations show that the Italian public opinion searched for coronavirus information in the first days after the identification of the first cases with a higher volume of searches than in the previous weeks after the outbreak in China. These results confirmed the hypothesis that the Italian public opinion had been attracted more by an outbreak in Italy than one outside Italy. Our findings are consistent with the social amplification of risk model, based on the thesis that events about hazards interact with psychological, social, institutional, and cultural processes in ways that can heighten or attenuate individual and social perceptions of risk and can shape risk behavior [23]. In particular, the Internet and mass media play an important role in communicating about risks and emergencies before, during, and after a catastrophe [24]. It is interesting to note the low volume of research for “coronavirus symptoms”: probably the Italian population was more interested in knowing the phenomenon by looking for news about its evolution, rather than a technical knowledge of the characteristics of the virus.

Our study showed that official data released by government authorities received substantial attention in the Italian public opinion.

Therefore, public health officials can use web search engine data to measure public attention towards a disease outbreak and to better understand social and behavioral barriers for infection control.

An essential measure of the deadliness of a disease outbreak is the case-fatality rate. The CFR is the ratio of the number of deaths attributed to a disease, to the total number of confirmed cases. However, early in an outbreak, even reasonable estimates of the CFR can be too high—or too low.

Due to the variability of this measure among different countries, there is reason to suspect that these rough early CFR calculations are overestimating the probability that an individual who contracts Covid-19 will die from it. Reports suggest significant ascertainment bias for Covid-19: approximately 80% of confirmed cases are mild [25]. There may be many cases with very mild symptoms that have gone completely undetected. Also, CFR seems to differ by sex: a recent report of the Institute of Health showed a higher CFR in males (7.2%) rather than females (4.1%) [26]. However, it is important to note that CFR data may be affected by the clinical features of patients. Another report of the Institute of Health [27] described the clinical characteristics of some deceased patients. Analysis of 355 medical records showed that only 3

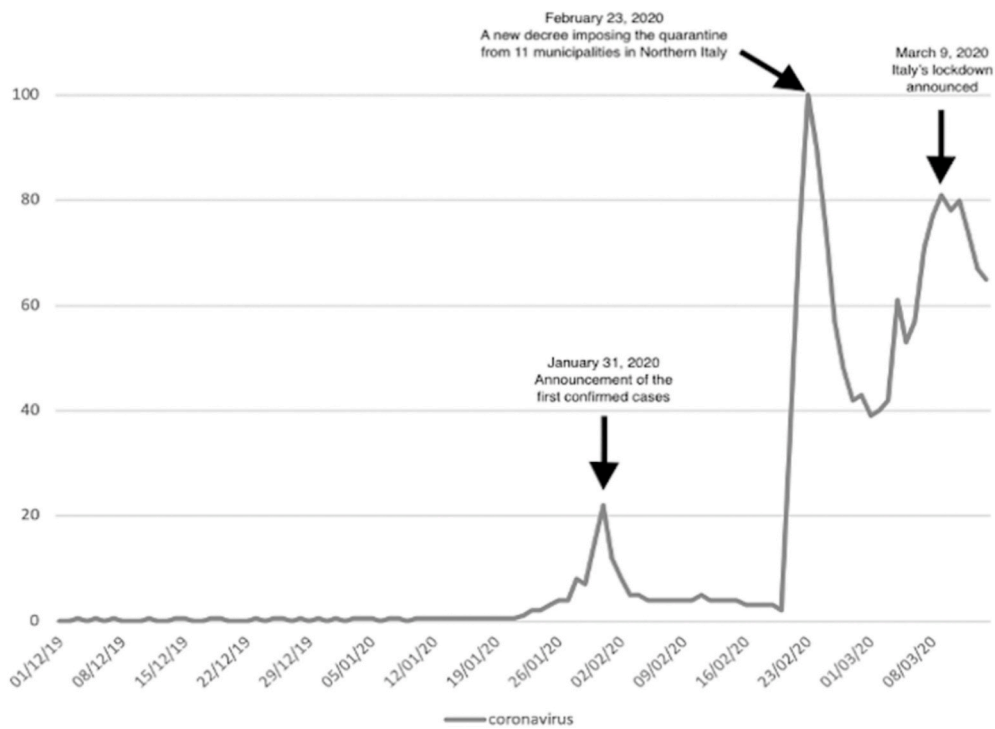


Fig. 3. Search volume reaction to the Italian Government’s press releases on the coronavirus emergency. Source: Google Trends.

