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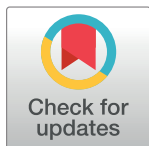
## RESEARCH ARTICLE

## A scientometric overview of CORD-19

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## Abstract

As the COVID-19 pandemic unfolds, researchers from all disciplines are coming together and contributing their expertise. CORD-19, a dataset of COVID-19 and coronavirus publications, has been made available alongside calls to help mine the information it contains and to create tools to search it more effectively. We analyse the delineation of the publications included in CORD-19 from a scientometric perspective. Based on a comparison to the Web of Science database, we find that CORD-19 provides an almost complete coverage of research on COVID-19 and coronaviruses. CORD-19 contains not only research that deals directly with COVID-19 and coronaviruses, but also research on viruses in general. Publications from CORD-19 focus mostly on a few well-defined research areas, in particular: coronaviruses (primarily SARS-CoV, MERS-CoV and SARS-CoV-2); public health and viral epidemics; molecular biology of viruses; influenza and other families of viruses; immunology and antivirals; clinical medicine. CORD-19 publications that appeared in 2020, especially editorials and letters, are disproportionately popular on social media. While we fully endorse the CORD-19 initiative, it is important to be aware that CORD-19 extends beyond research on COVID-19 and coronaviruses.

## OPEN ACCESS

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**Data Availability Statement:** Most of our analysis can be replicated using code and following the instructions given in the accompanying repository: [https://github.com/CWTSLeiden/cwts\\_covid](https://github.com/CWTSLeiden/cwts_covid).

Analyses based on Altmetric, Dimensions, Twitter and Web of Science data require access to these services.

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## Introduction

The COVID-19 pandemic is attracting the attention of the global scientific community. Bio-medical research on the virus and on the management of the crisis from an epidemiological and healthcare point of view has full priority. Furthermore, many research communities, funding agencies and third-parties are taking action to support the fight against the pandemic with their own expertise and resources. Multidisciplinary open collaboration will prove instrumental to fight the current and future pandemics [1, 2].

Several initiatives have been taken to share COVID-19-related scientific research as openly as possible, from public, private and non-profit organisations. It has been readily recognized that health crises are also information crises [3–6]. For example, the World Health Organization maintains a list of relevant research updated daily [7], as well as a portal to provide information to the public [8], similar to the the European Commission [9]. Publishers are opening access to relevant publications, and some open-access publishers have lifted publishing fees for the same reason.

Another initiative is the release of the COVID-19 Open Research Dataset (CORD-19) [10]. CORD-19 is a growing, daily-updated dataset of COVID-19 publications, capturing new as well as past research on “COVID-19 and the coronavirus family of viruses for use by the global research community.” The reason to release this dataset is “to mobilize researchers to apply recent advances in natural language processing to generate new insights in support of the fight against this infectious disease.” The initiative has the backing of the US White House [11] and is a partnership of several institutions including the Allen Institute for Artificial Intelligence, the Chan Zuckerberg Initiative, Georgetown University’s Center for Security and Emerging Technology, Microsoft Research, the National Library of Medicine of the National Institutes of Health, and Unpaywall. CORD-19 is released together with a set of challenges hosted by Kaggle, mainly focused on automatically extracting structured and actionable information from such a large set of publications. The release of this dataset is a positive call for action directed towards the natural language processing, machine learning and related research communities. This call has been taken up: For example, the ACL conference has run an emergency NLP COVID-19 workshop which mentioned the CORD-19 dataset on its call for papers (<https://www.nlpcovid19workshop.org>) and a TREC-COVID challenge has been announced on CORD-19 (<https://ir.nist.gov/covidSubmit>).

In order to contribute to an informed use of the CORD-19 dataset, we present a scientometric analysis of its contents. We first consider the subject delineation of CORD-19. Field or subject delineation is a complex task, which usually benefits from an interplay of information retrieval, or search-based approaches, and bibliometric mapping [12–14]. Based on a comparison to the Web of Science database, we find that CORD-19 provides an almost complete coverage of research on COVID-19 and coronaviruses. We also show that CORD-19 covers other research topics beyond COVID-19 and coronaviruses.

We then provide a detailed analysis of the research covered by CORD-19, enriching the dataset with data from Dimensions [15] and using both citation analysis and text analysis. We show that CORD-19 broadly focuses on biomedical research on viruses and related health issues. The articles it covers are quite heterogeneous. CORD-19 contains a core of research directly on COVID-19 and coronaviruses, but in addition it contains many articles on related yet distinct streams of virus research, such as on influenza, molecular biology and public health. Secondly, we identify three broad periods in the accumulation of literature in CORD-19: a pre-SARS (2003) period, a post-SARS period and the current pandemic (2020). We also present a brief analysis of Altmetric data [16, 17] related to papers in CORD-19. We find that papers published in 2020 are disproportionately represented in social media and news by Altmetric indicators, especially on Twitter. We also observe that non-research articles, such as editorials and letters, are particularly popular on social media. We conclude by emphasizing the importance of being aware of the broad coverage of CORD-19, which extends beyond research on COVID-19 and coronaviruses. We also propose some directions for future work.

