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Editorial

Emergence of the metaverse and ChatGPT in journal publishing after the COVID-19 pandemic

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The "COVID" President, from 2020 to 2022

As soon as I took office as president of the Korean Council of Science Editors (KCSE) on January 17, 2020, the COVID-19 pandemic began. Therefore, most workshops and seminars held by the KCSE were operated online. The training programs designed were all executed without any difficulties. There were four workshops in 2020, 11 in 2021, and nine in 2022. The editors and staff of the KCSE's member institutes participated in these events more actively than before the COVID-19 pandemic, and the number of participants increased. Even before the pandemic, scholarly journal publishing had already been digitalized and implemented online through manuscript management systems (e-submission systems); therefore, the pandemic did not cause operational problems. The number of submissions during the first year of the COVID-19 pandemic soared, especially in the medical field [1] and on the topic of COVID-19 itself.

Many scientific articles have helped medical professionals care for persons infected with COVID-19. Therefore, scientific journals received a very high level of recognition as a valuable resource for society as a whole during this critical pandemic. I am delighted to see that scientific, technological, and medical journals in Korea have played a pivotal role in combating COVID-19, and I am proud to have served as the president of the organization of those journal editors for 3 years. I applaud our members for their devotion to journal publishing as editor-publishers [2]. As I complete my term as president, I would like to emphasize two emerging trends in journal publishing: the metaverse and artificial intelligence. Regarding the latter topic, I wish to discuss ChatGPT and some issues related to its use in scholarly publishing.

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Adoption of the Metaverse for Editors' Meetings and as a Journal Platform

With the increasing frequency of online meetings and events, the metaverse has become an emerging topic. At my university, Hallym University in Korea, professors received training on how to use the metaverse for educational applications, which can be categorized into four types: augmented reality, lifelogging, mirror worlds, and virtual reality [3]. As an example of how the metaverse has been used in a professional context, the European Association of Science Editors opened its annual meeting and conference in the metaverse—specifically, GatherTown—a virtual conference venue. I was able to participate in the conference with my avatar. Although it was challenging to attend all sessions at the conference due to time zone differences, it was possible to understand the presentations. A strength of the metaverse is that it makes it possible to attend a meeting in any region and have discussions with other attendees, since they are nearby in a certain virtual space. Attendees can find others by navigating through space in the metaverse. For the KCSE's annual meetings and conferences, the metaverse was not adopted due to difficulties explaining it to editors. However, it would be worthwhile to try this new event format soon because most editors are now familiar with the online meeting format.

In the virtual world, a simulation outcome can be displayed in real time as if a three-dimensional object exists in front of us. If viewers can view the object from any angle, they will have a better and more comprehensive understanding of the content. If the three-dimensional structure is essential for readers to understand the content, journal publication in the metaverse is a suitable alternative [4].

Emergence of ChatGPT—an Artificial Intelligence Chatbot

New trends in journal publishing and editing include artificial intelligence platforms or programs. Various artificial intelligence-assisted tools for scholarly journals have already existed for some time, assisting in information retrieval, writing and editing, citation management, review, plagiarism checks, and journal selection [5]. A recent striking tool is ChatGPT—an artificial intelligence (AI) chatbot—operated by OpenAI since November 30, 2022 [6]. ChatGPT answers questions in a conversational style. How can ChatGPT be used for journal publishing and editing? It cannot provide appropriate answers for information retrieval, citation management, peer review, and plagiarism checks. However, it will be helpful in writing, editing, journal selection, and references recommendation. Its answers to specific queries are somewhat reasonable, so that authors can use ChatGPT for descriptions in the Introduction section, which includes the definition of relevant terms and the conceptual background. Paraphrasing is also possible, and the quality is acceptable. ChatGPT's translation ability is good, although it is not perfect or top-tier level. Non-native English speakers can benefit from ChatGPT, although other popular translation tools also exist, including Papago (https://papago.naver.com) and Google Translate (https://translate.google.com). English proofreading is also possible, and ChatGPT can be helpful in this regard. When I asked ChatGPT for English proofreading, the results were 10 times better than the original manuscript, as evaluated by the Grammarly premium version (Grammarly Inc) (Suppls. 1, 2, and Fig. 1). A professional English editor stated that "It can certainly help fix mechanical grammar problems and make some texts sound more natural in English, but it does not do a good job of detecting when things do not make sense or when there are problems in a logical flow. One also has to be very careful to prevent it from paraphrasing too aggressively, because ChatGPT is excellent at creating new texts that sometimes omit important details. For example, it could do a very good job of summarizing a 250-word abstract into a single paragraph, but that is not always what is needed or appropriate" (Andrew Dombrowski, PhD, Compecs Inc, email communication, January 27, 2023). Although the manuscript was first proofread using ChatGPT, it was finally published after further proofreading by professional native English speakers [7].

ChatGPT can suggest an appropriate journal for submission when the main text is included in the inquiry. It can also recommend core reference articles or data for writing an article or conducting research on a specific field or topic; thus, it can help researchers save time in searching the literature or identifying sources of data, although its answers are not perfect.

Would editor training be another potential field where ChatGPT can be used? Since many society journal editors are not full-time editors, but voluntary editor-publishers, novice editors are faced with the need to learn many terms in journal publishing. If they have difficulty understanding those new terms, inquiring with ChatGPT may be constructive if ChatGPT can provide precise and reasonably accurate answers. To assess its ability to do so, I queried ChatGPT on 58 terms related to digital standards from January 19 to 21, 2023 (Suppl. 3). The answers given by ChatGPT are listed in Suppl. 4. Out of ChatGPT's 58 responses, 42 (72.4%) were reasonable and helpful for editors. However, 16 answers (27.6%) remained that were insufficient or incorrect (Suppl. 3). Therefore, it is not possible to recommend that novice editor-publishers get help from ChatGPT for terms related to the digital standards of journal publishing. In Suppl. 4, 16 inappropriate answers are marked in red text with strikethrough.

Similarly, unreasonable or incorrect answers were also found in ChatGPT's knowledge and ability to interpret questions on a parasitology examination in a medical college [7], where ChatGPT answered 48 out of 79 items (60.8%) correctly. Even among the 48 correct answers, seven explanations (14.6%) required revision. Thus, ChatGPT's answers are not very acceptable for knowledge specific to a certain field. Therefore, if authors consider citing ChatGPT's answers in their manuscripts, they should meticulously check the veracity of the answers.

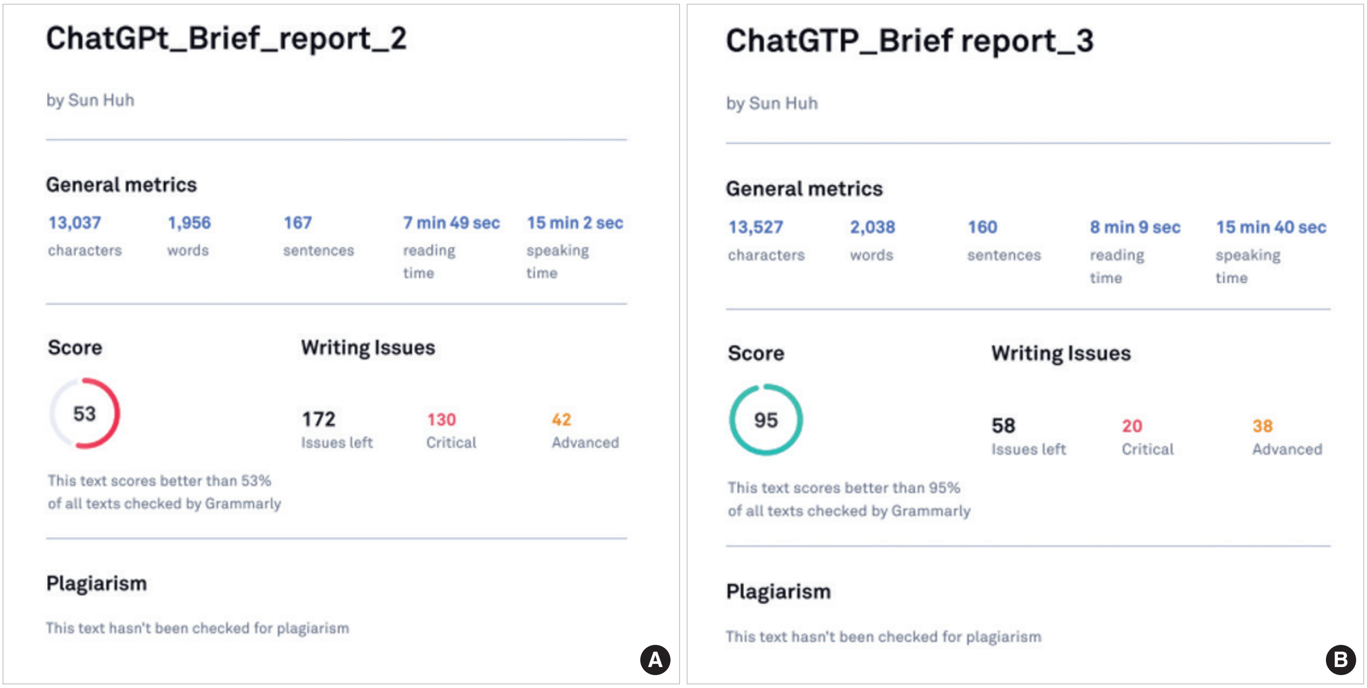

Fig. 1. Grammarly scores before and after English proofreading of the manuscript by ChatGPT. ChatGPT_brief_report_2 (A) is the result of before proofreading by ChatGPT (B).

Is ChatGPT Eligible to Serve as an Author?

Some publishers or editors do not allow ChatGPT as an author or co-author [8], citing as a reason the fact that ChatGPT could not fulfill the authorship criteria because it could not take legal responsibility. There is a debate on ChatGPT's authorship eligibility. I currently do not consider ChatGPT eligible to be an author, primarily because "an AI chatbot cannot be an author of a copyrighted work, and the text automatically generated by an AI chatbot cannot be a copyrighted work" [9].