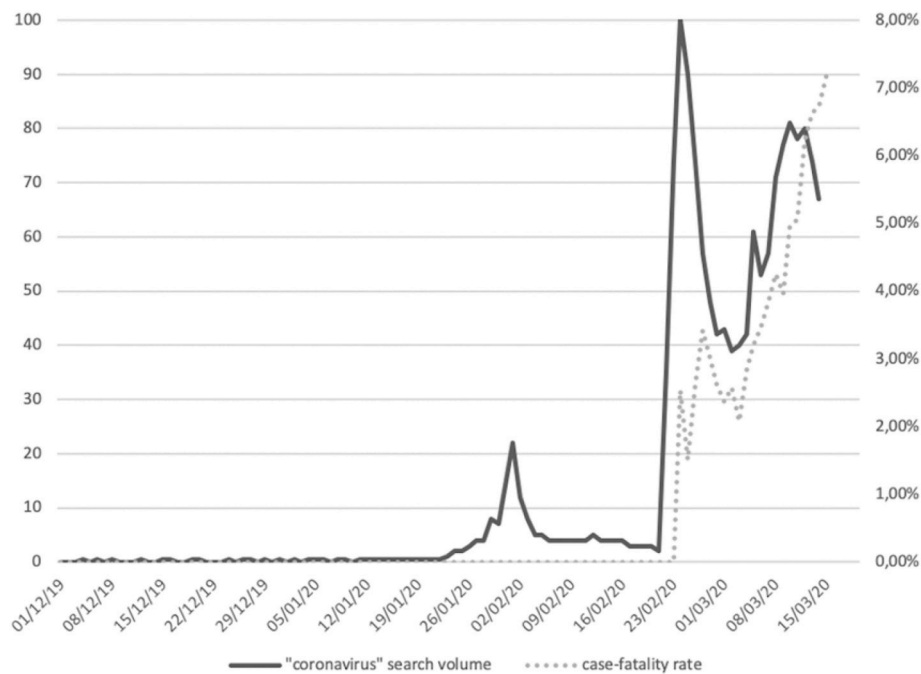


Fig. 4. Case-fatality rate and coronavirus query interest trends. Source: Google Trends and the Ministry of Health.

(0.8%) cases had no comorbidities, 89 (25.1%) had 1, 91 (25.6%) had two, and 172 (48.5%) had three or more comorbidities. Also, most deaths (42.5%) occurred in the 80–89 age group, and the average age was 79.5. These data suggest that clinical history and age strongly influence mortality risk.

Regardless of what the final CFR ends up being, the public needs to understand how and why these figures evolve and change throughout an outbreak. That will enable more transparent reporting by the media and policymakers, and ultimately help to avoid the erosion of trust. The

correlation found between the CFR and the search volume suggests that mortality increase has generated growing public interest in the disease. Although it is only an estimate far from real value, its growth worries people.

There are a few limitations to our study. The data used could be biased: in some countries, Google is not the most used search engine and does not provide data on the volume of searches in China [28,29]. In addition, the data analyzed was related to the internet research and not to the individuals. Some studies reported the characteristics of Italian

internet users [30,31], but to our knowledge, there is no study on the prevalence of internet use among elderly people who were most at risk of Covid-19 [32]. However, previous studies have demonstrated the possibility of using search engine data for influenza surveillance [14, 33]. The proposed digital surveillance system may be sufficient. However, such data could be expanded by including social media, such as Twitter.

This study shows that tracking searches through Google Trends as a public focus indicator is an essential tool for decision-makers. Knowledge of patient information seeking behavior can provide health and health information experts with valuable details used to improve the patients' health [34]. Our study can be useful to guide communication strategies in public health and increase the population's perception of risk. Proper risk perception is crucial to effectively address disasters and new emerging diseases, improving health system response capacity, and stimulating the adoption of correct behaviors to counteract the spread of the disease.

