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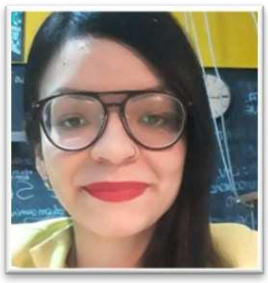

The pandemic has brought opportunities for greater inclusion in science: A thematic analysis of documents on open science practices

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ABSTRACT

Introduction: The response to the Covid-19 pandemic caused the expansion of the volume of scientific data and the encouragement of Open Science (OS) practices as scientists share their data in attempts to control the global public health emergency. As a result, opportunities for OS have also expanded during the pandemic. Objective: The herein study aimed to map shared narratives about OS practices during the pandemic paying particular attention to debates on public access to knowledge and practices and values of Equity, Diversity and Inclusion (EDI). Methodology: We have conducted a thematic and documental analysis of 30 journal articles, news pieces, blog posts and institutional material published in Portuguese obtained via key-word searches on SciELO, Google, Chamber of Deputies and the Senate databases. Results: Data shows that 36.6% (11) of the documents mentioned EDI while 70% (21) included discussions on public and universal access to scientific knowledge. As the documents could mention both themes, they were coded in both categories as needed. In addition, 23% (7) of the sample did not mention any of these categories while 77% presented discussions on at least one of them. Conclusion: Open Science practices were associated with the need of a rapid response to the pandemic leading to questions on whether these practices will endure following the absence of such urgency. Regardless of being in its preliminary state, the EDI debate pointed to opportunities for co-production of knowledge and the need for more inclusive practices, including live public debates on evidence production.

KEYWORDS

Open access. Open science. Pandemics. Covid-19.

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Pandemia trouxe oportunidades para mais inclusão na ciência: uma análise temática de documentos sobre práticas de ciência aberta

RESUMO

Introdução: A pandemia da Covid-19 produziu um grande volume de dados científicos e fomentou práticas abertas de ciência em função do compartilhamento de dados para o controle do vírus Sars-CoV-2. Tal cenário gerou oportunidades para o movimento da ciência aberta (CA). Objetivo: O intuito deste artigo é mapear as narrativas circulantes sobre práticas de CA durante a pandemia – com destaque aos debates sobre acesso público ao conhecimento e a práticas e valores característicos de Equidade, Diversidade e Inclusão (EDI). Metodologia: Realizou-se análise documental e temática de 30 artigos científicos, notícias na imprensa, posts de blogs e materiais institucionais publicados em português obtidos

mediante busca por palavras-chave no SciELO, Google e bibliotecas da Câmara e do Senado. Resultados: Observou-se que 36,6% (11) dos documentos mencionaram valores de EDI, enquanto 70% (21) incluíram discussões sobre acesso público e universal ao conhecimento. Os textos poderiam apresentar ambas as temáticas, sendo contabilizados tanto na categoria de EDI quanto de acesso público. Da amostra, 23% (7) não mencionaram nenhuma dessas duas categorias e 77% apresentaram ao menos uma delas. Conclusão: De modo geral, o uso da ciência aberta foi associado à rápida produção de respostas para a pandemia, o que levanta questões sobre a continuidade de práticas abertas em períodos em que essa urgência não esteja presente. Quanto ao debate sobre EDI, embora ainda incipiente, a pandemia apresenta oportunidades de coprodução do conhecimento e práticas mais inclusivas – com experiências de debates públicos em tempo real da construção de evidências.

PALAVRAS-CHAVE

Acesso aberto. Acesso à informação. Pandemia. Covid-19.

CRediT

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1 INTRODUCTION

The Covid-19 pandemic indicated the need for scientific information for political and everyday decision-making, and science tried to meet this demand. The volume of publications generated in five months of the pandemic surpassed even the most prolific emerging fields of study, such as nanotechnology (Porter; Hook, 2020). Publications related to Covid-19 grew at an average monthly rate of 166% between January and April 2020 (Bermúdez-Rodríguez *et al*., 2020). In addition, by June 2020, 42,700 scientific articles had been published specifically on the Covid-19 pandemic (Porter; Hook, 2020).

Accompanying the growth in the volume of data generated, there has also been a growing debate about the economic barriers to accessing scientific knowledge, as well as the importance of collaborative and transparent practices among scientists (Belli *et al*., 2020; Homolak; Kodvanj; Virag, 2020). Open access articles that had been growing before the pandemic overtook restricted access articles for the first time (Hook, 2021) and received the most attention on social media (Belli *et al*., 2020; Homolak; Kodvanj; Virag, 2020). This period also experienced an upsurge in articles with this access model on the coronavirus family: with 91.4% in 2020; while the percentage was 59.2% between 2001 and 2020 (BELLI *et al*., 2020).