A newer and more powerful AI systems may emerge in the near future. If that is the case, the scientific community will need to carefully consider any new technologies that appear.

How to Cite ChatGPT's Answer in an Article?

Besides authorship, content generated as a response by ChatGPT can be cited in the text. An important problem, however, is that there is no consistent answer to the same inquiry according to the version or time change; furthermore, there is no archiving site for ChatGPT's answers. Therefore, it is recommended to list the answer as a supplement to enable readers to check the work done by ChatGPT as follows:

Suppl. 1. Answer of ChatGPT (2023 Jan 9 ver.) to the inquiry, "What is the definition of an editor-publisher?" (cited 2023 Jan 19, 8:30 PM [Seoul time])

Appreciation to KCSE Board Members and Editors, and Staff of the Member Institutes

Despite the difficulties of the COVID-19 pandemic, which has changed our lives and routines over the past 3 years, I am pleased to have completed my duties as the fourth president of KCSE and hand over my responsibilities to Professor Kihong Kim of Ajou University. It is also a source of great pride that Professor Kihong Kim has participated in Crossref as a board member and raised international recognition of KCSE [10]. Fortunately, over the past 3 years, current account surpluses have improved the organization's fiscal status. I would like to finish my retirement address by expressing profound gratitude to the board members and editors of all member organizations who have shared moments of joy and pain for the past 3 years.

Conflict of Interest

Sun Huh was the president of the Korean Council of Science Editors from January 17, 2020 to January 13, 2023, but had no role in the decision to publish this article. No other potential conflict of interest relevant to this article was reported.

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Supplementary Material

Supplementary files are available from the Harvard Dataverse at https://doi.org/10.7910/DVN/LBB7QS.

Suppl. 1. Manuscript before English proofreading by ChatGPT.
Suppl. 2. Manuscript after English proofreading by ChatGPT.
Suppl. 3. Fifty-eight terms on digital standards of journal publishing (queried via ChatGPT) and the acceptability of its answers.
Suppl. 4. Answer of ChatGPT (2023 Jan 9 ver.) to 58 topics on digital standards of journal publishing (cited January 19, 2023, 8:30 PM–January 21, 2023, 21:00 PM [Seoul time]).

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Editorial

Presidential address

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I am honored to be taking on the role of the fifth President of the Korean Council of Science Editors (KCSE) for the next 3 years. The COVID-19 pandemic, which has plagued the world for the past 3 years, appears to be coming to an end. Even during the pandemic, the KCSE has persistently worked toward achieving its goal of elevating Korean science, technology, and medical journals to meet global standards by improving their editing and publishing abilities.

The field of academic journal publishing is undergoing accelerated change and innovation on a global scale. Advanced IT technologies such as artificial intelligence are being widely adopted, and institutional changes leading to the swift expansion of open access publishing are taking place. Rapid growth is being observed in preprint and data publishing, and there are increasing community efforts to maintain the publicness and sustainability of academic information archives. The KCSE will lead efforts to rapidly introduce and implement these new changes in Korea, just as it has been doing consistently over the past 12 years. Since its establishment in 2011, the KCSE has developed into a significant organization with both local and international impacts. Various renowned organizations at the forefront of changes in journal publishing frequently invite the KCSE to attend events and share our experiences and viewpoints. We plan to increase our involvement in international efforts and play a role in shaping the global journal publishing culture. *Science Editing*, the official journal of the KCSE launched in 2014, serves as a venue for presenting material directly relevant to editing and publishing and for fostering discussions among editors, authors, reviewers, and publishers. This journal has evolved into an internationally recognized publication, having featured many unique and excellent articles. Together with Professor Jaegyun Park, who will be assuming the position of the incoming Editor-in-Chief, we will do our best to advance the journal and establish it as a leading publication in its field.

Academic journals reflect the scholarly endeavors of researchers and serve as important records of human civilization. The advancement of academia and the development of academic journals are interdependent and cannot be separated. Journals in Korea have recently undergone substantial improvements, yet there remain numerous deficiencies compared to those in leading countries. The KCSE will constantly endeavor to improve Korean academic journals through collaboration with its members and editors.

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Review

Can an artificial intelligence chatbot be the author of a scholarly article?

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Abstract

At the end of 2022, the appearance of ChatGPT, an artificial intelligence (AI) chatbot with amazing writing ability, caused a great sensation in academia. The chatbot turned out to be very capable, but also capable of deception, and the news broke that several researchers had listed the chatbot (including its earlier version) as co-authors of their academic papers. In response, *Nature* and *Science* expressed their position that this chatbot cannot be listed as an author in the papers they publish. Since an AI chatbot is not a human being, in the current legal system, the text automatically generated by an AI chatbot cannot be a copyrighted work; thus, an AI chatbot cannot be an author of a copyrighted work. Current AI chatbots such as ChatGPT are much more advanced than search engines in that they produce original text, but they still remain at the level of a search engine in that they cannot take responsibility for their writing. For this reason, they also cannot be authors from the perspective of research ethics.

Keywords

Authorship; Artificial intelligence; Chatbot; Copyright; Research ethics

Introduction

An artificial intelligence (AI) chatbot, called ChatGPT [1], which can generate human-like text, was released by OpenAI in November 2022 and has since become a global issue. In education, concerns have arisen about students using this amazing chatbot to complete assignments [2]. It was also reported that this chatbot was listed in academic papers as a co-author [3]. Opinions were formulated about the need for guidelines for the use of AI chatbots in scientific writing [4]. In response to these concerns, *Nature* has added the following to its existing editorial policies [5,6]:

> Large Language Models (LLMs), such as ChatGPT, do not currently satisfy our authorship criteria. Notably an attribution of authorship carries with it accountability for the work, which cannot be effectively applied to LLMs. Use of an LLM should be properly documented in the Methods section (and if a Methods section is not available, in a suitable alternative part) of the manuscript.

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Science has also stated that it will specify in its license and editorial policy that ChatGPT-generated output cannot be used and attributed in papers [7].

A broader issue remains, however—can chatbots be authors of academic papers and, if not, why not? Even if, as *Nature* states, chatbots cannot be authors of academic papers now, what about more advanced chatbots in the future? Journal editors may wonder about this. Therefore, this article deals with the issue of AI chatbots as authors from the perspectives of law and research ethics.

Ethics statement

As a literature-based legal study, approval by the Institutional Review Board and informed consent were not required.

Study design

This study addresses the issue of AI chatbot authorship both from the legal and research ethics perspectives. It relied mainly on current law, judicial precedents, and other legal literature, which were searched in various legal databases.

AI Chatbot Authorship from the Perspective of Copyright Law

In November 1981, a computer program called Racter was named as the author of a prose text that was published in the magazine *OMNI* [8]. Subsequently, Racter's book, the first written by a computer program, was published in 1984 [9]. Racter prompted substantial thought about AI and copyright issues [10]. Since then, with the development of the AI industry, many academic discussions have taken place about AI and authorship (and also inventorship). The question is, can the authorship of AI be acknowledged from the perspective of current copyright law? Copyright offices and courts in many countries have generally expressed negative opinions on this issue.

In some countries, the answer to this question can be found directly in their copyright statutes. For example, the Korean Copyright Act defines "a work" as "a creation that expresses the thoughts or feelings of a human being" and an "author" as "a person who creates a work" (Article 2(i), (ii)) [11]. Therefore, according to the Act, anything created by a nonhuman being cannot be a copyrighted work, and a nonhuman being cannot be an author. In other words, it is self-evident that an AI chatbot cannot be an author under Korean law. In other countries, where the copyright statute does not directly address this issue, courts and copyright offices interpret their copyright statutes as endorsing the so-called "human authorship principle" ("human creator principle" may be a more accurate expression), which means that for a work to be copyrightable, it must be created by a human [12–17].

As a representative example, in the 2018 case of Feilin Law Firm v Baidu, the Beijing Internet Court of China articulated that the report automatically generated by the Wolters Kluwer Database in the inquest process is not a copyrighted work because it was not created by a natural person and the Wolters Kluwer Database cannot be recognized as its author [15]. Chinese copyright law does not explicitly state that the creator of a work must be a human being. Nonetheless, the court, on the grounds that AI does not have the capacity to have a right, held that originality alone is not sufficient for a work to be protected and a copyrighted work must be created by a natural person [15].

Courts in the United States have also protected only works created by natural persons. For example, in the Monkey Selfies case, an animal rights group argued on behalf of Naruto (a 6-year-old crested macaque) that the monkey was the author and copyright holder of the photos at issue. However, the US Court of Appeals dismissed the complaint on the grounds that monkeys are not humans and therefore lack statutory standing under the Copyright Act [16]. In 2022, the US Copyright Office endorsed the principle of human authorship by affirming its previous decision to reject copyright registration for a two-dimensional artwork named "Entrance to Paradise," which was allegedly automatically generated by an AI program named Creativity Machine [12].

In 2021, the Copyright Office of India and the Copyright Office of Canada both accepted a copyright registration application where an AI painting app named Raghav was listed as a co-author of a painting titled "Suryast" [18–20]. However, it is too early to determine that the copyrightability has been recognized for a work automatically generated by AI, or that the co-authorship of AI has been recognized. At first, the Indian Copyright Office rejected the application for copyright registration with Raghav as the sole author, but the application was accepted later, when Ankit Sahni, the owner of Raghav, applied for copyright registration with himself and Raghav as co-authors [18]. Above all, copyright is a nonregistered right, which means that copyright automatically arises at the same time as the creation of a work, regardless of any formalities, such as copyright notice or copyright registration (Article 5(2) of the Berne Convention for the Protection of Literary and Artistic Works, hereafter the "Berne Convention") [21]. In other words, registration does not grant copyright; even if a work is registered with the Copyright Office, in the event of a legal dispute, the copyright of the work—and the status of the author and copyright owner—may be denied as a result of a court's deliberation.