To facilitate the analysis and use of the CORD-19 dataset, we release our code (see [S1 Appendix](#)). In combination with access to Dimensions, Altmetric, Web of Science and Twitter, our results can be replicated. Finally, we underline that we have no specific biomedical expertise. We invite experts to improve the interpretation of our results.

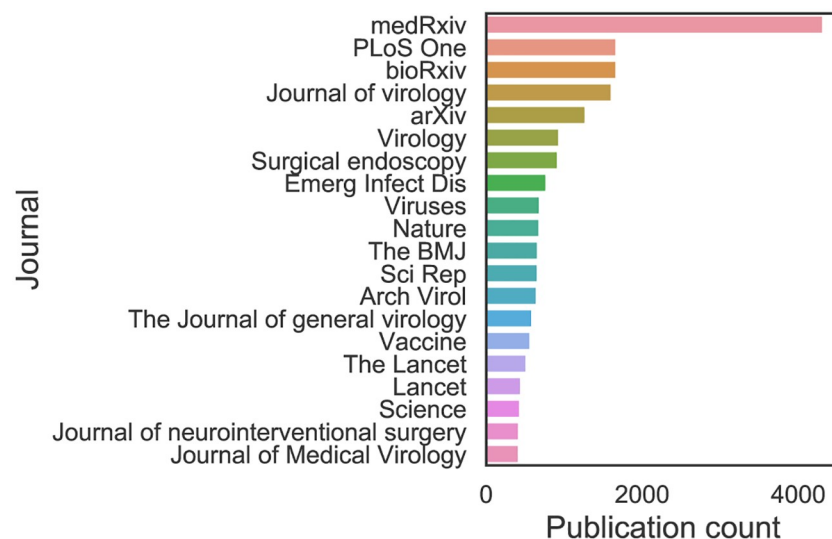
## The CORD-19 dataset

The CORD-19 dataset [10] is being updated on a daily basis. We use the version of the dataset from July 1, 2020. This version of CORD-19 contains 169, 821 articles, of which 77, 777 are equipped with full text. The dataset collects publications from the following sources:

- Medline and PubMed's PMC open access corpus, via the query:  
"COVID-19" OR Coronavirus OR "Corona virus"  
OR "2019-nCoV" OR "SARS-CoV" OR "MERS-CoV"  
OR "Severe Acute Respiratory Syndrome" OR  
"Middle East Respiratory Syndrome".
- COVID-19 research articles from the WHO database [18].
- arXiv, bioRxiv and medRxiv pre-prints using the same query as in PMC.

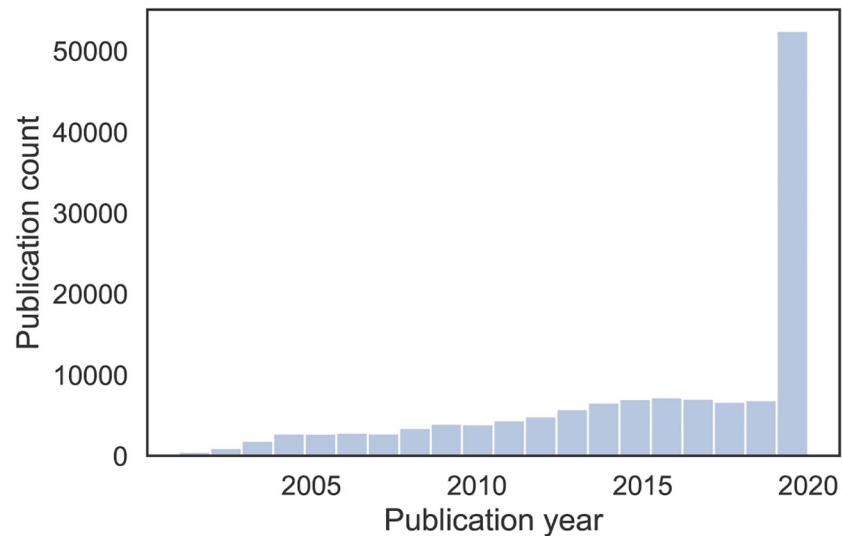
A relatively small number of publications prior to the SARS 2003 outbreak is followed by a steady increase in the number of publications up to 2020, when the growth accelerated substantially (Fig 1). The top 20 sources (i.e., journals and pre-print servers) by number of publications are given in Fig 2, highlighting how CORD-19 is composed of publications from varied sources. Pre-print servers, the Journal of Virology and PLOS ONE stand out. The main contributors to the dataset are Medline, PMC and Elsevier (Fig A.1b in S1 Appendix), which have made a large part of their relevant literature available. The availability of full texts is relatively high, but not yet complete, and is proportionally stable over time (Fig A.1a in S1 Appendix). This is because, even though most publishers and journals have opened up their publications, some have not yet done so. In particular, the Journal of Virology, Nature, Science, The Lancet and BMJ provided no or only few articles in full text at the time of our analysis (July 2020).