The pandemic has reinvigorated the open science debate, as international agreements have mobilized the international scientific community to make existing and future coronavirus publications open access. This allowed barrier-free access to information about the new acute respiratory disease. On January 31, 2020, the Wellcome Trust appealed to the scientific community, publishers, and research funding foundations to make their research data on the disease fast and open (Wellcome Trust, 2020).

1.1 Open science and inclusive practices

The open science movement had been somewhat outlined in the early days of science (David, 2008) but it gained strength with the digitization of knowledge, with the advent of the internet and the new ICTs (Information and Communication Technologies) from the 1990s onwards, which generated new technological possibilities for the dissemination and access to scientific studies (Burgelman *et al*., 2019).

More than a movement linked to the new possibilities of technology; however, this movement has principles that shake up the economic and production infrastructure of science, with the possibility of bringing science and society closer together. This possibility is described in important documents that are considered milestones for the open movement, such as the Budapest (2002), Bethesda (2003) and Berlin (2003) declarations. These documents show the optimism of new technologies, which could facilitate access to scientific knowledge and make science contribute more directly to the progress of humanity and the maintenance and preservation of cultural heritage for future generations. In concrete terms, however, these milestones refer more specifically to open access, the possibility of accessing a scientific study for free, without going into detail about the paths and challenges for this knowledge to actually be accessible to the public, considering not only economic barriers, but also those of contextualization, understanding, and even knowing that this data is available and can be accessed.

One document that makes progress in this direction was released by the United Nations Educational, Scientific and Cultural Organization (Unesco) during the pandemic. With the aim of developing a favorable political environment for open science practices with guidelines for member states (Unesco, 2021), the organization presents the idea that complex contemporary challenges such as the depletion of natural resources and access to health depend on open science to be solved, since many of them are mediated by science and technology. Furthermore,

the institution believes that more open practices improve the quality, reproducibility, and impact of science (Unesco, 2021).

The material clarifies it, above all, that open science practices should not be restricted to conversations between peers in the scientific community. In Unesco's definition, open science is an "inclusive construct" (Unesco, 2021, p.7), which should include dialogue with other knowledge systems. These practices should promote the inclusion and exchange of knowledge originating in groups that are "traditionally underrepresented or excluded (such as women, minorities, indigenous peoples, academics from disadvantaged countries and languages with few resources)" (Unesco, 2021, p. 5). Such practices should also aim to "reduce inequalities in access to scientific development, infrastructure, and capacities between different countries and regions" (Unesco, 2021, p. 5).

Unesco agrees with the challenges faced in the pandemic, which are not limited to economic barriers to accessing knowledge. With the high volume of scientific data available, evaluating this information, contextualizing it, disseminating it and engaging individuals to apply this knowledge in their lives have become increasingly difficult. Such has been the challenge of the abundance of information that has spread like an epidemic, that the phenomenon has been coined "infodemic" by the World Health Organization and seen as a global challenge that has made the Sars-CoV-2 control an arduous task (WHO, 2021). Furthermore, if the volume of data generated was already demanding, even more so was the fact that this information was consumed by different citizens, in different socio-economic contexts and with equally different levels of scientific literacy (Oliveira *et al*., 2021).

It should be noted, however, that economic barriers remain a challenge, despite a boom in open access articles during the pandemic. More recent documents on open science still denounce the limitations of the practice, even 20 years after the first milestones. Plan S, the open access policy put in place by the European Union in 2021, highlighted that paywalls (content only accessible for a fee) in scientific journals are an "anomaly" that "hinders the scientific enterprise in its very foundations and hampers its uptake by society"" (Coalision S, 2021).

Therefore, the context of the pandemic has brought an abundance of scientific knowledge, the need to share this data without barriers, but it has also intensified the debate about the absorption and understanding of scientific research; and, with this, the need for more inclusive practices that go beyond the availability of data and studies is gaining strength.

In this scenario, debates on Equity, Diversity, and Inclusion (EDI) in science are gaining momentum, with scientific journals considering, for example, more diversity in the chart of reviewers and authors, as well as publications that are closer to the themes and debates of society's cultural movements (Rode; Fontes, 2022). This demand is a response to disparities found in publications, even recently, such as the analysis that showed a strong gender gap in science: 65% of men and 35% of women as first author; 83% of men and 17% of women as last author; and 85% of men and 15% of women as first and last author (Mahmoudi, 2021).