In the current copyright regime, the author of a work becomes the first copyright holder (Article 5(1) of the Berne Convention) [20]. In this regard, the fact that AI is denied a legal personality and cannot be a copyright holder serves as a strong argument that AI cannot be an author. Another argument is that AI cannot exercise rights by itself, even if certain rights are granted to AI. For example, AI cannot decide by itself whether to exercise moral rights, such as the right to make the work public, the right to claim authorship of the work, and the right to integrity of the work, which are inalienable and exclusive to the author, unlike the economic rights of a work. In this respect, it is clear that AI cannot be an author under the current copyright regime. In addition, in a similar vein, AI cannot be an inventor [22,23].

Cases to be Distinguished

Journal articles and books have, in some cases, been authored by an institution or a group, and in other cases, writing is published under a pseudonym. What distinguishes these situations from occasions when chatbots are listed as authors?

Cases where an institution or organization is listed as an author

In some cases, the name of an institution or group is listed as the author of a book or academic paper. One may wonder whether this contradicts the principle of human authorship outlined above. In fact, it does not. Here, the institution or group named as the author may refer to all the natural persons belonging to it, or it may refer to a work made for hire (Articles 2(xxxi) and 9 of the Korean Copyright Act, Article 11(3) of the Chinese Copyright Act, Section 101 of the US Copyright Act [definition of a "work made for hire"], etc.) [11,24,25]

If all the people belonging to an institution or group contributed to the writing of a book or article, the name of the institution or group may be listed instead of listing all the names of the individuals. In this case, all the people belonging to the institution or group are considered co-authors. If a person employed by a research institution or research group writes an article as part of the business (i.e., research) of that institution or group, the institution or group may be the author or the first copyright holder as it is a work made for hire. A work made for hire means a work prepared by an employee within the scope of his or her employment. It should be noted that the concept and scope of a work made for hire may differ from country to country. In any case, it is common and preferable to list the names of all the individuals involved in writing the book or article in an appropriate place (such as in the acknowledgments, the author's information section, or the copyright page).

What should not be overlooked here is that the persons who wrote the book or article mentioned above are humans (natural persons). In Feilin Law Firm v Baidu, the court held that the report at issue was a work made for hire of the plaintiff Feilin Law Firm because it was found that the human employees of the plaintiff created the report at issue with the "assistance" of the Wolters Kluwer Database. If, instead, the above-mentioned report had been automatically generated by the Wolters Kluwer Database, as the defendant Baidu argued, the copyrightability of the report would have been denied, and therefore the court would not have been able to recognize the report as a work made for hire of the plaintiff [15]. In Shenzhen Tencent v Shanghai Yingxun, another case in China, the court acknowledged by the same logic that an article on the stock exchange was a work made for hire of Tencent [17]. These cases show that the principle of human authorship or a human creator must be complied with even in the case of a work made for hire.

Cases of publication under a pseudonym

A person may publish his or her writing under a pseudonym (for example, the name of a beloved pet). In fact, in the literary world, it is not unusual for authors to use pen names for various reasons [26]. In this case, the real author is known to the publisher but not to the public [26], and there is no intention to deceive the publisher or the public. From the perspective of copyright law, using a pen name or to maintain the anonymity of a work is also an exercise of the author's right to claim authorship [27]. In the case of academic papers, it is usual and desirable to accurately provide the names and affiliations of the authors to ensure the reliability of the paper and promote academic discussion. However, in exceptional circumstances where it is necessary to publish an academic paper under a pseudonym or anonymity, it is not impossible to do so with the permission of the publisher.

It is necessary to distinguish between publishing one's writing using a pseudonym and publishing an article under a fake author's name to make a non-author appear to be the author. The latter is based on the intention to deceive the journal that decides to publish the article, as well as the entire academic community. It is a clear violation of research and publication ethics [28], and also a crime according to Article 137(1)(i) of the Korean Copyright Act [11].

AI Chatbot Authorship from the Perspective of Research Ethics

Aside from the discussion on copyright law, from the perspective of research and publication ethics, the question remains of whether an AI chatbot can become an author of an academic paper. The answer to this question is, "it all depends."

The fact that AI cannot be an author under copyright law does not mean that an AI should never be listed as an author of an academic paper. This is because if a writing is not the work of a human, it may not be appropriate to attribute it to a human as an author.

Earlier, we saw the case of Racter, where an AI was actually attributed as the author. In the scientific community, a book authored by AI was published in 2019. The author of *Lithium-Ion Batteries*, introduced as the first machine-generated research book, is Beta Writer, an algorithm developed through a collaboration between Springer Nature and researchers at Goethe University [29].

From a legal point of view, writings generated by Racter and Beta Writer are not copyrighted works, and Racter and Beta Writer cannot be considered authors. Still, it was appropriate to publish the works under the names of "Racter" and "Beta Writer" because it would be against publishing ethics to publish such writings under the name of human beings. As the Beijing Internet Court mentioned as dicta in the case of Feilin Law Firm v Baidu, AI-generated outputs must not have a human being indicated as the author, whether the human being is the developer (owner) of the AI program or its user (a person who has rights and interests in the AI creation as determined by the court), and it must be indicated that the outputs were automatically generated by AI [15].

The publication of academic writing depends not on whether it is copyrighted, but on whether it can contribute to academia. As mentioned in the introduction to *Lithium-Ion Batterie*, written by one of the project directors, the reason why this book was published (i.e., the value of this book) did not lie in its content (i.e., the research results). In fact, the book contained many manifest flaws, such as grammatical errors. Rather, the real value of the book lay in the fact that "Beta Writer," which is not a human being, wrote a book on scientific research, which was expected to promote related discussions and future research. Likewise, if an editor thinks that an academic paper that was generated by an AI chatbot has some academic value, he or she may allow the publication of the paper credited to ChatGPT.

Then, why did major journals such as *Nature* and *Science* declare that AI chatbots cannot be authors of articles published in their journals? The reason can be found in *Nature's* editorial policies on authorship, which state, "[AI chatbots] do not *currently* satisfy our authorship criteria" (emphasis added) [5]. In other words, the reason why an AI chatbot cannot be an author is not just because AI chatbots are not human, but because the *currently available* AI chatbots do not meet the required qualifications for accountability. This also implies that an advanced AI chatbot in the future might meet the criteria for authorship of academic papers. It has also been pointed out that the fact that AI chatbots do not have the capacity to consent to the distribution of the paper is another reason why they cannot be considered authors [3], but this is only an argument from the perspective of copyright. From the perspective of research ethics, if an AI chatbot makes a significant contribution to research and can explain and prove the research results, it would be reasonable to recognize its authorship.

Today's most advanced AI chatbot seems to be able to play the role of a research assistant in much the same way as a search engine. Whereas a search engine provides only search results (a list of related literature), an AI chatbot can be considered a more advanced research assistant in that it provides its own answers to users' questions based on the related literature that it has learned. It is not reasonable to prevent a researcher from using a chatbot as a research tool and benefiting from the help it can provide, which would be similar to asking a researcher to perform arithmetic without a calculator. What is interesting is that ChatGPT, which has recently become a hot topic, cannot provide sources for its writings, and ChatGPT even has an unfortunate ability to provide fake information in a convincing way [30]. Therefore, AI chatbots such as the current ChatGPT are not "ideal" research assistants. A decent researcher would never fail to verify a text written by a research assistant who was good at writing, but also good at lying.

Conclusion

The current AI chatbot cannot be the author of an academic paper, not only from the perspective of copyright law but also from the perspective of research ethics. Although researchers can use AI chatbots as research tools, they must be aware that AI chatbots can be competent but dangerous research assistants, and the authenticity of any AI-generated text must be verified. Researchers should always remember that although using AI chatbots is exciting and full of potential, it also comes with heavy responsibilities.

Conflict of Interest

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Review

An algorithm for the selection of reporting guidelines

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Abstract

A reporting guideline can be defined as "a checklist, flow diagram, or structured text to guide authors in reporting a specific type of research, developed using explicit methodology." A reporting guideline outlines the bare minimum of information that must be presented in a research report in order to provide a transparent and understandable explanation of what was done and what was discovered. Many reporting guidelines have been developed, and it has become important to select the most appropriate reporting guideline for a manuscript. Herein, I propose an algorithm for the selection of reporting guidelines. This algorithm was developed based on the research design classification system and the content presented for major reporting guidelines through the EQUATOR (Enhancing the Quality and Transparency of Health Research) network. This algorithm asks 10 questions: "is it a protocol," "is it secondary research," "is it an *in vivo* animal study," "is it qualitative research," "is it economic evaluation research," "is it a diagnostic accuracy study or prognostic research," "is it quality improvement research," "is it a non-comparative study," "is it a comparative study between groups," and "is it an experimental study?" According to the responses, 16 appropriate reporting guidelines are suggested. Using this algorithm will make it possible to select reporting guidelines rationally and transparently.

Keywords

Reporting guideline; Research design; Biomedical research; Algorithms; Checklist

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Introduction

Background

The IMARD (introduction, methods, results, and discussion) is the most commonly used document format when writing scientific articles. In the introduction, the reason and purpose of the study are usually reported. In the methods section, the time, place, process, materials, and participants of the study are described. The answer to the research question and the meaning/impact of the current results are reported in the results and discussion section. In other words, scientific papers should include an appropriate report of the purpose, as well as information about the validity, usefulness, and meaning of the research [1]. There are many cases in which improper reporting (underreporting, Misreporting, and selective reporting) occurs in actual papers, lowering the validity of the research [2].

