Impact of the COVID-19 pandemic on scientific production

Juan D. Machin-Mastromatteo, Javier Tarango, José Refugio Romo-González

Universidad Autónoma de Chihuahua

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Abstract

This chapter reviews the processes and dynamics that researchers and other scientific production stakeholders have engaged in and experienced in response to the COVID-19 pandemic. It includes the analysis of the challenges around research, publishing, and scientific dissemination, as well as the management of research data (as, for example, the reinforcement of open data, open science, and data repositories), the role of open access, commercial publishers, and academic libraries. We also include a critique of scientific journals' dynamics, such as the explosion of the literature related to COVID-19 research and editorial issues and the related challenges to editorial processes and peer review, as well as the retractions that have occurred.

Keywords: COVID-19, scientific production, scientific publishing, dynamics, preprints, open access, academic libraries, challenges.

1. Introduction

In recent years, a major concern of countries planning for social and economic growth has related to the development of multiple indicators and their resulting positioning and ranking, particularly those related to scientific production. One of the goals of such development, especially for countries with underdeveloped or peripheral economies, involves achieving autonomy in the generation of knowledge to avoid scientific dependence.

Each country's advances in scientific production are commonly represented using quantitative indicators, which are usually linked to the number of publications and the impact of the journals where researchers are publishing. Other levels of impact analysis are not necessarily applied, such as: social, individual, disciplinary, institutional, regional, or national (Abramo and D'Angelo, 2014). These conditions are regularly impersonal, they represent a metrification of scientific production and such quantitative indicators are increasingly generating more doubts, criticisms and even rejection by researchers, a paradoxical outcome being the lack of recognition by scientists themselves (Mattedi and Spiess, 2017).

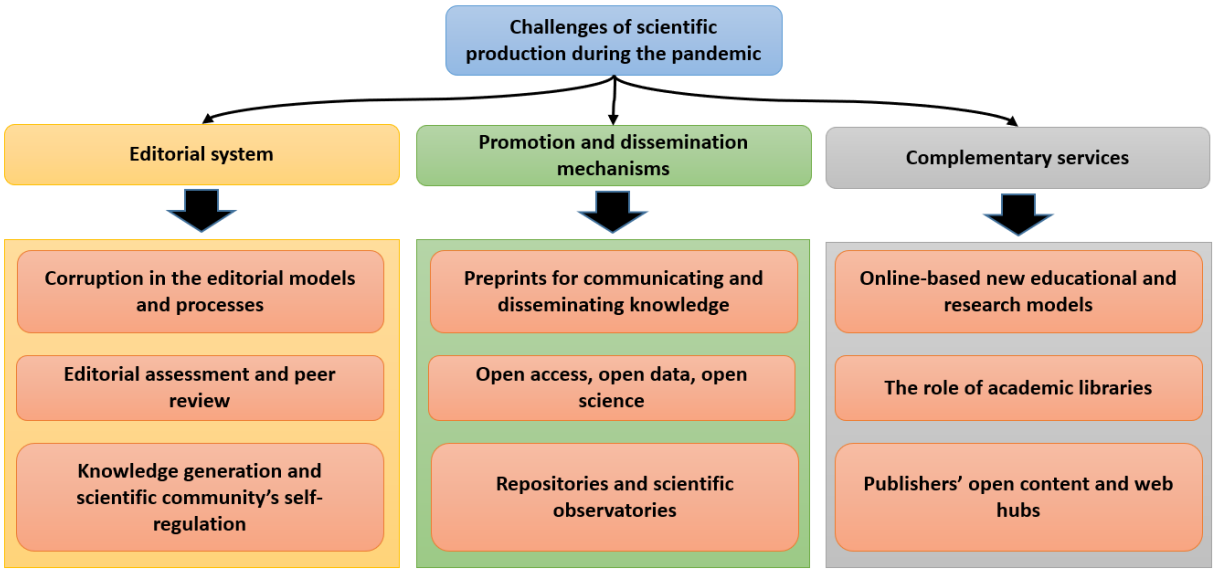
Countries' rankings and impact levels in terms of science, technology, and innovation (STI) have regularly been manifested through the development of public policies that seek to promote STI, influencing aspects such as: a) innovation, economic growth, and human development; b) strengthening and promoting education and research; and c) management processes and the role of the state in regulating and developing STI, both in the public and private sectors (Rincón, 2013). The desire of countries to integrate mechanisms for regulating and measuring STI has resulted in the generation of structural models that define scientific production patterns in three main areas: a) defining regulations and public policies to govern STI development; b) identifying the role of researchers for achieving scientific purposes; c) establishing the types of scientific products to be generated as priorities, which in turn become the quantitative parameters used to measure the desired behaviours (Delgado et al., 2020).