Using Dimensions data, we study the number of citations to papers in CORD-19 (Fig A.2 in S1 Appendix). The literature in CORD-19 gained more attention from the early 2000s, and some publications from 2020 are accumulating citations at an extreme rate. The most cited articles from 2020 include: "Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China" by Huang et al. (2020, The Lancet, also the most cited overall), "Clinical Characteristics of Coronavirus Disease 2019 in China" by Guan et al. (2020, The New England Journal of Medicine), "A Novel Coronavirus from Patients with Pneumonia in China, 2019" by Zhu et al. (2020, The New England Journal of Medicine) and "Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan,



**Fig 1. Publication years of CORD-19 papers.**

<https://doi.org/10.1371/journal.pone.0244839.g001>



**Fig 2. Top 20 journals and pre-print servers by number of CORD-19 articles.**

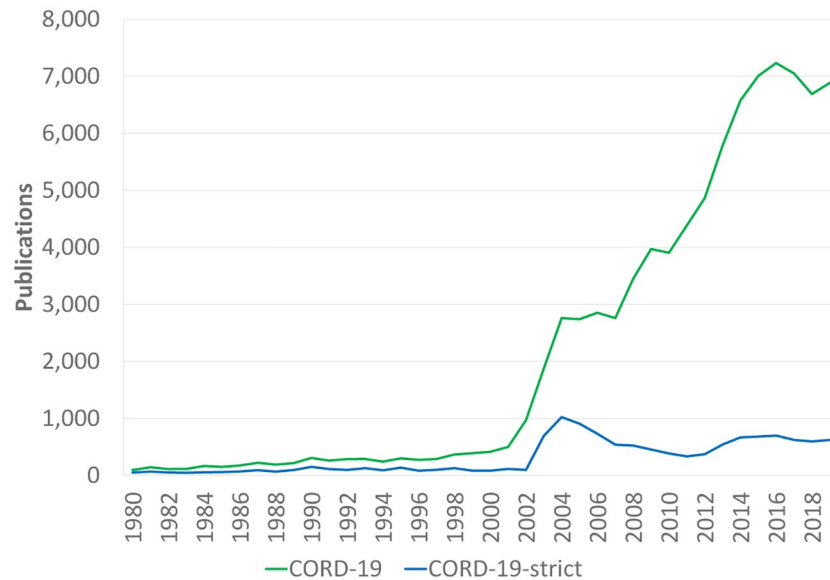
<https://doi.org/10.1371/journal.pone.0244839.g002>

China” by Wang et al. (2020, JAMA). The Lancet is the most cited journal in the dataset in terms of the absolute number of citations received from papers in CORD-19, based on Dimensions data. It is followed by PLOS ONE and Nature. Lastly, we consider the Fields of Research (FOR) categories provided by Dimensions, which cover all areas of research from the Australian and New Zealand Standard Research Classification (ANZSRC, <https://app.dimensions.ai/browse/categories/publication/for>). While about 30,000 articles have no classification, we find that, as expected, the Medical and Health Sciences cover most ground, followed by Biological Sciences (Fig A.3 in [S1 Appendix](#)). The second level FOR classification shows the presence of several sub-areas of these two top level fields, Clinical Sciences being the largest. More details and plots are provided in the accompanying repository.

### Delineation of CORD-19

We now analyse how the literature on COVID-19 and coronaviruses is delineated in CORD-19. We first examine whether the delineation might be too broad, meaning that CORD-19 would include publications that are of limited relevance for coronavirus research. We then examine whether the delineation might be too narrow, meaning that relevant publications would not be included in CORD-19. We focus on publications from the time period 1980–2019. We do not consider publications from 2020, because most of these publications are not yet available in the Web of Science (WoS) database used in our analysis.

[Fig 3](#) shows the annual number of publications in CORD-19 as well as the annual number of publications in a subset of CORD-19 that we refer to as ‘CORD-19-strict’. CORD-19-strict consists of all publications in CORD-19 that we have identified by applying the CORD-19 search query to the titles and abstracts of publications but not to their full texts. Hence, publications for which the CORD-19 search query yields a match only in the full text and not in the title and abstract are not included in CORD-19-strict. These publications probably do not directly focus on COVID-19 and coronaviruses, even though they may still be related to these topics in some way. If these publications had been directly focused on COVID-19 and coronaviruses, it can be expected that applying the CORD-19 search query to the title and abstract would have resulted in a match.