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.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijdr.2020.101982>.

References

- Corriere della Sera, Coronavirus, Primi Due Casi in Italia: Sono Due Turisti Cinesi, 2020. Available at: https://www.corriere.it/cronache/20_gennaio_30/coronavirus-italia-corona-9d6dc436-4343-11ea-bdc8-faf1f56f19b7.shtml. (Accessed 16 March 2020).
- Reuters, First Italian Dies of Coronavirus as Outbreak Flares in North, 2020. Available at: <https://www.reuters.com/article/us-china-health-italy-idUSKBN20FOUI>. (Accessed 16 March 2020).
- Corriere della Sera, Coronavirus: primi casi a Milano. Cosa sappiamo dei nuovi contagi in Lombardia, Veneto e Piemonte, 2020. Available at: https://www.corriere.it/cronache/20_febbraio_22/coronavirus-italia-nuovi-contagi-lombardia-veneto-245e72d4-5540-11ea-8418-2150c9ca483e.shtml. (Accessed 16 March 2020).
- Worldmeter, Coronavirus Update (Live): 174,090 Cases and 6,684 Deaths from COVID-19 Virus Outbreak, 2020. Available at: <https://www.worldometers.info/coronavirus/#countries>. (Accessed 16 March 2020).
- BBC News, Coronavirus: Italy Extends Emergency Measures Nationwide, 2020. Available at: <https://www.bbc.com/news/world-europe-51810673>. (Accessed 16 March 2020).
- BBC News, Coronavirus: Northern Italy Quarantines 16 Million People, 2020. Available at: <https://www.bbc.com/news/world-middle-east-51787238>. (Accessed 16 March 2020).
- The Wall Street Journal, Italy Hardens Nationwide Quarantine, 2020. Available at: <https://www.wsj.com/articles/italy-hardens-nationwide-quarantine-11583962093>. (Accessed 16 March 2020).
- Covid-19 - Situazione in Italia, Available at: <http://www.salute.gov.it/portale/nuovoCoronavirus/dettaglioContenutiNuovoCoronavirus.jsp?lingua=italiano&id=5351&area=nuovoCoronavirus&menu=vuoto>. (Accessed 16 March 2020).
- G. Eysenbach, 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.* 11 (1) (2009) e11.
- J. Ginsberg, M.H. Mohebbi, R.S. Patel, L. Brammer, M.S. Smolinski, L. Brilliant, Detecting influenza epidemics using search engine query data, *Nature* 457 (7232) (2009) 1012–1014.
- M. Salathé, Digital epidemiology: what is it, and where is it going? *Life Sci. Soc. Pol.* 14 (2018) 1.
- P.A. Eckhoff, A.J. Tatem, G. Editors, Digital methods in epidemiology can transform disease control, *Int. Health* 7 (2015) 77–78.
- H.A. Park, H. Jung, J. On, S.K. Park, H. Kang, Digital epidemiology: use of digital data collected for non-epidemiological purposes in epidemiological studies, *Healthc Inf. Res.* 24 (4) (2018) 253–262.
- S.V. Nuti, B. Wayda, I. Ranasinghe, et al., The use of Google trends in health care research: a systematic review, *PLoS One* 9 (10) (2014), e109583.
- J. Song, K. Ko, More diseases tracked by using Google trends, *Emerg. Infect. Dis.* 15 (8) (2009) 1327–1328.
- A.F. Kittler, J. Hobbs, L.A. Volk, G.L. Kreps, D.W. Bates, The Internet as a vehicle to communicate health information during a public health emergency: a survey analysis involving the anthrax scare of 2001, *J. Med. Internet Res.* 6 (1) (2004 Mar 3) e8, <https://doi.org/10.2196/jmir.6.1.e8>. PMID: 15111274; PMCID: PMC1550585.
- G. Wachinger, O. Renn, C. Begg, C. Kuhlicke, The risk perception paradox—implications for governance and communication of natural hazards, *Risk Anal.* 33 (2013) 1049–1065, <https://doi.org/10.1111/j.1539-6924.2012.01942.x>.