The creation of management structures for scientific production is typically built through processes of planned change, with the implementation of measurement projects and the generation of formal structures and policies. The COVID-19 pandemic has disrupted all aspects of productive life, including such STI structures and work modes, generating, almost spontaneously, a new set of behavioural patterns in scientific production and its dissemination and dissemination processes, including both good and bad practices.

2. The challenges of scientific production during the pandemic

The changes that are currently being experienced show both disruption and tragedy without recent precedent, but the scientific community is experiencing a fundamental and hopeful transformation (Taraborelli, 2020). The challenges to scientific production in terms of these unplanned transitions involve numerous actors, among which we can highlight researchers, librarians, citizens, teachers, and students, that is, both producers and consumers of knowledge (Heathers, 2020). According to our review of the literature, it is possible to identify nine challenges that scientific production has experienced due to the pandemic, which are grouped into three areas: a) editorial system; b) promotion and dissemination mechanisms; and c) complementary services (see Figure 1), which we detail in this chapter.

Figure 1. The challenges of scientific production during the pandemic



2.1. Corruption in the editorial models and processes

Some of the challenges of scientific production are not new. However, it is possible that they have been accentuated recently, as with the case of the corruption of science for political and economic purposes, perhaps a characteristic of our time, where scientific findings and economies are manipulated to advance political agendas (Chossudovsky, 2020). This situation has occurred in the pharmaceutical industry, which exerts pressure

on the publication of strategic topics and even attempts to block other companies. Larivière et al. (2020) consider that major crises have often revealed the (not always) explicit rules and practices of scientific communication, which turns out is not really satisfying the needs of science and society.

Heathers (2020) presents another example of corruption in science through the case of *The Lancet*, one of the oldest and most respected medical journals, where an article that was offering strong conclusions and whose results were considered authoritative was published. However, the use of the proposed drugs turned out to be dangerous to COVID-19 patients. This article was promptly retracted, which is considered an important process in modern publishing history, since, given researchers' rush to publish (derived from the 'mantra' 'publish or perish' and its related behaviours and systems), the peer review process might fail in some cases and hence, it will not detect anomalous data or findings. By January 26, 2021, Retraction Watch (2021) counted 66 retractions of documents related to COVID-19 and published in 2020, of which 19 were preprints published in medRxiv, bioRxiv and on the Social Science Resource Network (SSRN). One corresponded to a conference presentation, and 46 were retractions of journal articles, of which perhaps the most scandalous cases were three articles retracted from *The Lancet*, two from the *Journal of the American Pharmacists Association*, two from *Cureus,* one from the *New England Journal of Medicine*, and one from *PLOS ONE*. Five articles are related to the use of hydroxychloroquine and two deal with ivermectin, while one associated 5G technology to the induction of COVID-19 in cells. Soltani and Patini (2020) present a brief evaluation of 26 of these retracted articles and, according to their results, the reasons behind these retractions included doubts or errors in the data, results, or conclusions. The presence of corruptive elements in science, in the context of COVID-19, and according to Aspesi et al. (2020), causes a series of uncertainties, in the following areas:

- Scientific, including issues related to the infection itself.
- Political and social, related to social and political unrest, changes in cultural attitudes and public opinion toward science, as well as cooperation and open societies.