Even in science communication, which is aimed at the wider public, there is a demand for more inclusion. This has been echoed by studies calling for a review of the epistemological assumptions underlying science communication to include the needs of marginalized groups (Callwood *et al*., 2022; Finlay *et al*., 2021; Lewenstein, 2019). These are recent movements that will take time to break the paradigm of science communication, which has a history of treating the public without much differentiation, as a mass of non-scientists without paying special attention to the idea of diversity between communities, for example (Judd; McKinnon, 2021; Orthia *et al*., 2021).

The EDI debates also accompany long literature that evaluates the consequences of science's detachment from society. Ulrich Beck, for example, pointed out how science needs to absorb its influence on the world, since it generates risks and uncertainties, and not just neutral research (Beck, 1992). Similarly, science and technology can generate social inequalities if their

impact or society's demands are not considered (Dagnino, 2014). A third point is that, considering science as a sociotechnical phenomenon and an element of a collective, discursive, factual construction made up of agreements and consensus (Latour, 2011; Latour; Woolgar, 1979), citizens should also be able to access the construction of scientific evidence through tools that make this process more transparent.

1.2 Research questions

Thus, considering social and epistemic demands for greater inclusion and transparency in science, this study investigates how discourses on the open science movement circulated in Brazil and in other Portuguese-speaking regions. It also aims to identify to what extent did the scientific community address the need for inclusion and public access to knowledge during the pandemic. The article aims to answer two research questions:

1) What were the main ideas about the open science movement in the pandemic that circulated in Portuguese-language publications?
2) Do these publications mention issues about universal public access to knowledge or about equity, diversity, and inclusion?

2 METHODOLOGY

To answer these questions, a search was carried out in February 2023 for documents in the scholarly literature on open science. The search considered the period of the first three years of the Covid-19 pandemic: January 2020 to February 2023. In order to find a diversity of narratives and arguments, we consulted the websites of government institutions, the SciELO scientific article database indexer, the websites of the Chamber of Deputies and the Senate, and the Google search engine for a broader search. SciELO was chosen considering the objective of finding scientific articles in Portuguese. The search on SciELO and Google was carried out using a search strategy containing keywords in English and Portuguese, which were intended to allude to open science practices during the pandemic:

> ((*open access*) OR (*open research*) OR (*open science*) OR (*open data*) OR (*open practices*) OR (*open practices*) OR (*preprint**) OR (*pre-print**) OR (ciência aberta) OR (pesquisa aberta) OR (acesso aberto) OR (dado aberto) OR (prática aberta)) AND ((Covid) OR (COVID-19) OR (*Coronavirus*) OR (*Novel coronavirus*) OR (SARS-CoV-2) OR (*Covid-19 pandemic*) OR (*the pandemic*) OR (*epidemic*) OR (pandemia) OR (epidemia))

In SciELO, the search resulted in an initial sample of 909 documents, from which articles published in Portuguese were extracted (n=183). The titles and abstracts were subsequently evaluated t to discard documents that did not establish a direct and robust relationship between the topics of “open science” and “pandemic”, resulting in 56 articles.. We also excluded materials that did not approach the relationship between open science and the pandemic as their main subject following a thorough reading of the complete publications (in some cases, the open movement was only mentioned as a backdrop, or context, without further consideration). Finally, the final sample of documents retrieved by SciELO consisted of 13 documents and included conference proceedings, editorials, scientific articles and interviews.

After screening, the following were excluded from the sample: analyses of Covid mortality, treatments, and the use of interventions to manage Covid-19, access to educational technology during the pandemic, psychological suffering and the experiences of vulnerable groups during the pandemic, among others. For more general titles where the topic was unclear

(for example, “Government strategies during the Covid-19 pandemic”), the abstracts were read; and in case of uncertainty, we searched for keywords such as “open science”, “open access” and “open data” in the document to assess feasibility for the sample.