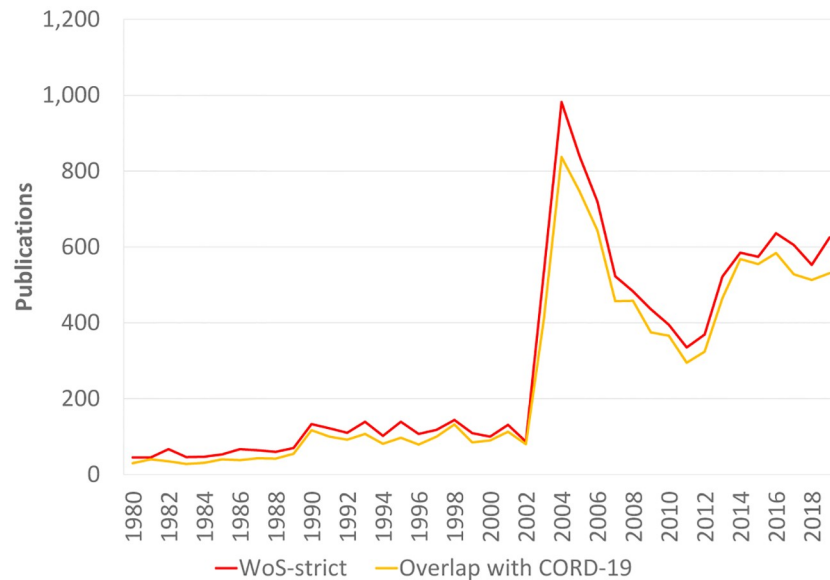
**Fig 3. Annual number of publications in CORD-19 and CORD-19-strict.**

<https://doi.org/10.1371/journal.pone.0244839.g003>

As can be seen in Fig 3, the number of CORD-19 publications started to increase around 2002 and 2003, which coincides with the 2002–2004 SARS outbreak. Looking at CORD-19-strict, a second increase took place after 2012, following the 2012 MERS outbreak. More significantly for our analysis, Fig 3 shows that CORD-19-strict includes only a relatively small subset of all publications in CORD-19. This suggests that CORD-19 includes many publications that are not directly focused on COVID-19 and coronaviruses research. The inclusion of these publications in CORD-19 does no harm and may be useful for a broader perspective on coronaviruses research. However, it is important for users of CORD-19 to be aware that the dataset includes a large number of publications whose relevance for COVID-19 and coronaviruses research needs a more careful assessment, and some of which may be of limited relevance.

We now take an opposite perspective, aiming to find out whether relevant publications may be missing in CORD-19. To do so, we use the CWTS in-house version of the WoS database [19]. Elsewhere in this paper, we use data from Dimensions instead of WoS. Because we do not have access to abstracts in Dimensions, we use WoS data in this section. We consider the following WoS citation indices: Science Citation Index Expanded, Social Sciences Citation Index, Arts & Humanities Citation Index, and Conference Proceedings Citation Index. We use the CORD-19 search query to identify relevant publications in WoS. The search query is applied to the titles, abstracts, and keywords of publications, where we note that abstracts and keywords are available only for publications from 1991 onward. We refer to the resulting set of publications as ‘WoS-strict’, where ‘strict’ indicates that publications have been identified in a similar way as in CORD-19-strict, so without searching in the full texts of publications.

Fig 4 shows the annual number of publications in WoS-strict. In addition, the figure shows the annual number of publications in WoS-strict that are also included in CORD-19, using DOIs and PubMed IDs to match publications in the two datasets. We see that almost all publications in WoS-strict can also be found in CORD-19. This indicates that CORD-19 provides an almost complete coverage of publications that have a clear relevance for research on COVID-19 and coronaviruses, at least when compared to WoS. Importantly, in a comparison of CORD-19 and WoS that we performed a few months previous to the one we report here



**Fig 4. Annual number of publications in WoS-strict and the overlap with CORD-19.**

<https://doi.org/10.1371/journal.pone.0244839.g004>

(discussed in an earlier version of the present paper [20]), we found substantial gaps in the coverage of the coronavirus literature by CORD-19. In a span of a few months, it appears that most gaps in the coverage of CORD-19 have been filled. This testifies to the efforts made by the CORD-19 team to expand the coverage of the dataset [21].