- Economic, due to the deterioration of the financial conditions for the publishing systems to function properly.
- Specific to higher education, since the question remains as to what will happen to budgets, students, and classes.
- Industrial, which involves responses from commercial providers.
- Regulatory, such as mandates and support systems to provide immediate open access to publications corresponding to research financed with public funds.

2.2. Editorial assessment and peer review

The pandemic has shed light on how the scientific community can self-regulate and make the criticisms and evaluations of new results more scalable. Taraborelli (2020) comments that changes could occur to the traditional peer review process, which is opaque and errors that may escape it might take months or years (if ever) to be identified and then cause the article to be retracted. Rather, the cited author points out that the peer review process requires the defects of a manuscript to be identified more quickly, which could include aspects such as: a) detecting defective results, methods that are reused for similar manuscripts or incomplete documents; and b) enabling the revision and improvement through collective comments that may even generate new research questions, as well as expanding manuscripts' results and usefulness. Recent trends such as open peer review and preprints present opportunities to do the above, while also opening research findings to a broader scientific community and seeking greater rigour in verifying the quality of manuscripts, including plagiarism detection.

Radical changes in the dynamics of scientific publishing have led to the generation of a new form of accelerated scientific production, with new studies appearing at a frenetic pace, positively offering results in real time, but without taking the validation time and steps that science requires and deserves, which is the negative side of the issue (Flamarique, 2020). This causes an excess of preprints that not only increase information overload but also may allow the ability to disseminate scientific information quickly, especially during emergencies such as the current one (Grados, 2020). According to Taraborelli (2020) and UCM (2020), preprints:

- Are scientific manuscripts that are available before being peer reviewed and formally published.
- Unlike the traditional publication process, which can take months or years to complete, researchers can publish a preprint immediately.
- Although scientific journals are often found behind paywalls, preprints are completely freely accessible to both the interested public.
- Preprint defendants have called for the creation of places of rapid response for its review.

The role of peer reviewers can be considered to be at stake, when new review models begin to emerge. In this context, Rabin (2020) highlights some emerging concerns:

- Questioning whether the peer review process is broken.
- Scientists around the world fear that the rush to make COVID-19 research results available has overwhelmed the peer review process and hence it is not working properly.
- The credibility of medical journals may be particularly questioned when they are most necessary (especially in times of a pandemic), since it is a generally accepted fact that peer review allows ensuring and maintaining the quality of research, for it is the mechanism in which each manuscript received is evaluated by at least two experts in the field.

The peer review process produces evaluations on a manuscript, which may require authors to develop revisions, corrections, or they can even recommend the rejection of the document because of important flaws.

Accelerated publication processes, characterized by the abundance of research on COVID-19, have also reshaped peer review in scientific journals to ensure rapid dissemination, but there is a risk of approving poor-quality manuscripts, with critical flaws, or erroneous results, which ends up being very harmful for any discipline (Know, 2020; Soltani and Patini, 2020). Chossudovsky (2020) considers that harmful dynamics in publications include actions such as: a) manipulation of images and alteration of data that cannot be verified; and b) publication of false scientific studies and use of suspicious data in important scientific studies, which may be published and then retracted even in leading

scientific journals. However, according to Taraborelli (2020), by sparking an uncontrolled race to increase knowledge, COVID-19 has somehow accelerated open access and open science. Jarvis (2020) specifies that the main challenges faced by journals and peer review, which have worsened during the pandemic, include:

- Journals have received an overwhelming number of articles on the subject that are awaiting to be reviewed, hoping that it will be conducted as fast, if not faster than usual, which is why scientific journals have tried to speed up the editorial review and peer review processes.
- Wide interest of scientists and health professionals to share their findings on the subject, even by professionals who were not previously dedicated to topics related to health emergencies, particularly those from the social sciences and humanities.
- Given the overabundant need for more peer reviewers, people with less experience or no experience have been approached to conduct them, which can lead to the dissemination of inaccurate results, although many manuscripts are rejected by editors due to the lack of expert reviewers.