The purpose of reporting guidelines is to reduce these problems, and a reporting guideline can be defined as "a checklist, flow diagram, or structured text to guide authors in reporting a specific type of research, developed using explicit methodology" [3]. Reporting guidelines were actively developed after the publication of CONSORT (Consolidated Standards of Reporting Trials), a reporting guideline for randomized controlled trials (RCTs), and there are now more than 500 reporting guidelines that can be used by research authors in the medical field. Almost all reporting guidelines are searchable and available through the EQUATOR (Enhancing the Quality and Transparency of Health Research; http://www.equator-network.org) network.

Researchers are the main users of the reporting guidelines, which can be utilized when writing manuscripts and protocols. Numerous reporting guidelines have been developed, and it has become important to select the most appropriate reporting guideline for a manuscript to be reviewed. However, a system that recommends appropriate reporting guidelines through tools such as algorithms is not yet available.

Objectives

The purpose of this study is to suggest an algorithm for selecting reporting guidelines.

Background for an Algorithm for the Selection of a Reporting Guideline

The currently developed reporting guidelines do not apply to all scientific studies. The EQUATOR network specifies the scope of reporting guidelines as health research. However, a classification of the developed reporting guidelines indicates that the actual scope includes human subjects and *in vivo* animal experiments. Of course, these reporting guidelines can also be applied even to studies without human subjects, as long as they are conducted using the same methodology as in human subject research. For example, a study of the data-sharing policies of academic journals could be reported using the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guideline for reporting observational research, even though it is not a human subject study, since it can be viewed as a cross-sectional study. In the future, the scope of reporting guidelines may be expanded to other scientific fields.

Since the reporting guidelines developed to date deal with human subject research and *in vivo* animal experiments, an algorithm for selecting appropriate reporting guidelines can be suggested through a few questions.

Questions in the Algorithm for the Selection of Reporting Guidelines

Preliminary consideration

As mentioned above, since the reporting guidelines are limited to human studies and *in vivo* animal studies, it is necessary to review whether the research design of the manuscript under consideration corresponds to a human study or an *in vivo* animal study. If the answer to this question is "no," then no reporting guidelines have been developed to date. If the answer to the preliminary consideration is "yes," then an appropriate reporting guideline can be selected through the questions below.

- Is it a protocol?
- Is it secondary research?
- Is it an *in vivo* animal study?
- Is it qualitative research?
- Is it economic evaluation research?
- Is it a diagnostic accuracy study or prognostic research?
- Is it quality improvement research?
- Is it a non-comparative study?
- Is it a comparative study between groups?
- Is it an experimental study?

Is it a protocol?

In health research, a protocol is a written research plan. In the medical field, protocols are mainly prepared when conducting clinical trials or systematic reviews. The main reporting guideline for clinical trials is SPIRIT (Standard Protocol Items: Recommendations for Interventional Trials) [4], and the main reporting guideline for systematic literature reviews is PRISMA-P (Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols) [5].

Is it secondary research?

Research can be divided into primary and secondary research. Primary research is a research approach that directly collects data, and secondary research is a research approach that relies on existing data when conducting systematic investigations [6]. The main type of secondary research conducted in the medical field encompasses systematic literature reviews and clinical practice guidelines. The reporting guidelines suitable for systematic literature reviews are based on the PRISMA guideline [7]. Various extensions exist for PRISMA, including PRISMA-DTA (PRISMA for Diagnostic Test Accuracy) [8], PRISMA-ScR (PRISMA Extension for Scoping Reviews) [9], and PRISMA-S (PRISMA Extension for Reporting Literature

Searches in Systematic Reviews) [10]. The reporting guidelines suitable for clinical practice guidelines are AGREE (Appraisal of Guidelines, Research and Evaluation) [11] and RIGHT (Reporting Tool for Practice Guidelines in Health Care) [12].

Is it an *in vivo* animal study?

Animal studies include *in vitro* studies and *in vivo* studies. The term *in vitro*, which means "in glass" in Latin, describes diagnostic procedures, scientific tests, and experiments that are carried out by researchers away from a living thing. An *in vitro* experiment takes place in a sterile setting, such as a test tube or Petri dish. The Latin term *in vivo* means "among the living." It describes procedures, tests, and examinations that scientists carry out in or on a complete living organism, such as humans or laboratory animals [13]. In general, there are no appropriate reporting guidelines for *in vitro* studies, while the ARRIVE (Animal Research: Reporting of *In Vivo* Experiments) reporting guideline exists for *in vivo* studies [14].

Is it qualitative research?

Quantitative research deals with numbers and statistics when gathering and analyzing data, whereas qualitative research deals with words and meanings. The results of qualitative research are written to aid in understanding ideas, experiences, or concepts. A researcher can gain comprehensive knowledge on poorly understood subjects through this type of research. Common qualitative techniques include open-ended questions in interviews, written descriptions of observations, and literature reviews that examine concepts and theories [15]. Two major reporting guidelines for qualitative research are SRQR (Standards for Reporting Qualitative Research) [16] and COREQ (Consolidated Criteria for Reporting Qualitative Research) [17].

Is it economic evaluation research?

Economic evaluation research can be defined as "the process of systematic identification, measurement and valuation of the inputs and outcomes of two alternative activities, and the subsequent comparative analysis of these" [18]. For economic evaluation studies, the most appropriate reporting guideline is the CHEERS (Consolidated Health Economic Evaluation Reporting Standard) 2022 [19].

Is it a diagnostic accuracy study or prognostic research?

A diagnostic test accuracy study provides evidence on how well a test correctly identifies or rules out disease and informs subsequent decisions about treatment for clinicians, their patients, and healthcare providers who interpret diagnostic accuracy studies for patient care [20]. The reporting guideline used to report research on diagnostic accuracy is STARD (Standards for Reporting Diagnostic Accuracy Studies) [21].

In general, prognosis-related papers should be reported according to the observational study reporting guideline (STROBE), but in the case of a prognostic prediction model, it should be reported according to TRIPOD (Transparent Reporting of a Multivariable Prediction Model for Individual Prognosis or Diagnosis) [22].

Is it quality improvement research?

Quality improvement is the framework used to systematically improve care. To reduce variation, achieve predictable results, and improve outcomes for patients, healthcare systems, and organizations, quality improvement aims to standardize processes and structure [23]. For quality improvement studies, the most appropriate reporting guideline is SQUIRE (Standards for Quality Improvement Reporting Excellence) [24].

If the answer to question 8 is "no," the study design is an interventional study. An interventional research design is classified according to the questions of DAMI (Design Algorithm for Medical Literature on Intervention) [25].

Is it a non-comparative study?

According to the DAMI tool, the first question to ask is whether a study is analytical or descriptive. DAMI asks this question: "Were the primary outcomes compared according to intervention/exposure or the existence of a disease?" [25]. If the answer is "no," a study is descriptive, and the corresponding research design is a case report and a case series. Case reports and case series are generally classified according to the number of reported cases, and studies reporting three or more cases are classified as case series [26].

For case reports, the representative reporting guideline is the CARE (Case Report Guidelines) [27]. There are no leading reporting guidelines for case series. However, since case series are mainly published in surgical journals, it is possible for them to use reporting guidelines developed for various surgical fields, including general surgery (the PROCESS [Preferred Reporting of Case Series in Surgery] guideline) [28], as well as case group study reporting guidelines in the field of plastic surgery [29].

Is it a comparative study between groups?

Comparative studies can be divided into within-group and between-group comparative studies. A within-group comparison refers to repeated measurements of the primary outcome among the same individuals or group at different time points [25]. DAMI's question on this is, "Were the primary outcomes of different groups compared?" Research designs that correspond to a "yes" response to this question include before-after

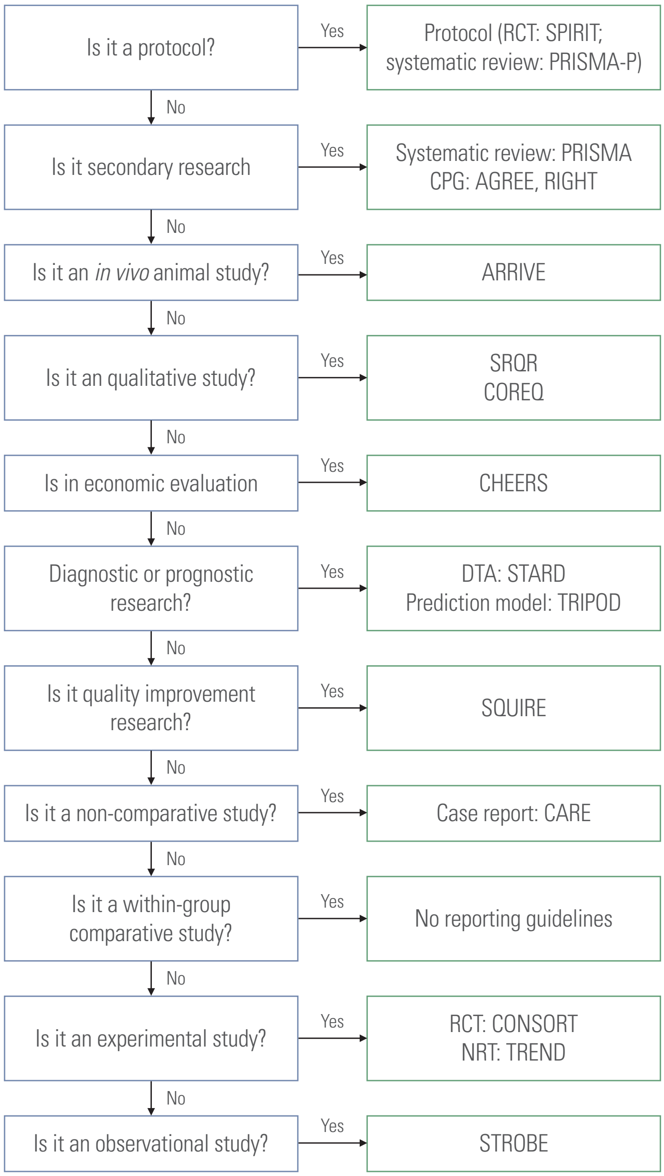

Fig. 1. Algorithm for the selection of reporting guidelines. RCT, randomized controlled trial; SPIRIT, Standard Protocol Items: Recommendations for Interventional Trials; PRISMA-P, Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols; PRISMA, Preferred Reporting Items for Systematic Review and Meta-Analysis; CPG, clinical practice guideline; AGREE, Appraisal of Guidelines for Research and Evaluation; RIGHT, Reporting Tool for Practice Guidelines in Health Care; ARRIVE, Animal Research: Reporting of *In Vivo* Experiments; SRQR, Standards for Reporting Qualitative Research; COREQ, Consolidated Criteria for Reporting Qualitative Research; CHEERS, Consolidated Health Economic Evaluation Reporting Standards; DTA, diagnostic test accuracy; STARD, Standards for Reporting Diagnostic Accuracy Studies; TRIPOD, Transparent Reporting of a Multivariable Prediction Model for Individual Prognosis or Diagnosis; SQUIRE, Standards for Quality Improvement Reporting Excellence; CARE, Case Report Guidelines; CONSORT, Consolidated Standards of Reporting Trials; NRT, nonrandomized trial; TREND, Transparent Reporting of Evaluations with Nonrandomized Designs; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology.

