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

Journal Pre-proof

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Impact of COVID-19 dentistry-related literature: An Altmetric study

Running title: COVID-19 and dentistry-related literature

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Conflict of interest

None disclosed.

ABSTRACT

Introduction: Scientific literature on COVID-19 grew rapidly during the pandemic. The aim of this study was to provide a comprehensive overview of the popularity on the Web of the available dental publications on COVID-19 and to examine associations between article characteristics, online mentions and citations.

Materials & Methods: An Altmetric Explorer search was conducted for COVID-19 articles published in dentaljournals by means of 3 keywords: “COVID-19”, “SARS-CoV-2” and “pandemic”. The following Altmetric data were collected: Altmetric attention score (AAS), mentions by news outlets, Tweets, Mendeley readers, and Web of Science citations. Additionally, article title, type, topic, origin andopen access status, journal title, quartile of impact factor (IF) distribution and time lapse between COVID-19 pandemic onset and publication date were analysed.

Results*:* 253 articles that had been published in 48 dental journals were eligible for the study. AAS was significantly influenced by article topic, type, origin and journal IF quartile. There was a negligible correlation between AAS and Web of science citations. Mendeley was the only Altmetric source highly correlated with citations.

Conclusions: There was a substantial online interest in COVID-19 dentistry-related literature as depicted by the AASs of the reviewed articles and social media metrics. Mendeley reader counts were highly correlated with citations, and they may therefore be valuable in research impact evaluation.

Keywords: COVID-19; social media; altmetrics; bibliometrics; dentistry

Introduction

On December 31, 2019, a cluster of severe pneumonia cases of unknown aetiology was reported by Chinese health officials in Wuhan city, Hubei Province, China.[1] Shortly after the announcement, a novel β-coronavirus (severe acute respiratory syndrome coronavirus 2; SARS-CoV-2) was detected as the causative agent for the coronavirus disease 2019 (COVID-19). In less than 3 months, COVID-19 has spread to 114 countries urging the World Health Organization (WHO) to declare a global pandemic.[2] Since then, COVID-19 has taken a heavy toll with more than 445 million confirmed cases worldwide including nearly 6 million deaths, reported to WHO.[3]

The extraordinary virulence and the scarcity of data on this new pathological entity forced researchers around the world to produce evidence within a limited time frame to support clinical decision making.[4] The dental community has been also active in producing and disseminating COVID-19 research from the beginning of the crisis, mainly dealing with the management of dental offices during the outbreak, infection control in the practice, diagnosis and treatment of oral manifestations related to COVID-19 and the effects of the pandemic on dental education and residency programs.[5] The increase in global academic productivity on COVID-19 has been demonstrated by several bibliometric analyses in dentistry.[5-7] However, those authors focused entirely on assessing the scientific impact of the published evidence by analysing article characteristics by means of traditional bibliometric indicators, e.g., citation rates. Newly introduced Web-based metrics known as altmetrics[8] enable the measurement of the spread of a scientific article through social media platforms, and therefore the appraisal of the literature from a broader perspective. Recently, altmetrics has been recommended to complement citation counts in evaluating the dissemination and impact of COVID-19 research articles.[9] Seeing that a comprehensive bibliometric-altmetric assessment of COVID-19 research in dentistry is currently lacking, the present study aimed to provide a holistic overview of the popularity on the Web of the available articles published in dental journals and investigate possible correlations between article characteristics, online mentions and citations.

Methods

Search engine

Altmetric Explorer (AE, Altmetric LLP, London, UK) is a user-friendly Web-based platform that enables comparative tracking and analysis of online conversations surrounding scientific publications. AE collects relevant attention around each piece of published research from a wide range of sources extending to policy documents, over 5,000 English and non-English global news outlets and 15,000 academic and non-academic blogs, online reference managers, post-publication peer-review forums, social media, patent citations, and online sources like Wikipedia, YouTube, Dimensions and Web of Science citations.[10] Each article is assigned with a score (Altmetric Attention Score; AAS) that represents a weighted approximation of the quantity and reach of attention it has received. AAS, type and amount of online engagement are graphically illustrated by the colour-coded Altmetric donut.[11]

Search strategy

Using an institutional subscription, an advanced search of the full Altmetric database was carried out on Wednesday, 16 April 2022 for research outputs related to COVID-19 in the dental literature by means of 3 keywords; "COVID-19", "SARS-CoV-2" and "pandemic". The following filters were selected: "1105 DENTISTRY" (subjects for classification), "Articles" (type of output), and "All outputs" (type of open access; OA). No time limits were applied regarding publication date and period in which Altmetric mentions were tracked.