Additionally, Soltani and Patini (2020) point out that the context of the pandemic and the retraction of articles related to COVID-19 (a problem that we discussed in the previous section) has promoted and strengthened post-publication reviews; some researchers have even been encouraged to review their own published work.

The two most popular systems for disseminating preprints on COVID-19 are the BioRxiv and medRxiv repositories; as of December 2, 2020, there were 11,101 preprints, 8,702 at medRxiv and 2,399 at bioRxiv (bioRxiv, 2020). Most of these studies have the following characteristics: a) they try to identify speculative articles, while others are based on computational models, or on conspiracy theories; and b) 75% publicly provided information on their clinical selection procedures and 32% involved researchers to apply assessment criteria on their content (Know, 2020; Porter and Hook, 2020; Simba Publishing, 2020). Traffic to these servers has also increased substantially: MedRxiv pageviews have soared to 15 million per month, compared to one million per month before the pandemic began (Taraborelli, 2020). In the first two weeks of May, the rate at which new documents on COVID-19 were added increased to an average of 650 preprint

articles per day. In addition, preprints have been strongly positioned in the research ecosystem of this topic, as by May they represented a quarter of the documents produced (Porter and Hook, 2020).

There are other concerns related to information overload, since the excess of publications and data make it difficult to take advantage of them (Flamarique, 2020). It is also important to note that scientific articles tend to show special care in the expression of their metadata (specifically title, abstract and keywords), though it seems that during the pandemic there has not been less control over the correct use of specialized terminology in metadata, as some terms that correspond to different dimensions have been used indiscriminately or as synonyms, such as: COVID-19, SARS-COV-2, Novel Coronavirus, Coronaviruses, Systemic Inflammatory Response Syndrome, Coronavirus Disease, Severe Acute Respiratory Syndrome Coronavirus 2, or nCov-2019 (Grados, 2020).

2.3. Knowledge generation and the scientific community's self-regulation

According to Aspesi et al. (2020), recent changes in knowledge generation schemes, especially within the context of the pandemic, could affect institutions in the following ways:

- The current and ensuing financial crises will exacerbate the problem of radically reallocating the available funds almost exclusively to those institutions with high volumes of scientific publication, given the required budgetary adjustments.
- Research funding may well affect open access publication, on one side it might be favourable to repositories and institutional journals, while it might seriously prevent some researchers from publishing in important open access journals with article processing charges (APC).
- The introduction of new medical research programs or the expansion of existing ones (specifically those on the SARS-COV-2 virus), could partially offset the possible decrease in funding for research and limit the negative impact represented by the growth in the volume of articles.
- There may be an additional negative impact on the ability of academic libraries to sustain their acquisitions and keep their subscriptions.

The current challenges of scientific publications include at least the following tensions, which have been accentuated in the research related to COVID-19: a) closed science and publications as opposed to open ones, which are gaining more ground; b) the dominance of certain countries or regions; c) the explosion in the number of publications in a very short time makes it difficult to be up to date on the subject; d) those who publish in high-impact sources, have high indicators and enjoy appropriate funding will be the most recognized and successful researchers (Porter and Hook, 2020); hence, the usual divides among researchers are kept, if not aggravated. Moreover, Porter and Hook (2020) discuss the following risks regarding research in universities:

- A decrease in research funding, as governments are under pressure to manage national debts and health system expenditures.
- Universities' income from international students will affect many institutions in economies that have diversified their business models and educational institutions to cater to such markets.
- Perhaps government policy will once again drive institutions to produce more applied research, which will directly benefit the economy in the short term.

COVID-19 has posed more immediate challenges for researchers around the world, who have rapidly reoriented their studies to meet public health needs, as well as researchers from other disciplines, who have addressed the challenges of the pandemic from their own approaches. These changes in customary research practices have led to an exceptionally large volume of work being generated in a short time, even from fields of knowledge with slower growth.