studies and interrupted time series research. Currently, there are no clear reporting guidelines for within-group comparative studies.

Is it an experimental study?

If the investigators determined study participants' exposure to interventions, then the study is classified as an experimental study. In such studies, investigators directly control the intervention time, process, and administration. If the study participants are exposed to specific interventions without the direct control of investigators, then the study is classified as observational [25]. DAMI's question on this is, "Did the investigators allocate study participants to each group?" If the answer to this question is "yes," a study is classified as experimental, and if the assignment is randomized ("Was the group randomized?"), it is classified as a RCT. For RCTs, the most commonly used reporting guideline is the CONSORT 2010 statement [30]. There are 33 extensions of CONSORT. Widely known and used examples include the reporting guidelines for clinical trials related to COVID-19 (the CONSERVE 2021 statement) [31], RCTs related to artificial intelligence (CONSORT-AI Extension) [32], and RCTs conducted using cohorts and routinely collected data (CONSORT-ROUTINE) [33].

There is no reporting guideline for nonrandomized clinical trials in general, although the TREND (Transparent Reporting of Evaluations with Nonrandomized Designs) statement exists for use in behavioral and public health intervention clinical trials [34]. For observational studies, the STROBE statement should be used as a reporting guideline [35]. When using STROBE, an appropriate sub-checklist should be used in accordance with the representative observational study design (cohort studies, case-control studies, and cross-sectional studies). The DAMI question corresponding to cross-sectional studies is, "Were the data for exposure to the intervention and for primary outcomes collected concurrently?" The question that distinguishes cohort studies from case-control studies is, "Was each group organized on the basis of exposure to the intervention?"

Algorithm for Selecting Reporting Guidelines

Based on the answers to the above questions, an algorithm was constructed, as shown in Fig. 1. This algorithm should only be used for studies of human subjects or *in vivo* animal studies.

Conclusion

Peer reviewers, authors, and journals frequently use reporting guidelines. Reporting guidelines raise the standard of research that is published in biomedical journals. To make the best possible use of reporting guidelines, it is necessary to select the appropriate reporting guideline for a given study. The algorithm for selecting reporting guidelines presented in this paper will be helpful for this purpose. If the research designs and scope of research to which reporting guidelines are applied are expanded, the algorithm will also need to be updated.

Users must take care to ensure that the numerous new reporting guidelines are developed with the same level of scrutiny and rigor as more established guidelines and that the interventions that result are meaningful.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Review

The current state of graphical abstracts and how to create good graphical abstracts

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Abstract

Graphical abstracts (GAs), also known as visual abstracts, are powerful tools for communicating complex information and ideas clearly and concisely. These visual representations aim to capture the essential findings and central message of a research study, allowing the audience to understand and remember its content quickly. This review article describes the current state of GAs, including their benefits, limitations, and future directions in the development of GAs. It also presents methods and tips for producing a GA. In Korea, more than 10 medical journals have introduced GAs from 2021 to 2022. The number of citations was higher in articles with GAs than in those without GAs in the top 10 gastroenterology journals. There are five types of GAs: conceptual diagrams, flowcharts, infographics, iconographic abstracts, and photograph-like illustrations. A limitation of the GA system is the absence of a universal standard for GAs. The key steps for creating a GA are as follows: (1) start by identifying the main message; (2) choose an appropriate visual style; (3) draw an easy-to-understand graphic; (4) use colors and other design elements; and (5) request feedback. Available tools that are useful for creating GAs include Microsoft PowerPoint, Mind the Graph, Biorender, and Canva. Another effective method is collaborating with experts. Artificial intelligence will soon be able to produce GAs more efficiently from raw data or manuscripts, which will help researchers draw GAs more easily. GAs have become a crucial art for researchers to master, and their use is expected to expand in the future.

Keywords

Artificial intelligence; Data visualization; Graphical abstract; Visual abstract; Infographics

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Introduction

Scientific research, including medical research, has experienced rapid changes in the last 20 years. First, the number of papers published online has rapidly increased, especially in SCIE (Science Citation Index Expanded) journals [1]. For example, 3,000 to 5,000 biomedical papers are published on PubMed every day, making it impossible to read all the papers (Fig. 1). Thus,

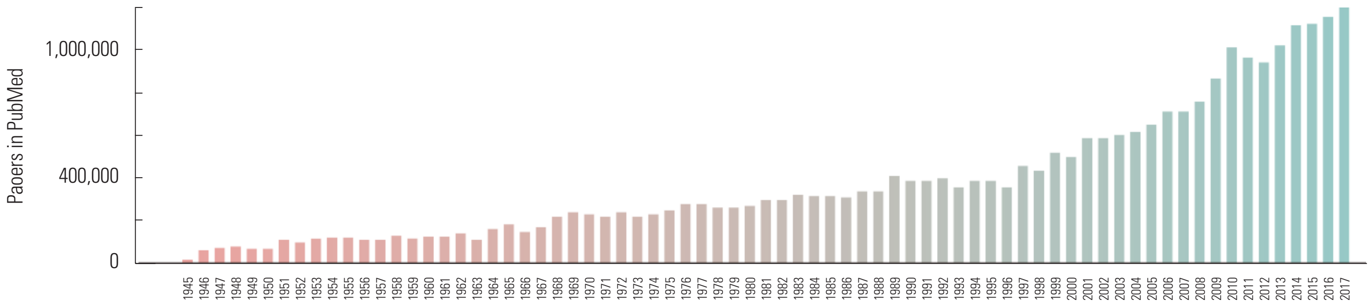

Fig. 1. Number of biomedical articles published in PubMed each year.

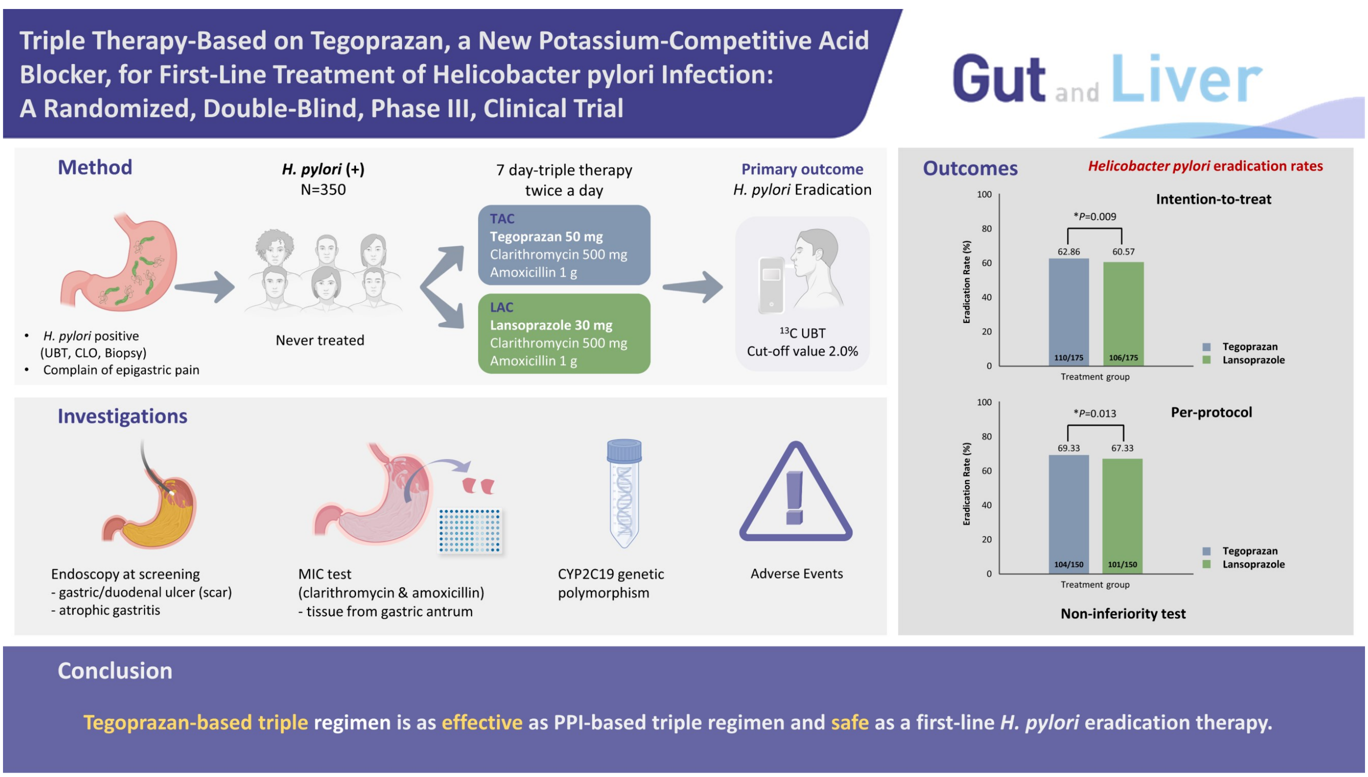

Fig. 2. Example of graphical abstract. Reprinted from Choi et al. [8], available under the Creative Commons License.

it has become increasingly difficult for researchers to quickly find the information they need. In addition, the number of SCIE journals has substantially increased, leading to an intensified impact factor war between various journals. Journals constantly contemplate effective methods to expose articles in their journals to researchers. This trend has further been intensified by the increasing number of open access journals [2]. Moreover, social media, such as Facebook and Twitter, has begun to play a more significant role in academic fields [3]. Closed approaches to information dissemination, such as academic conferences, were important in the past, but in recent years, a novel approach involving the open distribution of academic information through social media has emerged as an alternative [4,5]. Furthermore, with the rising trend of YouTube Shorts, succinct and compelling visual data have become more influential than traditional text [6].