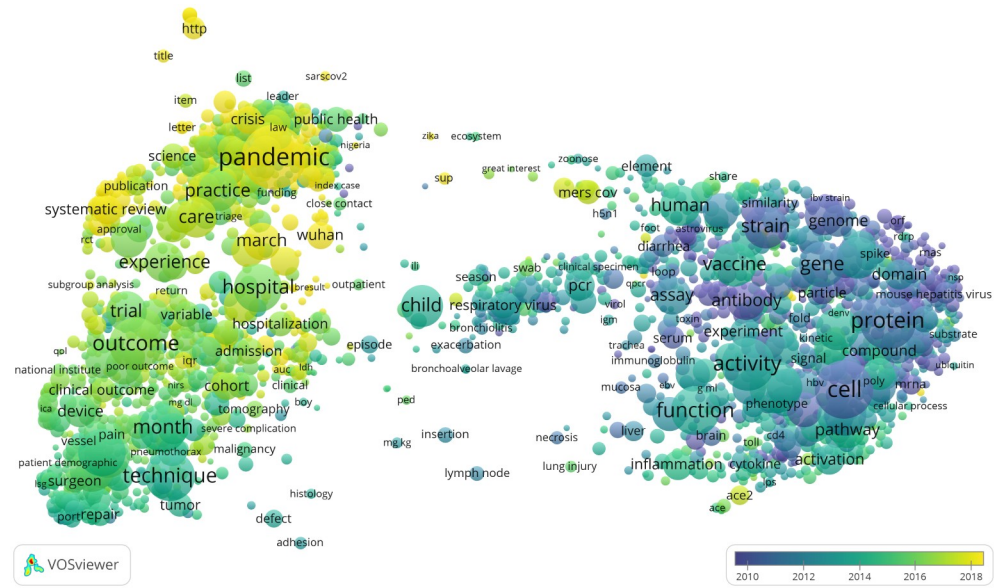
## Analysis of CORD-19

We conducted the following analyses on the CORD-19 dataset: a term map and a topic modeling analysis based on titles and abstracts of publications in CORD-19; a citation network analysis using Dimensions citation data; an altmetrics analysis using Altmetric data. The purpose of the former two analyses is to cluster CORD-19 publications and further clarify the contents of the dataset. For our analyses, we focus on 140,302 articles out of the 169,821 available in CORD-19, filtering out duplicates and articles without at least one identifier among DOI, PubMed ID, PubMed Central ID or arXiv ID.

### Term map

To get an accessible high-level overview of the contents of CORD-19, we used VOSviewer [22] to create a so-called term map of the publications in this dataset. Titles and abstracts of publications were concatenated into a single string and were then provided as input to VOSviewer. Using the text mining algorithms of VOSviewer, we identified the 2,115 most relevant terms in the titles and abstracts. A term is defined as a sequence of nouns and adjectives ending with a noun. Only terms occurring in at least 130 publications were considered. Plural terms were converted to singular. For each pair of terms, VOSviewer counted the number of publications in which both terms occur in the title or abstract. In this way, a co-occurrence network was obtained, indicating for each pair of terms the number of publications in which they occur together.

Fig 5 presents a visualisation of this co-occurrence network. The visualisation, referred to as a term map, shows the 2,115 terms included in the network. The size of a term reflects the number of publications in which the term occurs. The proximity of two terms in the map



**Fig 5. Term map highlighting temporal trends in the contents of COVID-19.** Also compare with the topic words in the S1 Appendix.

<https://doi.org/10.1371/journal.pone.0244839.g005>

approximately indicates the relatedness of the terms based on their number of co-occurrences. In general, the closer two terms are located to each other, the stronger they are related. This means that groups of terms located closely together in the map usually can be interpreted as topics. The horizontal and vertical axes have no special meaning. Labels are shown only for a selection of the terms in the term map. In order to avoid overlapping labels, for many of the less prominent terms no label is shown. The term map can also be explored interactively online ([https://bit.do/term\\_map\\_cord19\\_20200701](https://bit.do/term_map_cord19_20200701)). The labels of the less prominent terms can then be made visible by zooming in on specific areas in the map.

Colors can be used to present additional information in the term map. In Fig 5, for instance, the color of a term reflects the average publication year of the publications in which the term occurs. In this way, temporal trends are made visible. The term map shows a clear divide between biologically focused topics in the right area in the map and clinically focused topics and health research in the left area (for similar findings, see [23]). As shown by the colors of the terms, the topics in the left area in the map received a lot of attention in more recent years, while the topics in the right area received attention mostly in earlier years. Below, we use our term map to illustrate some of the analyses we present.

### Topic modelling

We conducted a topic modelling analysis, making use of the titles and abstracts of COVID-19 publications by concatenating them into a single string, similarly to what we did for the term map. Of the 140,302 articles, 31,055 have no abstract. Topic modelling is a technique to learn ‘topics’ from a corpus of documents. A topic is defined as a probability distribution over a vocabulary, where words with a high probability for the same topic tend to co-occur frequently in the same documents [24–26]. We applied a pre-processing pipeline using ScispaCy’s `en_core_sci_md` model [27] to convert each publication’s title and abstract into a bag-of-words representation. This included the following steps: entity detection and inclusion in the



bag-of-words for entities consisting of at least two tokens; lemmatisation; removal of (isolated) punctuation and stopwords; inclusion of frequent bigrams.