As of December 2, LitCovid, which according to its authors is the most exhaustive resource of COVID-19 research, counted 76,534 articles indexed in PubMed on the topic (Chen et al., 2020). Moreover, to illustrate the volume of COVID-19-related indexed documents that were published during 2020 (until 26 January, 2021) and in various disciplines, we applied in Scopus the search query used by LitCovid ("coronavirus" OR "ncov" OR "cov" OR "2019-nCoV" OR "COVID-19" OR "SARS-CoV-2"). This resulted in 98,154 documents published in sources indexed in Scopus, of which only five are marked to be retracted; obviously, Medicine is the discipline with most publications (46.9%),

followed by Biochemistry, Genetics and Molecular Biology (7.37%), Social Sciences (7.10%), Immunology and Microbiology (4.68%), Pharmacology, Toxicology and Pharmaceutics (2.91%), Nursing (2.88%), Environmental Science (2.62%), Computer Science (2.52%), Engineering (2.29%), and Psychology (2.08%). Although information professionals have been active publishing research related to responses to the pandemic, it is difficult to provide a precise percentage for the field of Library and Information Science without a much deeper analysis, because Scopus classifies some of our journals in the Social Sciences and others in Computer Science. Table 1 presents all the disciplines and their percentage of documents, based on the total of 98,154 indexed in Scopus. The total number of articles between LitCovid and Scopus differ, because the former uses Pubmed, which indexes sources from health disciplines, while Scopus is multidisciplinary.

Table 1. Percentage of COVID-19 related documents indexed in Scopus per discipline. Data source: Scopus (2020).

Discipline	% of documents published
Medicine	46.90%
Biochemistry, Genetics and Molecular Biology	7.37%
Social Sciences	7.10%
Immunology and Microbiology	4.68%
Pharmacology, Toxicology and Pharmaceutics	2.91%
Nursing	2.88%
Environmental Science	2.62%
Computer Science	2.52%
Engineering	2.29%
Psychology	2.08%
Neuroscience	1.92%
Multidisciplinary	1.79%
Agricultural and Biological Sciences	1.67%

Business, Management and Accounting	1.60%
Arts and Humanities	1.37%
Health Professions	1.36%
Economics, Econometrics and Finance	1.22%
Mathematics	1.19%
Chemistry	1.07%
Physics and Astronomy	0.99%
Chemical Engineering	0.76%
Energy	0.73%
Dentistry	0.70%
Materials Science	0.69%
Decision Sciences	0.54%
Veterinary	0.53%
Earth and Planetary Sciences	0.48%
Undefined	0.03%

Larivière et al. (2020) draw attention to the fact that not all articles on COVID-19 are open access. This contradicts a worldwide agreement, to which many commercial publishers are signatories. The Statement on data sharing in public health emergencies (Wellcome, 2016) was first established in 2016, within the context of the Zika virus outbreak. Signatories of this agreement commit to provide the World Health Organization (WHO) and the general public with access ('as rapidly and openly as possible') to the results of medical research whenever a worldwide public health emergency arises, which can be achieved by making all contents about the topic open access or by providing free access for the duration of the outbreak. It is strange, therefore, that not all the content published by the publishers that signed the agreement are openly available. This is verifiable by accessing commercial publishers' COVID-19 content hubs that, although a very good initiative, are incomplete, as they do not offer access to all COVID-19-related research (many articles behind paywalls are even from health disciplines, hence it is odd to find

some of them unavailable in databases from publishers that signed the Wellcome agreement). Many of them are difficult to navigate and some even lack proper searching functionality, which is needed in every information system with a large volume of documents.

Online or virtual education might seem as an aspect outside of knowledge generation and consumption, but it is another aspect that has particularly been challenged and impacted by the pandemic, as it has been more than a viable alternative for educational institutions; it has been the only option to continue providing educational programmes at all levels of instruction. Aspesi et al. (2020) consider two fundamental aspects: a) a significant number of students may be willing to switch to online courses and even online degrees, but it is not clear how many universities are appropriately equipped to run programmes of this nature; b) some publishers have experience and resources to offer courses and even programmes and may harness such an opportunity. Perhaps the biggest issue with education, particularly in 'old-fashioned' universities, and others perhaps more modern, is that the pandemic caught many institutions by surprise, so the staff were not prepared enough to face the challenges ahead. Hence, under the pandemic, universities have to compete in the same arena with other educational providers that use online tools as a matter of routine, while universities had to adopt them immediately.