Data collection

The search results generated by AE were saved and exported from the Research Outputs tab as a comma-separated values (CSV) file. All publications were screened for COVID-19 articles. We included publications which received Altmetric mentions and citations, and were published in English in dental journals included in Journal Citation Reports 2021 (JCR, Clarivate Analytics, Philadelphia, PA, USA) grouped under the subject category "Dentistry, Oral Surgery & Medicine" to ensure high

quality publication standards. Original research, reviews, short communications, concept/opinion/perspectives, commentaries, ethics articles, letters to the editor, editorials, technical notes, and case reports were considered for the purposes of the study. The following Altmetric data were collected for the outputs of each search query: AAS, news outlets and Twitter mentions, Mendeley readers, and Web of Science citations. Two researchers (K.D and C.L) read the abstracts of the articles finally included in the analysis and retrieved by consensus: article title, type and topic, journal title and quartile of impact factor (IF) distribution (Q1-Q4 or N/A; not assigned), time lapse between COVID-19 pandemic onset and online or print publication dates (0-12 months, 13-24 months), and origin of the affiliation of the corresponding author (country and continent). Article topics were classified as follows: impact on oral healthcare/attendance of oral healthcare settings, recommendations/practice management, diagnostic methods/infection control, oral manifestations of COVID-19/oral cancer, education, issues related to dental specialties or other. OA status (gold, closed, bronze, hybrid or green) was recorded as indicated by AE.

Statistical analysis

Statistical analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Graphical interpretation of normal Q–Q plots were used to determine the distribution of the data. For descriptive statistics, mean±SD, median (IQR) and n (%) were used for normally and non-normally distributed/categorical data, respectively. Independent samples t-test/one way analysis of variance (ANOVA) or Mann-Whitney U/Kruskal-Wallis H test, where appropriate, were used to analyse differences between groups. P-values of <0.05 were considered statistically significant. The correlation between different parameters was analysed with the Pearson or Spearman correlation coefficient, where appropriate. The correlation coefficients values were interpreted as follows: 0.00 to 0.30 (0.00 to -0.30), negligible correlation; 0.30 to 0.50 (-0.30 to -0.50), low (negative) correlation; 0.50 to 0.70 (-0.50 to -0.70), moderate positive (negative) correlation; 0.70 to .90 (-0.70 to -0.90), high positive (negative) correlation; 0.90 to 1.00 (-0.90 to -1.00), very high positive (negative) correlation.[12]

Results

The combined search originally yielded 492 articles in total. The original CSV file is available upon request. After removing 101 duplicates, the following articles were excluded from the study: 85 articles published in journals not listed in JCR, 8 articles without AAS and citations, 32 (product) news and patient communication, 6 authors' replies, 2 articles in non-English, 1 congress poster and 4 articles not related to COVID-19. Consequently, 253 articles were considered eligible for the study. Original research and letters to the editor were the prevailing article types (63 and 57 articles, respectively) followed by editorials (37 articles) and commentaries (31 articles). The distribution of articles per type is displayed in detail in Table 1.

The analysed articles were published in 48 dental journals. The Journal of Dental Education published most articles (30), followed by the British Journal of Oral & Maxillofacial Surgery (25), the British Dental Journal (19), and the Journal of Oral & Maxillofacial Surgery and Oral Diseases with 17 contributions each. More than 60% of the articles, namely 154 out of 253 articles, were published in Q3 and Q4 journals or journals without IF, whereas the top-ranked Q1 journals accommodated only 47 articles (18,6% of the included articles; Table 1). Bronze OA status was recorded in more than 70% of the publications, while 75% of the articles were published or appeared online within the first 12 months from the pandemic announcement (Table 1). Approximately 31% of the articles originated from USA, while UK and Brazil were second- and third-contributing approximately 7% each (36 and 35 articles, respectively). At continent level, 86 out of 253 articles came from affiliations located in North America, while 72 articles were produced in Europe, and 53 from Asian institutions (Table 1). The reviewed publications were assigned a mean AAS of 8.4 (SD: 51.55), were mostly discussed online by Mendeley readers (mean: 59.5 references, SD: 89.29), and received on average 6.1 Web of Science citations (SD: 18.13; Table 2). The article with the highest AAS, that is 785, was a commentary published in the British Dental Journal exploring the link between high bacterial load in the oral cavity and severity of SARS-CoV-2 infections (Supplementary Fig 1).[13] It was reproduced by 73 news outlets, 241 tweets and 332 Mendeley readers.