Definition and History of GAs

A graphical abstract (GA) is a visual representation of the key messages of a research paper or scientific article [6]. It typically consists of a single image or figure that summarizes the main results of the study in a concise and coherent format (Figs. 2, 3) [7,8]. The goal of a GA is to quickly convey the key

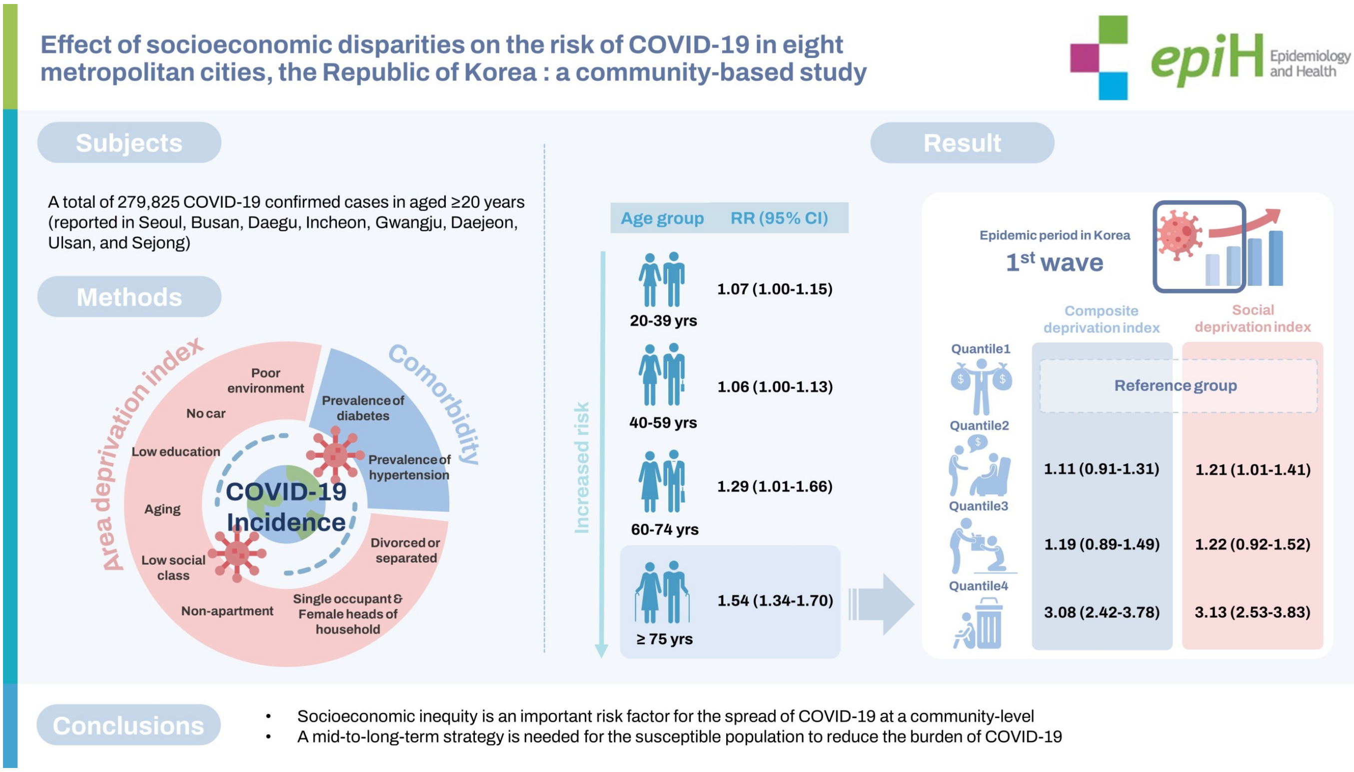

Fig. 3. Example of graphical abstract. Reprinted from Hwang et al. [9], available under the Creative Commons License.

takeaways of the research to a broad audience, including those who may not have the time or background to read the full article. Moreover, a GA should be differentiated from the other figures in an article.

GAs were introduced to academic journals in 2011, starting with journals in the field of chemistry [9]. Among medical journals, this trend was first started by Ibrahim et al. [10] in the *Annals of Surgery* in 2016. It is no surprise that GAs have become a changing face of journals, helping them to survive in the era of an overwhelming outpouring of SCIE papers, especially considering how dependent people are on visual processing. Because vision accounts for 87% of the five human senses, and color accounts for more than 60% of vision, GAs can effectively attract researchers' attention [11,12]. Therefore, the GA system can benefit both researchers and journals: researchers can quickly identify an article's relevance to their research just by skimming the GA, while journals can increase the number of article clicks and citations through GAs.

An increase in GAs has been observed in all academic fields. According to a study published by Yoon et al. [9] in 2017, the number of journals adopting the GA system increased by 350% from 2011 to 2015, a trend also evident in the fields of geography, sociology, psychology, economics, and political science. The same phenomenon was also observed in Korea: ever since the *Journal of Korean Medical Science* introduced the GA system in Korea, more than 10 medical SCIE journals based in Korea have introduced the GA system from 2021 to 2022, including the *Korean Journal of Internal Medicine* [13].

GAs have recently become an essential element that authors must create for publication in a journal. There has even been an increase in journals that require GAs at the first stage of submission. To sum up, authors must learn how to create GAs for successful publication and promotion of their research.

Whom Should GAs Target?

For whom GAs should be made is an important issue. Researchers need to know their readership to determine the terminology used and the level of difficulty of the GA. Since the birth of GAs is closely related to the rise of social media, which is mostly used by the general public, it is plausible to assume that the main readership of GAs is the general public. In such cases, GAs may stimulate further interest among the general public in researchers' study findings. Therefore, considerable thought and skill are needed to create simple GAs that target nonprofessionals and are suitable for wide distribution through the media. At the same time, considering that the general public is not very interested in professional scientific research, it is also likely that professional researchers are the main readership of GAs. In this case, producing a detailed GA that uses professional terminology is effective for disseminating the study. Although no studies have specifically investigated the demographics of internet users that primarily click on GAs, one study analyzed the readership of GAs based on online engagement, such as the composite of tweets, replies, and likes. In 2019, the findings of surgical research articles were posted on Twitter in the three following forms: plain English, visual abstract, and standard tweets [14]. The overall online engagement by the public was low for all three forms (1.8 times, 2.5 times, and 1.2 times, respectively), but online engagement by healthcare professionals was active in all three forms (29.4 times, 45.3 times, 28.8 times, respectively). According to this particular study, it is more likely for healthcare professionals to take an interest in GAs than the general public, proving that it is effective for GAs to target healthcare professionals [14]. Studies on GAs are still lacking, and additional research is necessary in the future.

Are GAs Really Effective in Increasing the Dissemination or Citation of Research?

Creating GAs requires extra time for authors and additional costs for journals. Therefore, many studies have been conducted on the effectiveness of GAs for authors, readers, and journals. Regarding the utility of GAs, the results have varied depending on the time period and study design. In a study published in 2021, GAs published in distinguished journals, such as *JAMA*, *BMJ*, and the *New England Journal of Medicine (NEJM),* were not effective in the dissemination of studies [15]. In addition, a study in 2016, which was published relatively early in the introduction of GAs, also demonstrated that the difference in citations according to GAs was not significant [16]. However, these unremarkable results began to change when GAs were introduced in earnest in medical journals. According to a study published in 2017 by Ibrahim et al. [10], who first introduced the GA system to the medical field, the dissemination of a study increased by about 7.7 times when a GA was included in a tweet than when only the title was tweeted. According to the aforementioned study on online engagement, healthcare professionals interacted more actively with the inclusion of a GA rather than an abstract or an article title (45.3 times vs. 29.4 times or 28.8 times, respectively). The effect of GAs encouraging online engagement in social media has been confirmed in several medical disciplines, including orthopedics, nephrology, psychiatry, and gastroenterology [13,17–19].

Whether an increase in online engagement actually leads to an increase in citations or journal impact factor was recently investigated in 2022. According to the results of a study analyzing the top 10 journals in the field of gastroenterology, the number of citations in Web of Science was significantly higher for articles with GAs than for those without GAs. Additionally, journals that had adopted the GA system also showed a steeper increase in their impact factors from 2020 to 2022 than journals that had not. To sum up, GAs can help increase both the citations of individual studies and the impact factor of journals. Authors are encouraged to produce high-quality GAs to effectively publicize their research, increase their citation count, and discover potential collaborators, even if creating GAs may require additional time and effort. It is further recommended that journals introduce the GA system as early as possible in consideration of the benefits of increased citations and impact factor over the cost.