2.4. Open access, open data, open science

According to the Complutense University of Madrid (UCM, 2020), open science is the ideal mechanism to respond to situations such as this pandemic. One of the ways that open science manifests itself is through preprints and their growing popularity may allow for a more solid model of open science to be developed, promoting greater collaboration, accelerating scientific progress and allowing the full force of scientific research to be available to scientists and non-scientists (Taraborelli, 2020). Le Guillou (2020) claims that preprints also promote two fundamental conditions:

- The need to share information and research results quickly.
- The promotion of open science, as well as open data.

Both conditions have changed the ways in which scientific discourse is experienced and have been strengthened in these times of the pandemic. Although the most critical views of preprints present them as a less polished, even rushed or hasty version of a scientific manuscript, nevertheless, preprints are a different scientific product and one that may be laying the foundation for a new model of scientific communication. They have become the most important large-scale collaborative experiment in modern science; the speed at which they allow research results to be available reflects the way systems are adapting in the research community to ensure that knowledge spreads as quickly as possible, as well as ensuring that more actors can make judgments about the contents (Porter and Hook, 2020). The usual processes of exclusive publication in scientific journals have been changing. Preprints have allowed researchers to make their results public once their research is completed, but these are unreviewed manuscripts (Flamarique, 2020).

According to Know (2020), repositories are rapidly disseminating science about the pandemic and are rigorously evaluating their content to protect themselves from poor-quality work, and to avoid receiving documents that make predictions about treatments. For Taraborelli (2020), this development has strong similarities with the trajectory of collaborative knowledge production systems (such as Wikipedia), while open repositories imitate the non-linear and iterative structure of scientific discourse.

Society's access to research results is limited by journals' open access policies and the interests of commercial publishers, which gives rise to other interests that seek to change scientific policies to guarantee a generalized, rapid, and effective access to science by society in general (UCM, 2020). An increase in openness has not necessarily represented lax editorial boards; on the contrary, they have become a source of power and responsibility over publication, in addition to representing a greater academic governance on journals, with more ethical and responsible editorial cultures (Grove, 2020).

Scientific openness is breaking disciplinary barriers, fostering collaboration, accelerating dissemination, and drastically expanding the audience of scientists who can review, criticize, or corroborate the findings of a study, in addition to increasing the speed of all these processes (Taraborelli, 2020). Open access gains more strength when its

objectives are to advance science and serve society, in addition to removing the barriers of access to content (through legal mechanisms), while open science ensures that all research, including its data, documents and processes are immediately available without restrictions and to all interested stakeholders (Larivière et al., 2020). The pandemic has revealed the benefits of open data for collaboration and a faster development of medical research. Open science will promote a greater exchange of data and research compared to the past, since there are multiple exchange tools available online (Le Guillou, 2020), which will continue to multiply.

There have been many initiatives to gather and provide open access to COVID-19 research and data. The WHO (2020) has established a content hub with a database by the Latin American and Caribbean Centre on Health Sciences Information (BIREME) that has been updated daily and can be either searched or downloaded. At the time of writing, the database has 102,633 full texts and 13,370 preprints. Since the beginning of 2020, Google Scholar's homepage has been including a section with direct links to websites with COVID-19-related research from some journals, publishers, and preprint servers (CDC, NEJM, JAMA, Lancet, Cell, BMJ, Nature, Science, Elsevier, Oxford, Wiley, and medRxiv).

Individual researchers have also prepared compilations of resources, for instance, Uribe-Tirado (2020) compiled open science resources, which facilitates access to data sources and open access documents about COVID-19, which the author claims that shows the benefits of scientific openness models. Governmental bodies have also offered new services in the context of the pandemic. For instance, in Latin America, the Brazilian Ministry of Science, Technology and Innovation (2020), as well as the Mexican National Council of Science and Technology (2020) have each developed portals with open access to documents and data related to the pandemic.