Topic, article type, article origin and IF quartile of the published article had a significant effect on AAS (Table 3). Specifically, studies on oral manifestations of COVID-19 and diagnosis or treatment of oral cancer related to COVID-19 had significantly higher median AAS compared to the rest ($p=0.018$; Fig. 1A). Reviews were the type of studies with significantly higher median AAS ($p=0.003$; Fig. 1B). Studies from Europe scored a significantly higher median AAS compared to studies from other continents ($p=0.04$; Fig. 1C). Studies published in Q1 journals had significantly higher AAS compared to studies published in journals in lower quartiles (Fig. 1C). The OA status of the journal and the time lapse did not influence the AAS of the studies ($p<0.05$; Supplementary Fig. 2). There was a negligible correlation between AAS and Web of Science citations ($\rho=0.25$; $p<0.001$). Additionally, citations were negligibly correlated with the number of Tweets ($\rho=0.12$; $p<0.01$), while there was a high positive correlation between citations and Mendeley readers ($\rho=0.76$; $p<0.01$). Table 4 summarizes all correlations between AAS, citations and online mentions.

Discussion

COVID-19 dentistry-related literature grew within a few months from a handful of manuscripts based on early experiences and existing knowledge[14,15] to a wealth of articles hosted in JCR-indexed journals. In accordance with previous results,[5] the most popular topics were recommendations/practice management, diagnostic methods/infection control and education. The peer-reviewed studies attracted more online attention compared to other altmetric studies in dentistry,[16-18] implying the intense interest of the general public and scholars in the available evidence-based literature on COVID-19.

Letters to the editor, editorials, commentaries and opinion articles dominated the selection of articles examined with nearly 6 out of 10 articles falling under these categories, indicating the relative lack of sufficient high-quality evidence to assist decision-making process.[6] Likewise, a bibliometric review of the COVID-19 literature in the top 20-ranked otorhinolaryngology journals showed that a redundance of comments and suggestions has been produced with editorials, letters to the editor and

commentaries accounting for 75% of the published articles.[4] Nonetheless, commentaries and letters to the editor reflecting personal experiences or institutional anti-COVID-19 strategies may be valuable in accumulating knowledge and warning against the pandemic, especially during the early stages of such an unprecedented crisis.

Despite the fact that letters to the editor and commentaries tend to attract less citations than original research contributions, 2 letters to the editors published in Clinical Oral Investigations and the Journal of Dental Research received more than 100 citations, namely 211 and 121, respectively, and can be considered as "citation classics". [19] The first letter highlighted the potential value of salivary diagnostics[20] while the second one drew attention to the assumed involvement of salivary glands in asymptomatic SARS-CoV-2 infections.[21]

In agreement with earlier bibliometric research,[6] the vast majority of publications resulted from either single countries or extensive collaboration between institutions of the same country. The highest level of international collaboration was achieved in a multi-centre study[22] aiming to evaluate the caries-control effectiveness of CariesCare International system adapted for the pandemic with non-aerosols generating procedures (non-AGP) and reducing in-office time. This 1-year multi-centre single-group interventional trial was conducted in 21 centres located in 13 countries while researchers from 24 countries were involved in authorship. The widest extent of collaboration among domestic affiliations was observed in the United States, where 11 institutions developed together an oral and maxillofacial surgery curriculum residency program to address the challenges of the pandemic.[23]