Types of GAs

When the GA system was first implemented, GAs were mere pictures that worked as “bait,” allowing more exposure of their journals via Twitter. When researchers who used social media were interested in a GA and clicked on it, they were linked to the journal’s website. More recently, though, GAs have officially been published as a formal component of a manuscript and have undergone vast developments in structure and illustrations. Except for a few journals, there are no restrictions on the form of GAs; however, as evident from the GAs published to date, GAs can be divided into the five following types.

The first type of GA is the conceptual diagram (Fig. 4). This type of GA uses illustrations and diagrams to visually represent the key concepts and findings of a study. Conceptual diagrams are particularly useful for communicating complex or technical information, such as scientific or mathematical concepts. Another type of GA is the flowchart (Fig. 5). Flowcharts use arrows and other visual elements to delineate the flow of information or processes within a study. They are especially

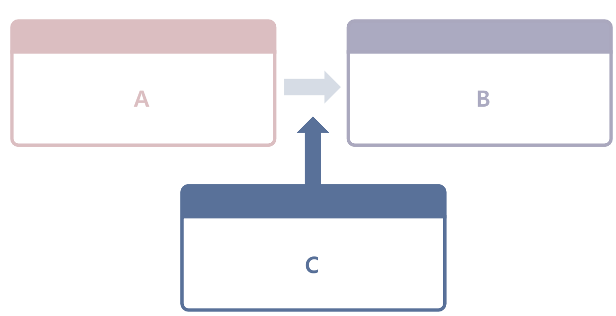

Fig. 4. Conceptual diagram style of graphical abstract.

suited for illustrating methods or procedures used in a study. The infographic is another popular choice for GAs (Fig. 6) [13].

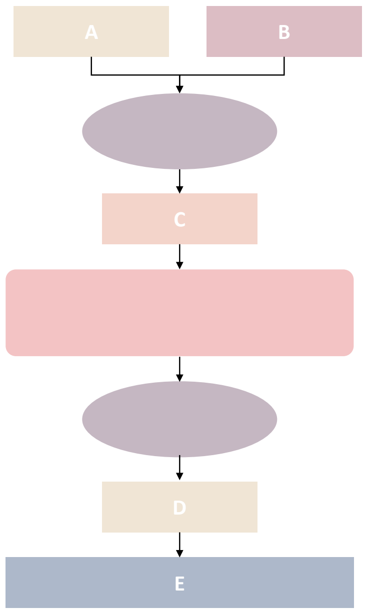

Fig. 5. Flowchart style of graphical abstract.

Infographics use a combination of illustrations, texts, and other design elements to present information in an engaging and easy-to-understand format. They are useful for summarizing extensive amounts of data in a compact and aesthetic manner. A fourth type of GA is the iconographic abstract, which uses a set of icons to represent the key findings and concepts of a study. This style of GAs is simple and easy to understand, making research accessible to a broader audience. Finally, GAs can also utilize photographs or photograph-like illustrations to depict the core message of a study. These GAs capture readers' attention and can be particularly effective in fields such as biology, ecology, or medicine. Overall, there are various types of GAs to choose from, each with its own strengths and best uses. The choice of a GA format depends on the main message of the study and its target audience.

The most used type of GAs in medical journals is currently the three-stage format provided by Elsevier. Depending on the type of the study, the three columns provided can be organized as patient, methods, and results, or as first, second, and third findings (Fig. 7). This format can be particularly useful in cohort studies. For randomized controlled trials, GAs in the format of a two-stage flow chart provided by the *NEJM* are widely used. In contrast, in review articles or experimental papers, there are numerous GAs in a free format, regardless of

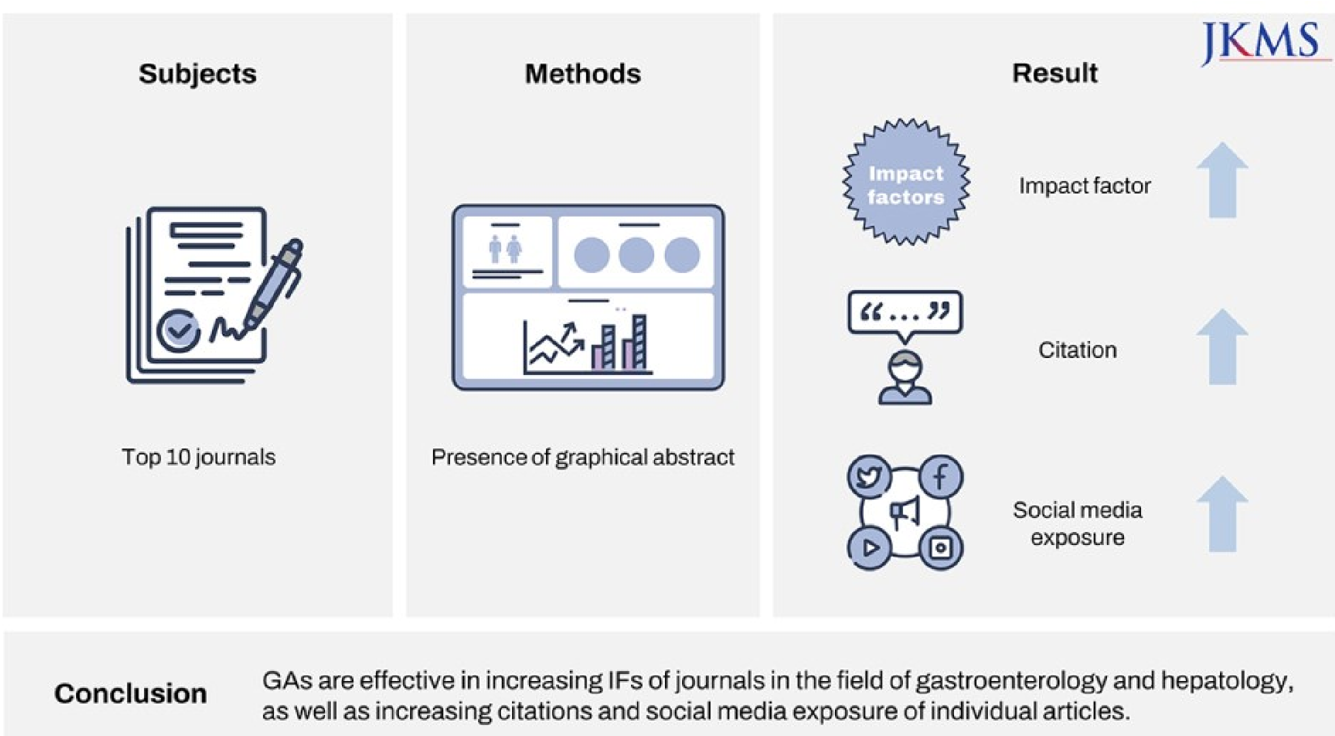

Fig. 6. Infographic-style of graphical abstract. Reprinted from Kim et al. [14], available under the Creative Commons License.

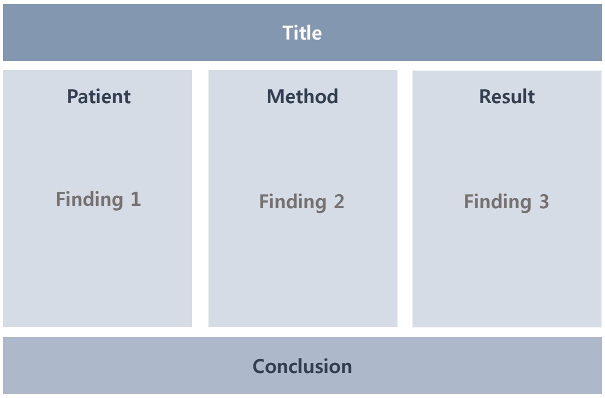

Fig. 7. Three-stage form of a graphical abstract.

the templates presented above. In conclusion, the most vital factor in determining the format of a GA is the study design. Therefore, before producing a GA, researchers must refer to GAs of preexisting papers with similar designs to those of their studies.

How to Create a Compelling GA

A GA is typically a single image or an illustration that summarizes the key points of the study in a comprehensible and visually appealing manner. To create a compelling GA, one must follow the key steps presented below.

First, start by identifying the main message of the study. This serves as the focus of the GA, providing further guidance in determining the design and content of the illustration. Although researchers tend to indulge in the desire to include all their findings in their GAs, it is necessary to concentrate on one or two key points on average, with no more than three at most.

Second, choose an appropriate visual style for the GA. This might include using a combination of illustrations, diagrams, and text to convey the main message.

Third, avoid using excessive text or complex illustrations, since a GA should be easy to understand at a glance. It is essential to keep in mind that a GA is not an end in itself but has the purpose of further disseminating the research in social media. In other words, a GA is responsible for grasping the attention of its audience and prompting them to eventually read the full manuscript—in other words, a GA is not the full paper.

Fourth, use colors and other design elements that can engage the audience. This can draw the readers' attention to the key message of the study. Because some journals, such as *Allergy,* have predetermined color palettes for GAs, it is recommended to check the instructions in advance.

Fifth, request feedback on the GA from others and make any necessary revisions. This process ensures that the GA effectively communicates the main findings of the study.

Useful Tools or Collaborators for Creating GAs

There are various programs that can create effective GAs. Microsoft PowerPoint (Microsoft Corp), a widely used program that creates presentations, can also be utilized to create GAs. The program offers a range of tools and features that can create visual representations illustrating complex information, such as charts, diagrams and images. One of the benefits of creating GAs with Microsoft PowerPoint is its universal availability and user-friendly interface. Additionally, Microsoft PowerPoint offers a wide range of templates and design elements that generate professional-level GAs. Another tool available is Mind the Graph (https://mindthegraph.com), a web-based subscription service that allows users to create GAs, infographics, and other types of scientific illustrations. The platform offers a wide range of predesigned templates, visual elements, and features that can make custom, eye-catching GAs efficiently. Other web-based graphic design tools, such as Biorender (https://biorender.com) and Canva (https://www.canva.com), are also available to help researchers in producing GAs.