Chart 1: Summary of the analysis of documents in Portuguese on open science in the Covid-19 pandemic*

Title	Type of publication	EDI presence	Presence public access
2020 - How was scientific production in the year of the pandemic?	Blog post	No	No
Scientific communication on the move: from its origins to current debates	Scientific article	Yes	Yes
The importance of open access in times of pandemic	Congress proceedings	Yes	Yes
The pandemic and the emergence of Open Science	Scientific article	No	Yes
Aaron Swartz: open access bandit or hero?	Scientific article	No	Yes
Open access to facilitate research and information on COVID-19	Blog post	No	Yes
Now is the time for open access policies - here's why	Blog post	No	Yes
Warning to navigators - times are changing	Blog post	No	No
Bio-manguinhos promotes panel on Open Science and Covid-19	Institutional news	No	No
Open science, open access: literature review of scientific communication on Covid-19 on the SciELO platform (2020)	Scientific article	No	Yes
Open Science and preprints in scientific publishing	Opinion piece	Yes	Yes
Open Science: Emergency Response or the New Normal?	Scientific article	No	Yes
Citizen and open science in times of pandemic!	Editorial	Yes	Yes
COVID-19: Scientific collaboration and open science	Institutional note	Yes	Yes
Scientific dissemination takes open access to a new level	Blog post	No	Yes
Interview with Eloy Rodrigues: "There Will Be No Open Science If the Excessive and Erroneous Use of Metrics Is Not Abandoned"	Interview in scientific journal	Yes	Yes
Open access initiatives in the fight against the pandemic: open data and intellectual property in the dissemination of information and knowledge	Scientific article	Yes	Yes
Information initiatives of the Brazilian Institute of Information in Science and Technology (Ibict) in times of the pandemic	Scientific article	Yes	No
The case for open research in times of COVID-19	Blog post	No	No
The impact of open access on the production and dissemination of knowledge about Covid-19	Scientific article	No	Yes
What is open science? And what are the obstacles to it?	News article	No	Yes

The coronavirus outbreak (COVID-19) highlights serious shortcomings in scientific communication	Blog post	No	No
Politicization of scientific controversies by the Brazilian media in times of pandemic: the circulation of preprints on Covid-19 and its repercussions	Scientific article	No	No
Why is it important to support open infrastructure for publishing preprints?	Blog post	Yes	Yes
Preprints in Brazilian science: considerations from the perspective of Nursing	Blog post	No	No
Medical publishing in times of pandemic	Editorial	No	Yes
Towards Open Science: Contributing to a Change in Research Culture	Blog post	No	No
Learn why the "Open Science" movement can accelerate the search for the COVID-19 vaccine	Blog post	Yes	Yes
SciELO Books and open access in epidemic times: More important than ever	Blog post	Yes	Yes
Urgency of knowledge generation during the covid-19 pandemic: a retrospective on integrity in health publications	Scientific article	No	Yes

Source: The authors (2023).
* Documents titles are originally in Portuguese.

The Google search was carried out using keyword combinations similar to those in SciELO. Filtering by title and abstract resulted in an initial sample of 23 documents, including newspaper articles, journalistic websites and blog posts. After reading all the documents, the final sample consisted of 17 texts, most of which were produced in Brazil. Even so, there are three publications in the Portuguese-language sample that are translations of texts originally written in English (Heath; Vézina, 2020; Larivière; Shu; Sugimoto, 2020; Petrou, 2020). There are also four publications from Portugal (Apóstolo; Silva, 2021; Rodrigues, 2020, 2022; Silva, 2022), which were considered in our sample.

Consequently, a total of 30 documents were analyzed (see Chart 1)[1], adding up the results of the SciELO (n=13) and Google (n=17) searches. This final corpus includes editorials, press reports, blog posts and publicity materials from governmental or global institutions, such as Unesco. It is worth highlighting that after consulting the websites of the Library of the Chamber of Deputies, the National Library and the Library of the Presidency of the Republic we did not retrieve any results. Only one document on the pandemic was found in the Senate Library, but it did not present a definitive debate on open science (Brasil, 2021). The document, however, contained a list of relevant primary sources to be consulted in the context of the coronavirus which demonstrates, to some extent, the importance of sharing scientific data during the pandemic in the country (Brasil, 2021).

From the collection of documents, a thematic analysis was conducted treating recurrent affirmations to specific subjects as relevant themes, with the observation of nuclei of meaning (Minayo, 2008); this included s phrases, expressions, and passages related to access to scientific knowledge by a wider audience or that made references to EDI (Equity, Diversity, and Inclusion) characteristics. Thematic analysis is widely used in qualitative studies, sometimes without any specificity or even as a reference to the method specifically (Terry *et al*., 2017). It is also considered documentary analysis and has the aim of reconstructing social processes, and serves as a moment to capture certain conjunctures (Alonso, 2016). In this study, documents

[1] The chart with the full analysis of the documents is available at: bit.ly/3JGqFOT.

are the empirical basis for identifying how discourses on open science circulated during the pandemic, considering documents in Portuguese.