Similar to the study of Soltani et al.,[5] USA, UK and Brazil were the leading countries in COVID-19 research published in dental journals. The fact that the abovementioned countries - together with India - present the highest numbers of confirmed deaths worldwide[24] may account for their outstanding research performance. When comparing countries by original research articles, contrary to Brazil, USA and UK remained at the top of the list. Interestingly enough, 26 out of 35 Brazilian publications were commentaries and letters to the editor. Likewise, India the No 4 in the overall ranking on research productivity, contributed only 1 original research article. Since China was the epicentre of pandemic's start and Italy was the first European country severely hit by COVID-19, it might have been expected that those countries would have been frontrunners in dental research related to COVID-

19,[6] but our study could not confirm this. Differences between studies in the number of databases, language of publication or type of journals reviewed may additionally be held accountable for the observed productivity disparities between countries.

A paradoxical finding observed was the eagerness of some authors to share identical standpoints in the form of letters and commentary articles hosted by different journals.[4] From this perspective, some researchers affiliated with institutions in South America appeared to have co-authored up to 4 comment articles and letters in order to communicate their COVID-19 concerns and recommendations for their specialties.

Articles published in Q1 journals were significantly more popular on social media platforms than lower profile journals in contrast to a previous altmetric analysis of the non-COVID-19 dental literature.[25] Hypothetically, the emergency nature of the outbreak prompted massively social media users and/or readers of the highest IF dental journals to share online published COVID-19 articles.

The significantly higher AAS assigned to studies on oral manifestations of COVID-19/diagnosis and treatment of oral cancer during the pandemic compared to other topics may be clarified by the high levels of online attention to oral cancer identified by prepandemic studies.[26,27] Unlike findings on the long-term effect of OA on the social impact of dental journal articles,[28] there was no influence of OA status of the journals on the AAS of the articles. This might be explained by the fact that more than 50 publishers are making nowadays their coronavirus-related articles directly accessible in PubMed Central facilitating text mining and secondary analysis.[29]

In line with Altmetric studies in other dental fields,[17,18,25,30,31] the correlation between AAS and citation was negligible. Based on these results, AAS should not be used in assessing the citability of COVID-19 research articles published in dental journals. Tweets targeting COVID-19 dental literature were also poorly correlated with Web of Science citations. Tweets are often posted by people outside the science sector who most likely, as nonexperts, fail to evaluate properly the quality of articles, and therefore engage with articles less approved by scholars.[32] Our study confirmed also the common finding in similar articles that Mendeley readership is the Altmetric source with the highest correlation with citations.[32,33] Contrary to the other social networks monitored by AE, Mendeley audience refers largely to academics and researchers. Most of these users responded in a

survey to have read and cited or intended to cite most of the research outputs included in their Mendeley library.[34]

To the authors' knowledge, this is the first integrated bibliometric analysis of COVID-19 articles published in dental journals combining altmetrics and citations. Theoretically, the actual volume of the dental scientific literature on COVID-19 might have been underestimated due to non-inclusion of national databases indexing journals in other languages than English. Nevertheless, since all eligible manuscripts published in journals listed in JCR were investigated, the present study seemingly provides compelling evidence on the status and trends of the bulk of COVID-19 dental articles fulfilling certain quality standards.

Conclusions

- Dental articles on COVID-19 attracted considerable attention by social media users.
- AAS was significantly influenced by article topic, type, origin and journal IF quartile.
- There was a negligible correlation between AAS and citations of COVID-19 articles published in dental journals.
- Mendeley reader counts may offer early evidence of the scientific impact COVID-19 articles published in dental journals.

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Table 1 Distribution of articles per article topic, type, origin, OA status, time lapse between pandemic onset and publication and dental journal IF quartile

		N	%
Topic	Impact on oral health/Attendance of oral healthcare settings	31	12.3
	Recommendations/Practice management	50	19.8
	Diagnostic methods/Infection control	44	17.4
	Oral cancer/Oral manifestations of COVID-19	22	8.7
	Education	33	13.0
	Issues related to dental specialties	31	12.3
	Other	42	16.6
Type	Letter to the editor/Commentary/Opinion	107	42.3
	Editorial	37	14.6
	Original research	63	24.9
	Review	10	4.0
	Short communication	26	10.3
	Other	10	4.0
Origin	North America	86	34.0
	South America/other	40	15.8
	Europe	73	28.9
	Asia	53	20.9
	N/A	1	0.4
Time lapse	0-12 months	190	75.1
	13-24 months	63	24.9
OA status	Gold	18	7.1
	Closed	38	15.0
	Bronze	185	73.1
	Hybrid	6	2.4
	Green	6	2.4
Journal IF Quartile	Q1	47	18.6
	Q2	52	20.6
	Q3	73	28.9
	Q4/other	81	32.0