Scholars in charge of library and information science journals or guest editors had the initiative of making calls for papers to publish special issues dedicated to COVID-19, all of them to appear in Emerald-published journals:

- *Information and Learning Sciences* published a two-part special issue 'Evidence-based and Pragmatic Online Teaching and Learning Approaches: A Response to Emergency Transitions to Remote Online Education in K-12, Higher Education, and Librarianship' (available in open access for the first six months) (Reynolds and Chu, 2020).
- *Digital Library Perspectives* is publishing two special issues: 'Digital libraries and COVID-19: responding to a global emergency', appearing in 2020, and 'Digital libraries and COVID-19: the new normal' to be published in 2021 (Tammaro and Machin-Mastromatteo, 2020).
- *Library Hi Tech* will be publishing in 2021 'COVID-19 Pandemic and Health Informatics' (So et al., 2020).
- *Information Discovery and Delivery* is going to publish 'Using Data Science to Understand the Coronavirus Pandemic', also in 2021 (Tian et al., 2020).

In the world of open data, we have the case of Figshare (2020), a data repository mainly used by researchers to make their research data freely accessible. In this case, a COVID-19 hub has been set up to upload directly the data from research related to the virus and the pandemic, guaranteeing at the same time a more direct Access to data about this topic.

Many commercial publishers, including the major six in size have also opened specialized web hubs with access to scientific information, full texts, scientific dissemination information, as well as health, psychological and educational recommendations, resources, and support materials (Elsevier, 2020; Emerald Publishing, 2020a; Springer Nature, 2020; SAGE, 2020; Taylor & Francis, 2020; Wiley, 2020a). For instance, these offer advice to set up online meetings and courses, as well as tutorials for making sure library users know about enabling remote access to the major databases, especially because physical access to the campus is restricted. The following paragraphs summarize some of the available initiatives, although this is not an exhaustive selection.

Major publishers who are also signatories of the Wellcome agreement have opened access to most of their publications on the pandemic. Emerald Publishing (2020b) also

offered a fund to finance the APCs for publishing articles on the pandemic in their journals, regardless of the field. Wiley (2020b) has also created a portal with information related to online education resources, which includes information to find online resources for various disciplines and for facilitating online courses, covering aspects such as rubrics, evaluation, feedback, video production, among other topics that may aid teaching.

Springer made a small collection of around 500 books free to download during the first semester of 2020. Elsevier has made available a tool for conducting data mining on the COVID-19 publications that they have published, something that is widely known that commercial publishers are usually very reluctant to do; this publisher is also providing special resources for researchers, students, and professors in health disciplines, as well as medics, librarians and journalists. Frontiers (2020), a publisher of gold open access journals is offering a website that gathers information about funding opportunities for COVID-19-related research. Finally, the Association of University Presses (2020), a group of around 80 university presses around the world, including Oxford, Cambridge, MIT, Cornell, Harvard and Uniandes, has also provided free downloads of parts of their collections.

One of the most relevant trends, driven by COVID-19, is that many of the largest publishers signed the Wellcome agreement and have mostly followed it, while offering other types of resources during the pandemic. Other publishers' responses were mixed, with some quickly providing full open access to their articles, while others provided temporary access, custom licences; yet others did not provide content at all (Aspesi et al., 2020). In promoting open access, Aspesi et al. (2020) highlight that publishers have concerns regarding income and profitability:

- In the short term, they seem to believe that the income they obtain from academic library subscriptions will be seriously reduced, which will turn into a long-term problem.
- Many academic libraries will face reduced budgets, and maybe they will be discontinuing other services first, rather than interrupting payments for their existing subscriptions, which will then be seriously reassessed.

- In the future, academic libraries will likely demand more favourable conditions when they renew their contracts and sign new, transformative and complex agreements, though this could take longer to materialize than expected.