In any case, it is a question of identifying topics of interest in a given sample, which can also be achieved quantitatively by searching for keywords (Terry et al., 2017). In qualitative thematic analysis, however, the subject of interest can be reached through context and approximations of meaning (Minayo, 2008). The qualitative approach to thematic analysis was chosen. Thus, it was considered that an article that mentions the need for linguistic or geographical variety in science, for example, is mentioning inclusion, even if the word specifically is not mentioned.

3 RESULTS

3.1 Open science in Brazil during the Covid-19 pandemic: main themes

The results strongly suggest that a recurring claim is that open science has proved essential in accelerating the speed at which responses are produced during the pandemic; this, in turn, has been seen as "a race against time" (Bermúdez-Rodríguez *et al*., 2020; EBSCO, 2020). Practices such as the acceleration of peer review processes, the explosion of preprints (manuscripts of scientific studies not yet peer-reviewed) and sharing the virus genome between databases have reduced the distance and time between the production and use of scientific information (Amaro *et al*., 2020; Petrou, 2020; Rode, 2020; Santos-D'Amorim, 2021; Spinak, 2020).

Authors note that the results obtained in the Covid-19 crisis (mapping variants of the virus, investigating the disease, possible therapies and vaccine development) cannot be dissociated from open science (Christ, 2021; Heath; Vézina, 2020; Rodrigues, 2020). In some documents related to the UN and Unesco, it is mentioned that the pandemic has given impetus for open science to become urgent (UN, 2020; Unesco, [n.d.]).

In contrast to the optimism related to this speed, several texts note the need to consider issues of research integrity, ethics and the general quality of studies produced in the period (Penido *et al.*, 2022; Unesco, 2020). The specific consideration of user privacy is noteworthy, with the use of geolocation data in the pandemic, used by some governments as a measure to assess the spread of the disease[2] (Unesco, 2020).

In one article (Stueber; Silveira; Teixeira, 2022), open science in Brazil appears to be associated with the SUS (Unified Health System), as an initiative that aligns with its principles. In the text, the actors agree that the democratization of health depends on the democratization of knowledge, and therefore depends on open science. Furthermore, they emphasize how open science in Brazil is associated with public funding of research institutions (Stueber; Silveira; Teixeira, 2022).

Some publications have cited the use of certain practices during the pandemic as examples of open science, including the graphs and GIFs used by scientists to popularize the concept of "flattening the curve" regarding Covid-19 cases and deaths (Heath; Vézina, 2020). Additionally, a platform in Brazil has highlighted the efforts of grassroots health workers in select communities, which is also considered part of the open movement (Ferreira, 2020).

There is disagreement regarding whether open science increases or decreases disinformation in the referenced documents. While knowledge co-production practices can help reduce it, preprint publication can also lead to information confusion. Santos-D'Amorim (2021) identifies preprints as the primary factor responsible for information confusion. In fact,

[2] During the pandemic in Brazil, a partnership was made with cell phone operators, who provided geolocation data to monitor which regions were following the social isolation order to contain the spread of Sars-CoV-2 (SCHREIBER, 2020).

preprinting is a much-debated and contentious topic within the sample. Many articles examine the contradictions of this practice, highlighting at times the rapid dissemination of scientific information, while also pointing out the circulation of low-quality publications lacking endorsement from the scientific community (Nassi-Calò, 2022; Rode, 2020; Rodrigues, 2022; Santos-D'Amorim, 2021). A specific point was made about the preprint relating to certain databases lacking an open infrastructure, which hinders sharing through servers and indexing platforms (Nassi-Calò, 2022).