- Scolobig Anna, Tim Prior, Dagmar Schröter, Jörin Jonas, Patt Anthony, Towards people-centred approaches for effective disaster risk management: balancing rhetoric with reality, *Int. J. Disaster Risk Reduct.* 12 (2015) 202–212, <https://doi.org/10.1016/j.ijdr.2015.01.006>. ISSN 2212-4209.
- G.E.C. Charnley, I. Kelman, K. Gaythorpe, et al., Understanding the risks for post-disaster infectious disease outbreaks: a systematic review protocol, *BMJ Open* 10 (2020), e039608, <https://doi.org/10.1136/bmjopen-2020-039608>.
- Dipartimento della Protezione Civile, COVID-19 Italia – Monitoraggio Della Situazione, 2020. Available at: <http://opendatadpc.maps.arcgis.com/apps/opsdashboard/index.html#/b0c68bce2cce478eac82fe38d4138b1>. (Accessed 18 March 2020).
- Time, The WHO Just Declared Coronavirus COVID-19 a Pandemic, 2020. Available at: <https://time.com/5791661/who-coronavirus-pandemic-declaration/>. (Accessed 16 March 2020).
- Worldometer, Coronavirus Cases, 2020. Available at: <https://www.worldometers.info/coronavirus/>. (Accessed 18 March 2020).
- J.X. Kasperon, R.E. Kasperon, N. Pidgeon, P. Slovic, The social amplification of risk: assessing fifteen years of research and theory, in: N. Pidgeon, R. Kasperon, P. Slovic (Eds.), *The Social Amplification of Risk*, Cambridge University Press, Cambridge, 2003, pp. 13–46.
- I. Chun-Hai Fung, K.W. Fu, Y. Ying, et al., Chinese social media reaction to the MERS-CoV and avian influenza A(H7N9) outbreaks, *Infect. Dis. Poverty* 2 (1) (2013) 31.
- Novel Coronavirus Pneumonia Emergency Response Epidemiology Team, The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China, *Zhonghua Liuxingbingxue Zazhi* 41 (2) (2020) 145–151.
- I.S.S. Epidemia, COVID-19 Aggiornamento Nazionale 12 Marzo 2020, 2020. Available at: https://www.epicentro.iss.it/coronavirus/bollettino/Bollettino-sorveglianza-integrata-COVID-19_12-marzo-2020.pdf. (Accessed 18 March 2020).
- ISS, Characteristics of COVID-19 Patients Dying in Italy, Available at: <https://www.epicentro.iss.it/coronavirus/sars-cov-2-decessi-italia>. (Accessed 18 March 2020).
- Statista, Search Engine Market Share Worldwide 2019, 2020. Available at: <https://www.statista.com/statistics/216573/worldwide-market-share-of-search-engines/>. (Accessed 18 March 2020).
- Chandler Nguyen, Search Engine Market Share in APAC September 2015, 2015. Available at: <http://www.chandlernguyen.com/blog/2015/09/22/search-engine-market-share-in-apac-september-2015/>. (Accessed 18 March 2020).
- V. Bianchini, M.R. Cecilia, R. Roncone, V. Cofini, Prevalence and factors associated with problematic internet use: an Italian survey among L'Aquila students, *Riv. Psichiatr.* 52 (2) (2017 Mar-Apr) 90–93, <https://doi.org/10.1708/2679.27445>. English PMID: 28492579.
- R. Siliquini, M. Ceruti, E. Lovato, F. Bert, S. Bruno, E. De Vito, G. Liguori, L. Manzoli, G. Messina, D. Minniti, G. La Torre, Surfing the internet for health information: an Italian survey on use and population choices, *BMC Med. Inf. Decis. Making* 11 (2011 Apr 7) 21, <https://doi.org/10.1186/1472-6947-11-21>. PMID: 21470435; PMCID: PMC3079597.
- <http://dati.istat.it/Index.aspx?QueryId=22994&lang=en>.
- S.Y. Shin, D.W. Seo, J. An, et al., High correlation of Middle East respiratory syndrome spread with Google search and Twitter trends in Korea, *Sci. Rep.* 6 (2016) 32920.
- A. Lalazaryan, F. Zare-Farashbandi, A Review of models and theories of health information seeking behavior, *Int. J. Health Syst. Disaster Manag.* 2 (2014) 193–203.