A significant reduction in subscriptions will likely occur globally and may force publishers to offer better terms, because even before the pandemic, increases in subscriptions and APCs were no longer sustainable or even reasonable, especially in developing countries. An intriguing development is that Springer Nature announced that, from 2021, it will start charging APCs of €9,500 per article to publish them in Nature and other 32 journals of this publisher, under a gold open access model (Else, 2020); this is to our understanding the highest price that any publisher has ever considered and it will be next to impossible for developing countries' institutions to even consider paying it, as they struggle with APCs from US$ 500 to 1,000.

Another effective form of scientific dissemination has been conducted by scientific observatories. In addition to LitCovid (Chen et al., 2020), which we mentioned earlier, the Ibero-American Observatory of Science, Technology and Society offers information on worldwide COVID-19-related scientific publications by using PubMed, including the number of publications by country, comparisons between the production of countries and collaboration data among researchers (Organization of Ibero-American States, 2020).

2.5. The role of academic libraries

Libraries in general, and medical libraries in particular, have assumed a leading role in the promotion of scientific information in the context of the pandemic, by: a) identifying the information skills required by medical librarians and their users, beyond information search, retrieval, access and use; b) appropriately using evidence-based medicine to identify the suitability of scientific information for making appropriate medical decisions; and c) fighting against unscientific assumptions and beliefs (Grados, 2020).

The actions of medical libraries are characterized by: a) promoting public health awareness through preventive measures; b) avoiding fake news and alternative facts; c) avoiding the proliferation of misinformation and conspiracy theories, thus preventing

infodemic (excessive amount of information) and misinformation, which makes it difficult for people to find reliable sources (Organização Pan-Americana da Saúde, and Organização Mundial da Saúde, 2020; Research Information, 2020). According to the sources cited above, these challenges offer the possibility of supporting research teams by providing access to the most recent and reliable information and publications, in addition to facilitating support in the writing of scientific articles and providing filters to face information overload.

Based on the new behavioural patterns of information use, two aspects related to academic libraries are of concern: their reopening for post-pandemic operation (or the so-called new normal) and their new modus operandi for using available resources, might be of no interest to users and become unused resources. In the case of the reopening processes of academic libraries, anticipating such a possibility, there have been proposals for adopting biosafety protocols in order to reopening in a safer and more effective way, and at various stages, without affecting the stability of the physical collection and including aspects such as disinfecting buildings, office equipment and collections (Ramírez et al., 2020).

The closing, opening, and closing processes in libraries have obviously been impacting face-to-face services; in addition, such processes require interrupting and restarting of work and operations, which imply financial and other costs. Adapting to new changes also requires resources, if face-to-face services are to be provided again, it is necessary to ‘re-ignite the engines’, and if libraries do not return to their regular operations, new online services must be created, while existing ones are strengthened. Such restarting and suspension of activities create difficulties and concerns, at least in terms of sustainability. A group of experts who participated in a webcast organized by Research Information (2020), concluded that it will be necessary to:

- Generate online services.
- Develop content selection processes.
- Define controls for accessing and using physical information resources.
- Seek mechanisms to continue supporting research.
- Generate digitization processes of available information resources.

- Integrate openness models to promote publication.
- Generate digital literacy programmes with a focus on online education and publishing.

3. Conclusion

The quality conditions required to publish manuscripts, to evaluate them with transparency and strong scrutiny, have always been accepted as necessary. The pandemic has strengthened this position and drawn further attention to their flaws. The abundance of publications without quality control mechanisms causes issues of information overload, but they have strengthened interesting scientific production dynamics and highlighted the importance of open models and products, as well as to the need for maintaining quality in scientific communication. Teachers, researchers, librarians, and information users must adapt to these new challenges of scientific production, first within the period of the pandemic and then considering the emerging changes after it, when it will be time to define new guidelines and set firmer positions regarding new products and workflows related to research, editorial evaluation, peer review, content generation, forming the new information services that will be demanded.

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