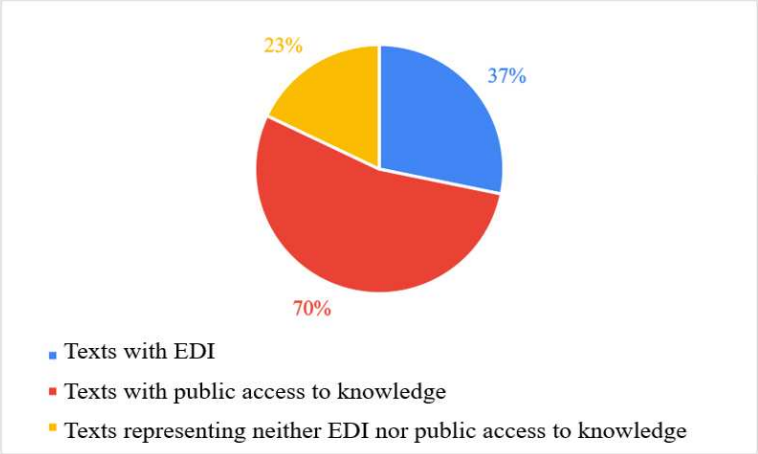
Various viewpoints on the future prospects of open science in the post-pandemic were discussed, ranging from enthusiastic reflections such as "the open access paradigm has hit the publishing market like a tsunami" (Spinak, 2020) to more measured perspectives. Among less optimistic analyses, some have raised whether open practices have been an exceptional regime during the pandemic. It is believed that this regime has been observed in both the Zika and Ebola epidemics, but the current model has demonstrated a notable level of resilience (Rodrigues, 2020). The Zika outbreak served as a catalyst for the need of prompt responses, prompting the utilization of open science rhetoric and methods (Bermúdez-Rodríguez et al., 2020; Rodrigues, 2020; Penido et al., 2022).

3.2 Public access to knowledge and EDI (Equity, Diversity, and Inclusion)

The material collected showed the presence or absence of mentions of EDI (Equity, Diversity, and Inclusion) or the need for people outside science to access scientific data and publications. It was considered that citations to these categories do not necessarily need to be linked to the pandemic, but could be present as context or as reinforcement to central arguments within publications in the sample.

Among the 30 texts analyzed, 36.6% (11) of the documents mentioned EDI, while 70% (21) of the sample cited public and universal access to knowledge. The texts could present both themes and were counted in both the EDI and public access categories (see Graph 1). Most of the materials that mentioned EDI also alluded to public access to knowledge, except when inclusion was mentioned as a characteristic internal to the scientific community, such as the linguistic and geographical diversity of scientific articles in open infrastructure databases. Seven publications (23%) in the sample have no mention of inclusion or public access and 77% had at least one of the categories.

Graph 1. Presence of arguments about public access, inclusion, and diversity in science



Source: The Authors (2023).

Concerning the materials with passages related to inclusion (36.6%), there were mentions of the need for open science to be allied to the struggle of social movements and other systems of thought (Rode, 2020), as well as embracing inclusive principles to “leave no one behind”

(Unesco, [n.d.])[3]. The relationship between citizen science and the open movement during the pandemic was also present in the sample with emphasis on the potential of publications using simple language to foster the co-production of knowledge, promoting an alliance between citizens and scientists in the production of evidence (Apóstolo; Silva, 2021). Open practices have also been cited as capable of consolidating social rights, such as the right to access scientific information and education (Ferreira, 2020).

Regional inequality in scientific production, with richer countries having more funds to pay publication fees, was cited (Silva, 2022). And, as a counterpoint to this trend of systems with more economic barriers to access, Brazilian open science – represented by platforms such as Ibict and SciELO – was mentioned as promoting greater regional and linguistic diversity in academic production (Amaro et al., 2020; Nassi-Calò, 2022; Penido *et al*., 2022).

Specifically in the relationship between inclusion and the context of the pandemic, it was highlighted that open practices in science can allow "global and equal access to treatments, medicines, and vaccines" (Rosa; Silva; Pavão, 2021, p. 16). The Covid-19 crisis has also included other actors in the open science movement and brought greater demand for barrier-free sharing of access to knowledge (UN, 2020). Furthermore, the social demand for more scientific information has brought about a convergence between education and open science in the pandemic (Ferreira, 2020).

The issue of public and universal access to knowledge was present in 70% of the documents. In some publications, the greater dissemination of scientific knowledge through open practices improves the public's perception of and trust in science (Ferreira, 2020; Santos-D'Amorim, 2021; Barata, 2022). It was also considered that opening up scientific data can make science "more socially responsible, and more aware of the consequences and social implications of the decisions made" (Silva, 2022, p. 141) and also "more connected to the needs of the population" (Rosa; Silva; Pavão, 2021, p. 3).Open practices have allowed political leaders to make decisions quickly (Rodrigues, 2022) and to exercise citizenship by promoting greater transparency (Apóstolo; Silva, 2021; Candido, 2023; Stueber; Silveira; Teixeira, 2022). Unesco documents also state that making scientific data available helps to combat disinformation (Unesco, 2020), with citizens being better able to "debunk false information" (Unesco, [n.d.]).