We started by training a Latent Dirichlet Allocation (LDA) model [28], using `gensim`'s implementation [29] and 15 topics. From a topic coherence analysis [30], we found 15 to 25 to be a good value for the number of topics. We decided to remain on the lower end to facilitate the interpretation of the results. We further filtered out words that appear in fewer than ten or in more than half of the documents. Lastly, we verified our results using a Correlated Topic Model [31] (using `tomotopy`, <https://bab2min.github.io/tomotopy> [version 0.7.0]), which reduces to a Structural Topic Model without covariates [32]. This model explicitly captures topic correlations. It confirmed the topic structure we found with LDA, as well as the topics' temporal unfolding. More details are provided in the accompanying repository. We report results of the LDA model in what follows.

The top 20 words per topic are given in the [S1 Appendix](#). In [Fig A.4 in S1 Appendix](#), we show the yearly topic intensity, from 1980 to 2020. Three periods in the relative focus of the literature seem to emerge. Pre-SARS research mainly focused on molecular biology and immunology (topics 3, 8, 11 and 12). Subsequently, due primarily to the SARS and MERS outbreaks (topic 5), the literature broadened its focus to include topics such as epidemics (topics 9 and 10), public health (topics 0, 4 and 13) and clinical medicine (topics 2, 6, 7 and 14). Lastly, in 2020 the literature is also heavily focused on the COVID-19 outbreak, its ongoing management and consequences (topic 1). From this first analysis, we observe how coronavirus research seems to be produced in bursts following outbreaks instead of following a more steady progress.

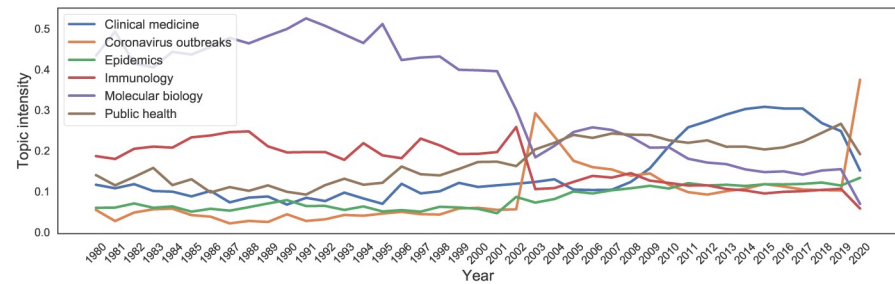
In order to analyse the contents of CORD-19 at a higher level of granularity, we grouped the identified topics into *general topics*. We used agglomerative clustering based on the Jensen-Shannon distances among topic-word distributions to inform the grouping of topics (see the accompanying repository for more details). To be sure, the resulting grouping is a simplification of the actual publication contents. It is also worth considering that topics overlap substantially. The following general topics were identified:

- “Clinical medicine”: topics 2, 6, 7, 14;
- “Coronavirus outbreaks” (SARS, MERS, COVID-19): topics 1, 5;
- “Epidemics”: topics 9, 10;
- “Immunology”: topics 8, 12;
- “Molecular biology”: topics 3, 11;
- “Public health”: topics 0, 4, 13.

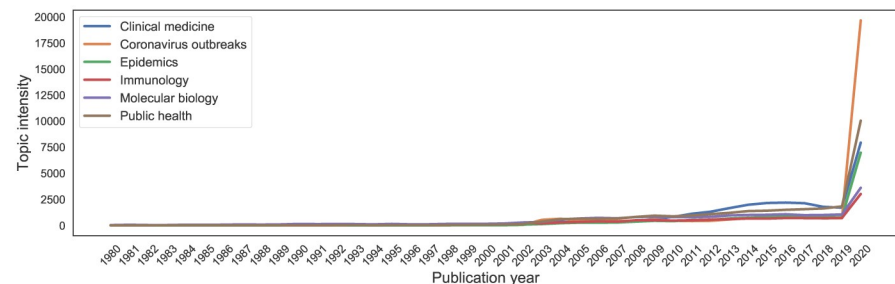
CORD-19 is dominated by literature on coronavirus outbreaks, and to a lesser degree public health, epidemics and clinical medicine. There are fewer publications focusing on molecular biology and immunology. [Fig 6](#) shows the relative (average per paper) and absolute (total over all papers) topic intensities of the general topics. The temporal development of the contents of CORD-19 discussed above is largely confirmed. The 2003 SARS outbreak generated a shift associated with a rise in publications on coronavirus epidemics, which is happening again, at a much larger scale, in 2020 for COVID-19. Molecular biology and immunology research, on the other hand, have lost ground in relative terms.

## Citation clusters

The previous two analyses were based on textual data. We now turn to a view based on citations to characterise the CORD-19 dataset.



(a) Relative topic intensity: This can be interpreted as the mean topic intensity per paper.



(b) Absolute topic intensity: This can be interpreted as the number of papers per topic.

**Fig 6. Intensity of the general topics over time.** (a) Relative topic intensity: This can be interpreted as the mean topic intensity per paper. (b) Absolute topic intensity: This can be interpreted as the number of papers per topic.