Table 2

	Median	IQR	Mean	SD
AAS	2	4-1	8.4	51.6
News	0	0-0	0.5	4.9
Tweets	2	4-1	5.7	19.9
Mendeley readers	33	74-15	59.5	89.2
Citations	1	4-0	6.1	18.1

Descriptive statistics of AAS, online mentions per Altmetric source and citations of the articles examined in the study. Although data do not follow a normal distribution, mean values and SD are also shown to allow comparison with similar studies (IQR, interquartile range = Q3-Q1; SD, standard deviation)

Table 3 Distribution of AAS per article characteristic and intra-group comparisons. Although data do not follow a normal distribution, mean values and SD are also shown to allow comparison with similar studies (IQR, interquartile range = Q3-Q1; SD, standard deviation)

Topic	AAS (median)	IQR	AAS (mean)	SD	P value
Impact on oral health/Attendance of oral healthcare settings	2	5-1	3.9	4.5	
Recommendations/Practice management	2	4-1	20.1	110.6	
Diagnostic methods/Infection control	2	12-1	13	35.5	0.018
Oral manifestations of COVID-19/	2.5	5-1	6.4	11.2	
Oral cancer					
Education	1	3-1	2.8	3.2	

Issues related to dental specialties	1	2-1	3	4.5	
Other	1	2-1	2.4	2.8	
Type					
Letter to the editor/ Commentary/ Opinion	1	3,5-1	12.5	76.5	
Editorial	2	4-1	4.6	7.1	
Original research	2	4-1	7.2	26.2	0.003
Review	7.5	12-2	8.3	7.5	
Short communication	1	2-1	2	2.8	
Other	1.5	5-1	3.9	4.8	
Origin					
North America	1	4-1	5.3	13.8	
South America/other	1.5	3-1	2.4	2.7	0.04
Europe	2	7-1	16.0	91.5	
Asia	1	3-1	7.3	29.0	
N/A	-	-	-	-	
OA status					
Gold	1.0	3-1	2.2	2.0	
Closed	1	2-1	3.7	8.5	0.109
Bronze	2	4-1	10.3	60.1	
Hybrid	1.5	4-1	3.5	4.0	
Green	2.5	10-1	5.0	5.3	
Time lapse					
0-12 months	2	4-1	9.1	57.6	0.46
13-24 months	1	3-1	6.5	26.1	
Journal IF Quartile					
Q1	3	10-1	8.7	18.7	0.0001
Q2	1	2-1	6.6	28.8	