Scientific dissemination, when combined with open science practices, has been identified as fundamental for public access to knowledge during the pandemic (Ferreira, 2020; Santos-D'Amorim, 2021; Barata, 2022). There are mentions of how the sharing of open data and articles on social media has enabled the pandemic to be "debated and investigated in real-time and online by the scientific community and the public" (Ferreira, 2020, p. 7). More specifically, Twitter has played an important role in disseminating scientific articles beyond the academic community (Bermúdez-Rodríguez et al., 2020, p. 15-16).

It was pointed out that, during the pandemic, the search for competition and prestige in academic practice ended up giving way to a greater focus on research, which connected science with the public (Rodrigues, 2020), as well as showing the importance of open access for a "collaborative research culture" (Donato; Villanueva; Escada, 2020). In addition, the Covid-19 crisis revealed the "urgent need to bring science closer to decision-making and society" (UN, 2020) and; as evidence of a greater connection between scientists and society, studies cited the intense use of preprints as an example of the rapid dissemination of scientific knowledge beyond peers (Nassi-Calò, 2022; Penido *et al*., 2022). One of the texts referred to Aaron Swartz's "Guerrilla Manifesto for Open Access"[4]and recalled that not making information available to the public is directly related to the concentration of power (Cunha, 2020).

[3] In some passages with quotation marks, the reference does not contain page numbers because they are websites where page numbers do not apply, or presentations and files without this information.

[4] Available at: https://archive.org/details/GuerillaOpenAccessManifesto. Accessed on: 02/07/23.

4 DISCUSSION

Considering the first guiding question of this article, i.e., "how have open science narratives circulated in the pandemic in Portuguese documents?", it can be seen that open science practices were seen not only as relevant but as central to the control of Sars-CoV-2 (Amaro *et al*., 2020; Petrou, 2020; Rode, 2020; Santos-D'Amorim, 2021; Spinak, 2020). Such centrality places the open science movement with the social legitimacy to actually expand its potential and replace closed hegemonic practices in science, and not just be a marginal movement or one that is only partially operationalized when passing the cost of publishing in open access, for example, to authors. In essence, this type of practice increases inequalities in sciences as countries with less funding and resources for science continue to be underrepresented (Silva, 2022).

However, although a greater expansion of open science practices is possible due to the importance of the unconstrained rapid sharing of data during the pandemic, there was no debate in the sample about the ways in which this greater expansion could occur, or whether there are actual structural changes underway so that open science becomes stabilized as a practice beyond the Covid-19 scenario. What is observed is a situational justification for the movement as being necessary given the need for quick and effective measures to control the virus. Hence, we question whether open practices in science will only be adopted in regimes of urgency, in which there is a high social demand on the scientific community for rapid responses, or if they will continue to be justified once once the urgency has passed.

This association of open science with speed and the ability to provide quick answers could limit the use of open practices to moments of crisis. Thus, one question we identify is whether open and more collaborative practices in the scientific community end up being used as a central modus operandi in isolated scientific moments such as the pandemic and in some cases as means to ensure the survival of more closed practices in times of calm. Previous experiences indicate this strategic and punctual use of open practices. Authors have pointed out that the demand for rapid production of responses, in which open practices are used more centrally, is common in public health crises, as they were during the Zika and Ebola epidemics (Bermúdez-Rodríguez et al., 2020; Rodrigues, 2020; Penido *et al*., 2022). A suggestion, therefore, is that future research could consider how more structural changes in the pandemic have been set in motion in order to ensure greater permanence and expansion of open practices beyond specific demands.

In counterpoint, preprints point to the need for strategic use of open science practices beyond academic settings. Although preprints are publications that have been developing gradually, with manuscripts circulating before peer review in programs such as the Information Exchange Groups (IEGs) of the US National Institute of Health (NIH) in the 1960s; with another milestone being the creation in 1991 of the ArXiv.org platform (Cobb, 2017); in the pandemic, the circulation of this type of publication gains strength. About ten months after the first confirmed case of Covid-19 in 2020, 30,000 preprints on the new coronavirus were made available (Fraser *et al*., 2021); and, in Latin America, the first platform aimed at this type of publication was created in May 2020: SciELO Preprints (Mendonça; Tanigushi; Packer, 2022); and, further on, the EmeRI (Emerging Research Information) platform was launched in Brazil, as a specific demand of the pandemic, a partnership between ABEC (Brazilian Association of Scientific Editors) and Ibict (Brazilian Institute of Information in Science and Technology) (EmeRI, 2020).