<https://doi.org/10.1371/journal.pone.0244839.g006>

We constructed a citation network based on the references included in all papers in COR-19, as provided by Dimensions. We considered not only references to papers in COR-19, but also all other references in COR-19 papers. These ‘external’ references provide additional information regarding the structure of COR-19. For example, two papers may not be immediately connected via papers in the COR-19 dataset, but they may have common references external to COR-19. We considered only the giant weakly connected component, which amounted to 1,844,831 publications and 3,974,851 citation links, of which 104,508 publications belong to the COR-19 dataset. This is the citation network that we work with in the remainder of this section.

We clustered the citation network using the Leiden algorithm (implementation from *igraph*) [33]. Each citation link was weighted as  $1/k_i$ , where  $k_i$  is the number of references of publication  $i$ . The inclusion of the ‘external’ references in the context of clustering is also known as the extended direct citation approach [34]. In this approach, the publications contained in COR-19 are weighted with a so-called node weight of 1, while the ‘external’ publications are weighted with a weight of 0 (see [34] for more details). We clustered the citation network in a hierarchical fashion. At the most detailed level, the citation network was clustered using a resolution of  $2 \cdot 10^{-5}$ . We aggregated the citation network based on this clustering, and then clustered the resulting aggregated citation network at a resolution of  $1 \cdot 10^{-5}$ . We refer to the former clustering as the bottom level clustering, and to the latter as the top level clustering. The ‘external’ publications help cluster publications from COR-19 more accurately. In what follows, we focus only on the 104,508 publications included in COR-19.

The clustering at the bottom level has 11 clusters that include more than 2,000 COR-19 publications each (Fig A.5b in S1 Appendix). In total, these 11 clusters cover 54% of the





in the bottom level clustering (Fig A.7 in [S1 Appendix](#)). While the third and sixth clusters are focused on molecular biology and immunology, the first, second and fourth are mainly concerned with coronavirus outbreaks, and the fifth covers clinical medicine.

Our citation-based results substantiate our earlier findings based on textual analyses. Both point to the existence of distinct research areas covered by CORD-19: coronaviruses, molecular biology research on viruses, public health and epidemics and other related topics (immunology, clinical medicine). These areas of research are interrelated, yet also contain specialised information, and they show different temporal trends.

## Altmetrics

CORD-19 publications have also been explored using Altmetric data, with the aim of describing their reception on social media, paying special attention to the dissemination of the publications across various social media sources. As can be seen in [Table 1](#), a total of 88,570 publications in the CORD-19 dataset (63%) have received some mention in Altmetric. This is a rather high coverage of publications compared to previous studies [[35](#)], which reported an overall coverage of 21.5% of 2012 publications on Twitter, and about 31% for publications in the biomedical and health sciences. This high coverage is even higher when the focus is on the most recent publications (i.e., those published in the early months of 2020), of which over 68% have received some social media mention covered by Altmetric.

[Table 2](#) presents a more detailed description of the type of social media events around CORD-19 publications. We selected some of the most relevant sources covered by Altmetric, namely Twitter, blogs, recommendations in F1000Prime, news media mentions, citations in policy documents and citations in Wikipedia entries. Clearly, the most important source is Twitter, which by far accounts for the largest share of all (social) media interactions analysed. The second most important source are mentions in news media and blogs. The observation that there are more mentions in news media than in blogs also contrasts with previous studies [[35](#)]. This may signal the particular relevance of CORD-19 publications for mainstream news media. Another noteworthy characteristic is the recency of the publications being mentioned, particularly on Twitter and in news media. About 87% of all Twitter mentions relate to publications from 2020, and 75% of all mentions in mainstream news media also relate to 2020 publications.

[Table 3](#) shows the main altmetrics per publication type. All CORD-19 publications with Altmetric data were matched with publications in the WoS database. In this way, a publication

**Table 1. Coverage of CORD-19 publications by Altmetric.**

	CORD-19 publications	In Altmetric	Share in Altmetric
All	140,302	88,570	63.1%
2020	52,440	36,058	68.8%

<https://doi.org/10.1371/journal.pone.0244839.t001>

**Table 2. Social media events around CORD-19 publications.**

	Twitter	Blogs	F1000
All	5,868,992	29,119	1,605
2020	5,087,442 (87%)	18,705 (64%)	312 (19%)
	News media	Policy documents	Wikipedia citations
All	222,966	10,609	5,365
2020	168,106 (75%)	1,169 (19%)	1,218 (23%)

<https://doi.org/10.1371/journal.pone.0244839.t002>

Table 3. Main altmetrics per WoS publication type.