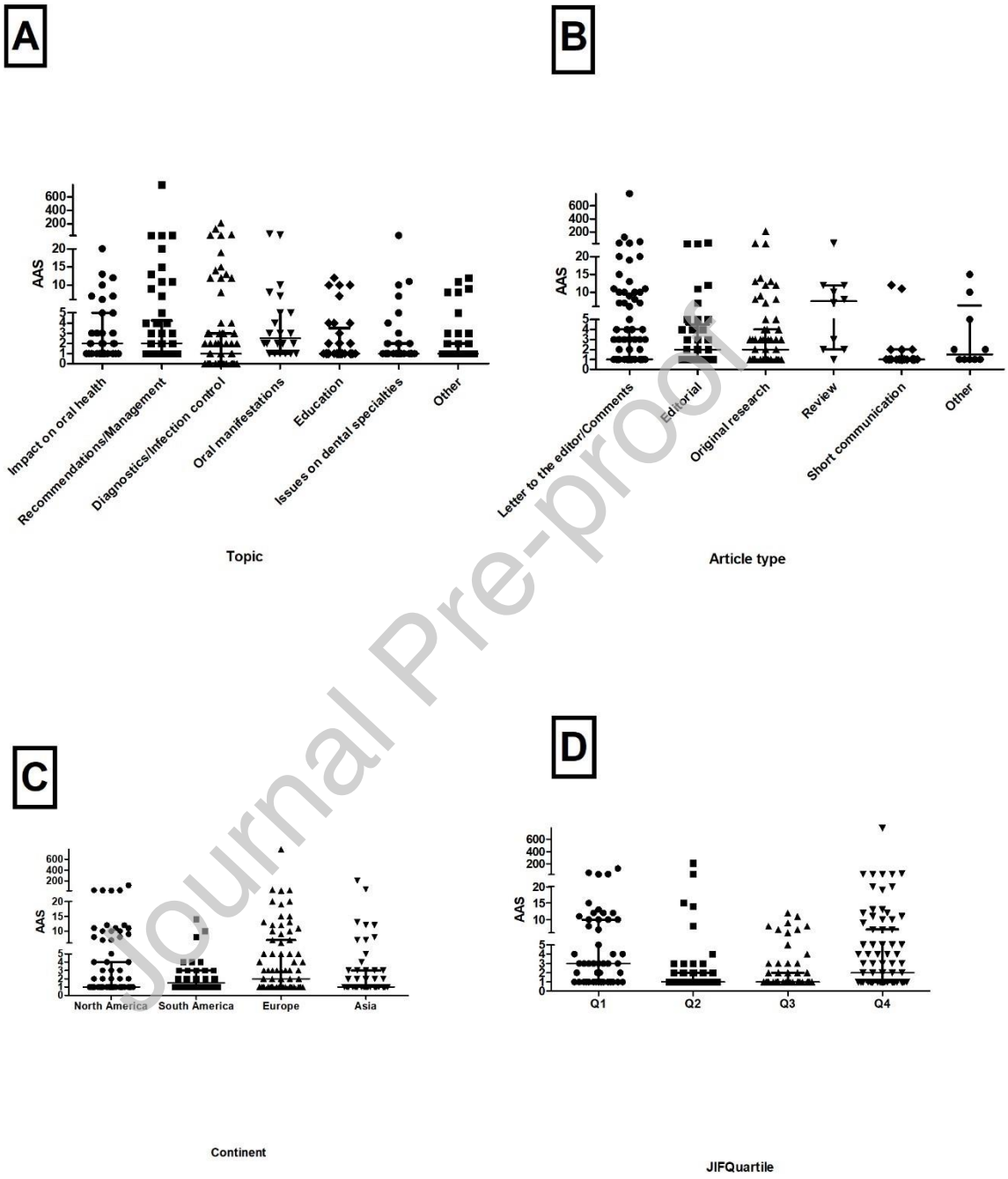
Q3	1	2-1	2.3	2.4
Q4/other	2	7-1	15.0	86.9

Correlations

			AAS	News	Tweets	Mendeley readers	Citations
Spearman's rho	AAS	Correlation Coefficient		0.52	0.68	0.24	0.25
		Sig. (2-tailed)		0.000	0.000	0.000	0.000
	News outlets	Correlation Coefficient			0.14	0.07	0.13
		Sig. (2-tailed)			0.029	0.257	0.045
	Tweeters	Correlation Coefficient				0.20	0.120
		Sig. (2-tailed)				0.002	0.002
	Mendeley readers	Correlation Coefficient					0.76
		Sig. (2-tailed)					0.000

Table 4 Correlations between AAS, online mentions and citations

Fig. 1 Distribution of AAS in relation to: A. topic; B. article type; C. continent of origin and D. JIF quartile of the articles (black horizontal lines indicate medians)



Supplementary Fig. 1 Altmetric donut of the highest-AAS achieving article. AAS is presented in the centre of the graphic. Colour and thickness of the stripes indicate the type of Altmetric source and the frequency of mentions in each source, respectively (RED, news; ORANGE, blogs; GREEN, YouTube; LIGHT BLUE, Reddit; BLUE, Twitter; DARK BLUE, Facebook)

Supplementary Fig. 2 Distribution of AAS in relation to: A. OA status and B. time lapse between COVID-19 pandemic onset and online or print publication dates of the articles (black horizontal lines indicate medians)

Declaration of interests

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

Yours sincerely and on behalf of all co-authors,

Konstantina Delli