However, as described in our sample, preprints are controversial. Publications with no prior peer review reach managers and journalists, as well as the general public, which has generated much debate about the use of this as yet unconsolidated data by non-scientists, pointing out the potential to generate misinformation (Fraser *et al*., 2021). We therefore

consider the preprint to be an open science initiative that ended up being central to the pandemic and not a marginal practice, with signs of this centrality remaining beyond the crisis. Before the pandemic, the biomedical sciences were still starting out in the culture of preprints, during and after the pandemic the practice became cultural (Fraser *et al.,* 2021). However, the future of preprints is still uncertain given the controversial debates being waged about their role in scientific communication (Oliveira *et al*., 2021).

As for allusions to non-scientist public access to knowledge, 70% of the material in the sample mentions this aspect, a percentage that corroborates the fact that the open movement has been associated with the availability of knowledge to the general public since its inception, an idea that is also present in important open science milestones, such as the Budapest (2002), Bethesda (2003) and Berlin (2003) declarations. Unlike these documents, however, which cite public access as a value without detailing the ways in which scientific knowledge can be understood and contextualized by the wider public, the context of the pandemic is beginning to bring about more concrete discussions about bringing science closer to society. In this respect, it should be noted that, in order to bring science closer to the wider public, it is not enough just to make scientific data available without economic barriers, but to bring together other social actors capable of promoting the circulation, understanding, and contextualization of the available data. In this sense, the sample analyzed shows scientific dissemination, preprint platforms and the combination of open knowledge with the use of social networks by scientists as an example of how the expansion of open science to a wider public depends on partnerships and a networked practice, with actors positioned to conduct dialogues with citizens.

Thus, with the discussion about access to scientific knowledge by non-scientists gaining momentum in the pandemic, we can see that the debate combining EDI (Equity, Diversity, and Inclusion) in open science is gaining more specific contours, albeit in an incipient way, with mentions in 36.6% of the texts analyzed. In addition to debates about the linguistic and geographical representativeness of articles, there are mentions related to the context of the pandemic, such as greater collaboration between science and society, with evidence being seen as a process in the making, with real-time debates in society being held with the production of evidence and materials being produced to facilitate this approach.

The idea of a science that is at the same time discursive, disputed, with diverse materialities (Latour, 2011; Latour; Woolgar, 1979) and not just a closed process that reaches the public only as a result, favors inclusion and initiatives for the co-production of knowledge. The need for a scientific community that is more permeable to society and with an influence on the course of the evidence production process was discussed in some documents with some discussions about citizen science and also the approximation of open science with scientific dissemination and education during the pandemic (Apóstolo; Silva, 2021; Barata, 2022; Ferreira, 2020) here, however, we did not see a structural movement, with some isolated cases being cited by documents, or with statements about the potential of open science to foster inclusion.

5 CONCLUSION

The analysis indicates that the debate on open science practices in the Covid-19 pandemic was central, which established a direct association between the speed with which Sars-CoV-2 control measures were adopted and the demand for more transparent and collaborative measures in science. However, it is questionable whether the association between "open practices and speed" could be a way of the open science movement being a one-off demand, associated with public health crises, given that such strategic activation of open practices has already occurred in previous epidemics, such as Zika and Ebola. The link between open practices and movements to bring science closer to society is demonstrated by the number

of documents (77%) that mention public access to knowledge, EDI (Equity, Diversity, and Inclusion) contexts, or both.

Specifically, about EDI, this debate is still incipient (with 36.6% of mentions); however, the pandemic has brought opportunities to increase and expand inclusion in science, brought by discussions and cases that show science being debated in real time, with the participation of broad sectors of society. Although this participation has generated controversial debates with the association between preprints and disinformation, especially with this material being accessed by the general public and journalists, future studies could look in more detail at how the deleterious effects of this access occurred and what practices could mitigate them. Some materials have begun to show signs of how the association between science communication and open science, as well as the relationship between open practices in science and education, can contribute to a scenario in which social participation and inclusion in science is not seen as the antithesis of qualified knowledge.

Beyond the pandemic, the open science movement must invest in guaranteeing the guidelines and practices proposed by Unesco and, with them, expand the culture of open science (Unesco, 2021). While there have been successful results in opening scientific knowledge and infrastructure over the last 20 years, contemporary challenges point to an open science that aggregates, recognizes and works to expand public access to knowledge, through practices and values of Equity, Diversity, and Inclusion.

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