Type	Publications	Twitter	News media	Blogs	Wikipedia
Article	57,383 (70%)	1,401,325 (46%)	86,038 (63%)	11,970 (63%)	2,561 (56%)
Review	11,217 (14%)	288,135 (9%)	14,256 (10%)	2,451 (13%)	1,394 (31%)
Editorial	6,952 (8%)	706,524 (23%)	19,399 (14%)	2,707 (14%)	338 (7%)
Letter	4,195 (5%)	506,307 (17%)	15,613 (11%)	1,488 (8%)	123 (3%)
News	963 (1%)	35,626 (4%)	2,091 (2%)	466 (2%)	112 (3%)
Other	1,373 (2%)	4,136 (<1%)	218 (<1%)	54 (<1%)	13 (<1%)

<https://doi.org/10.1371/journal.pone.0244839.t003>

type was obtained for 82,083 publications. The publication type classification of the WoS database was used because WoS offers a more detailed classification than databases such as Dimensions and Microsoft Academic [36].

While most publications in CORD-19 are classified as article (70%) or review article (14%), it turns out that editorials, letters and news items receive a disproportionate amount of attention on social and online media. As a reference, we also show the proportion of Wikipedia citations per publication type, where most attention turns out to be given to review articles. These findings are in line with previous work [35]. Since editorials, letters and news items usually present news, debates, and opinions, often using a less technical language than regular articles, it is not surprising that they are more appealing for social media. However, in CORD-19, these three publication types receive many more tweets (44% of all tweets) than what was previously found (below 20%) [35].

Fig 9 presents term maps showing the altmetrics reception of CORD-19 publications. We cover the most immediate social media sources (or ‘fast’ sources [37]), which provide the earliest signals of the reception of publications. Twitter, blogs and news media all present a similar pattern, with a strong orientation towards the most recent COVID-19 publications, well captured by the largest cluster in both the bottom level and the top level citation network clustering (see Figs 7a and 8a). In terms of topics, terms such as ‘pandemic’, ‘hospital’, ‘hospitalization’ are among the most common terms used in publications mentioned in these social media platforms. These results are in line with those discussed in [38].

This preliminary altmetric analysis shows a strong present-day attention for research covered by the CORD-19 dataset. The majority of the tweets, blogs and news media mentions are focused on research produced during the current COVID-19 pandemic. The publication types that, in relative terms, receive most attention are editorials, letters and news items. This demonstrates the important role of social media, especially Twitter, in discussing COVID-19 research [39]. During a global pandemic like COVID-19, research is subject to high degrees of uncertainty [40, 41]. Rapidly increasing levels of social media activity around topics on which there is little academic consensus may increase the risk of scientific advice being misunderstood or misused by substantial segments of society. Social media analysis can provide tools for identifying and characterising areas with high levels of social media activity that may be in dissonance with the academic discourse. In future work, we plan to find and characterise these areas of discrepancy in order to inform scientists, science communicators, journalists and the public at large.

## Conclusion

We performed an in-depth analysis of the CORD-19 dataset of publications on COVID-19 and coronavirus research [10]. Our analysis of the delineation of CORD-19 indicates that the dataset is broader than just COVID-19 and coronavirus research. On the other hand, when



prominent component of COVID-19. It is likely that, as research on COVID-19 rapidly expands, these themes will broaden as well.

Lastly, we considered Altmeter data, in order to gauge how much attention COVID-19 research has attracted over time. The current COVID-19 outbreak dominates attention on social media, in particular from Twitter, highlighting the interest for scientific results during the COVID-19 pandemic. Editorials and letters in COVID-19 get a disproportionate amount of attention on social media.

Our work acknowledges that research on viruses, and coronaviruses specifically, does not exist in a vacuum. Delimiting research on a certain subject matter requires difficult choices that inevitably involve a certain degree of arbitrariness. We praise the breadth and relative coherence of COVID-19. This dataset rightly merits attention and is useful to allow many researchers to engage with the topic. Nevertheless, we also suggest that critical awareness is required when using COVID-19, as our results demonstrate that its contents cover a broad set of topics. Different subsets of COVID-19 should be used for specific purposes, for example for making historical analyses on funding of specific research topics or for automatically extracting structured information. We exemplified some approaches to segment COVID-19 in various ways.

Clearly, there are many areas for future COVID-19 work by the scientometric community. We conclude by suggesting three areas in particular. Firstly, there seems to be a need for a comprehensive and ongoing mapping of COVID-19-related research. A multidisciplinary map of COVID-19-related research, considering diverse disciplinary perspectives and information needs, will be useful to surface relevant research, also outside the biomedical domain. Secondly, COVID-19 provides a virtuous example of open data sharing. The scientometric community can contribute by creating and maintaining additional datasets on COVID-19 research. Thirdly, as shown by our results, there is a lot of social media attention for COVID-19 research. Indeed, the role of information, and especially reliable scientific information, has been central to the unfolding of the current pandemic [7]. Consequently, a relevant area for future work is to better understand the mechanics of online scientific information diffusion, using altmetrics and other data sources. This line of work has the potential to provide valuable information to experts and governments during the current and future pandemics.

## Supporting information

**S1 Appendix.**  
(PDF)

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