Finally, although traditional, one of the most effective ways to produce GAs is collaborating with experts. Illustrators are trained professionals who specialize in creating illustrations, which is a valuable asset in creating GAs. One of the benefits of working with illustrators is their specialized skills in creating these visuals, allowing GAs both to be visually appealing and to effectively communicate the key message researchers wish to convey. They can also provide guidance on composition, typography, and color choices that can easily draw the attention of the audience. However, since illustrators in general may have an insufficient understanding of the academic content, it is advised that researchers first create a rough draft of the GA and later collaborate with illustrators by discussing the visuals.

Limitation of GAs and Their Future Direction

Although GAs have become an essential part of academic journals, they still have some limitations. There is an ongoing debate on the effectiveness of GAs in increasing journal impact or citations. Some critics argue that GAs are not always effective in communicating the main findings of a study. Some GAs are too complex or vague to be understood at a glance, while others may not accurately represent the key findings of the study. Some studies simply are not suited for visual representation, making a GA unnecessary. In addition, there is currently no universal standard for GAs, which can lead to inconsistencies in their formats and contents. Lastly, creating high-quality GAs can be time-consuming and expensive. It requires a good understanding of design principles, as well as access to specialized software and tools.

In the long run, GAs have endless possibilities to overcome those limitations. Regarding the potential future directions for GAs, it should be first noted that GAs are becoming more engaging by incorporating animations, videos, and interactive elements such as hover effects, pop-ups, and links. In fact, video abstracts have recently been increasing in *NEJM*. Furthermore, given the recent fascination with artificial intelligence and machine learning technology, GAs may be created automatically after the extraction of raw data, allowing a more efficient and accurate communication of research findings. The development of such technology will reduce the burden of drafting GAs, enabling researchers to focus more on their scientific endeavors.

Conclusion

In conclusion, GAs are valuable tools for communicating complex information in a clear and concise manner. They have the ability to make research more accessible and engaging for a wide range of audiences. In today's era of social media, GAs have become a crucial art that researchers must master—a promising component of academic journals expected to gradually expand, despite some limitations.

Conflict of Interest

Jeong-Ju Yoo is the representative of Research Factory (Incheon, Korea). No other potential conflict of interest relevant to this article was reported.

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Original Article

Impact and perceived value of the revolutionary advent of artificial intelligence in research and publishing among researchers: a survey-based descriptive study

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Abstract

Purpose: This study was conducted to understand the perceptions and awareness of artificial intelligence (AI) in the academic publishing landscape.

Methods: We conducted a global survey entitled "Role and impact of AI on the future of academic publishing" to understand the impact of the AI wave in the scholarly publishing domain. This English-language survey was open to all researchers, authors, editors, publishers, and other stakeholders in the scholarly community. Conducted between August and October 2021, the survey received responses from around 212 universities across 54 countries.

Results: Out of 365 respondents, about 93% belonged to the age groups of 18–34 and 35–54 years. While 50% of the respondents selected plagiarism detection as the most widely known AI-based application, image recognition (42%), data analytics (40%), and language enhancement (39%) were some other known applications of AI. The respondents also expressed the opinion that the academic publishing landscape will significantly benefit from AI. However, the major challenges restraining the large-scale adoption of AI, as expressed by 93% of the respondents, were limited knowledge and expertise, as well as difficulties in integrating AI-based solutions into existing IT infrastructure.

Conclusion: The survey responses reflected the necessity of AI in research and publishing. This study suggests possible ways to support a smooth transition. This can be best achieved by educating and creating awareness to ease possible fears and hesitation, and to actualize the promising benefits of AI.

Keywords

Artificial intelligence; Plagiarism; Publishing; Author perspectives; Scholarly communication

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Introduction

Background/rationale

Artificial intelligence (AI) and machine learning have transformed several industries since their advent, facilitating easier and quicker automation of numerous processes. Likewise, AI-based technologies are being developed and implemented in the academic publishing industry to assist authors, editors, publishers, and stakeholders from allied industries. The deployment of AI in academic publishing has helped to tackle issues related to peer review, searching pertinent literature using scholarly databases, detecting plagiarism, identifying data fabrication, automated text analysis, content translation, content personalization, search engine optimization analysis, chatbots, and much more [1]. However, the views of authors and researchers who are at the epicenter of the publishing system are often not known. Although there are growing concerns over the potential misuse of AI in research and publishing, the drivers of the system must express their views to support and bring about changes that authors want to see in the publishing landscape [2]. Thus, it is imperative to examine and understand the perceived value and impact of AI on the future of academic publishing. Understanding authors' and researchers' viewpoints could provide stakeholders of science with an unambiguous idea of how to adopt AI to make the research and publishing system more efficient than it already is. Based on the data we gathered with this global survey, this report presents some thought-provoking trends that we identified.

Objectives

This study aimed to gain a better understanding of the perceptions and awareness of AI among researchers and other stakeholders of the scholarly community. Predominantly, we focused on identifying the adoption rate and popularity of AI-based tools amongst editors, publishers, and authors. Furthermore, the study also aimed to identify the perceived benefits of AI and concerns related to the use of AI in research and academic publishing.

Methods

Ethics statement

This study was based on a survey about journal publishing, the items of which included no sensitive personal information. No Institutional Review Board approval was required. The participants agreed to participate voluntarily in the survey.

Study design

This was a survey-based descriptive study.

Setting

We launched a global survey titled "Role and impact of AI on the future of academic publishing" [3] that was distributed online to collect the viewpoints of stakeholders in the scholarly community. The survey was conducted in the English language between August 27, 2021 and October 3, 2021, and was open to researchers, authors, journal editors, publishers, and other scholarly stakeholders through the SurveyMonkey tool.

Content validity test

To evaluate the content validity, a Likert scale was used to measure subject matter experts' satisfaction regarding the clarity and coverage of the items of the questionnaire and to understand whether the individual items seemed relevant for

Table 1. Content validity for the study of role and impact of artificial intelligence on academic publishing

No.	Criteria	Needs improvement (%)	Fair (%)	Good (%)	Very good (%)	Excellent (%)
1	Clarity of items in the questionnaire: The vocabulary level, language structure, and conceptual level of the questions meet the level of respondents. The questionnaire directions and items are written clearly and are easy to understand.	0	0	0	50	50
2	Organization and presentation of items: The items are organized and presented in a logical and sequential manner.	0	0	25	0	75
3	Adequateness of items: The questions are designed to determine the knowledge, perceptions, and attitudes of the respondents for the particular study. The number of questions is representative enough of the concept defined for the particular study.	0	0	0	75	25
4	Attainment of purpose: The instrument as a whole is relevant and could answer the basic purpose for which it is designed.	0	0	0	75	25
5	Objectivity: No aspect of the questionnaire suggests bias (such as gender stereotyping, etc.) on the part of the study. The items on the instrument can elicit responses that are stable, definite, consistent, and not conflicting.	0	0	0	50	50

determining the knowledge, perceptions, and attitudes of the respondents for the study. It was tested by four subject matter experts, two of whom are active professionals in editing and publication support services and the other two work in the development of natural language processing and AI-assisted tools. The subject matter experts agreed with the validity of these items for the survey on the role and impact of AI in the academic landscape. Table 1 shows that the questionnaire achieved high content validity according to the subject matter experts.

Participants and variables

After sending the survey questionnaire to email addresses listed in the Enago database and to internet users using social networks (Facebook and LinkedIn), 365 responses were collected. There was no exclusion criterion. Hence, the total target number could not be estimated. All items of the survey questionnaire were variables.

Data source/measurement

The survey covered several topics, such as researchers' awareness of researchers about the applications of AI in scholarly publishing, whether AI has revolutionized the publishing domain, and the expected prospects of AI for advancing academic research and publishing. The survey questionnaire is available in Suppl. 1.

Bias and study size

There was no bias in selecting participants. Sample size estimation could not be performed due to the nature of this survey-based descriptive study. All responses were included in the analysis.

Statistical methods

Descriptive statistics were applied to observe some trends in the overall perceptions of AI in the scholarly world, which are presented in this article.

Results

Characteristics of participants

The survey garnered 365 responses from researchers, authors, journal editors, publishers, and other stakeholders in the scholarly publishing industry at 212 universities across 54 countries. The collated data sample represented viewpoints from several countries and diverse academic roles. Data on sex, age, geographical distribution, the size of organizations/institutions, and respondents' job titles are summarized in Table 2.

Table 2. Demographic findings of participants (n=365)

Category	No. (%)
Sex	
Male	204 (56)
Female	150 (41)
Others	7 (2)
Preferred not to disclose	4 (1)
Age group (yr)	
18–34	178 (49)
35–54	161 (44)
55–74	22 (6)
≥75	4 (1)
Geographical distribution	
North America	190 (52)
Asia	88 (24)
Africa	33 (9)
Europe	29 (8)
South America	14 (4)
Australia/Oceania	11 (3)
Size of organization/institution	
Small (2–100)	142 (39)
Medium (100–500)	69 (19)
Large (>500)	128 (35)
Individual	26 (7)
Job title	
Postgraduate student	106 (29)
Doctoral student	80 (22)
Established researcher (having >5 publications)	59 (16)
Graduate student	55 (15)
Journal editor	22 (6)
Postdoctoral fellow	18 (5)
Publisher	7 (2)
Others	18 (5)

Awareness about applications of AI in academic publishing

Answers to the two questions related to the respondents' knowledge about AI app ing importance in most industries, it is not surprising that about 86% of the respondents (Fig. 1) in this survey had a sufficient working knowledge of AI or at least a basic understanding of AI and its concepts. Around 13% had heard these concepts but did not understand them very well. A small portion (1%) of respondents chose other responses, and a few of them also specified that although they had a the-

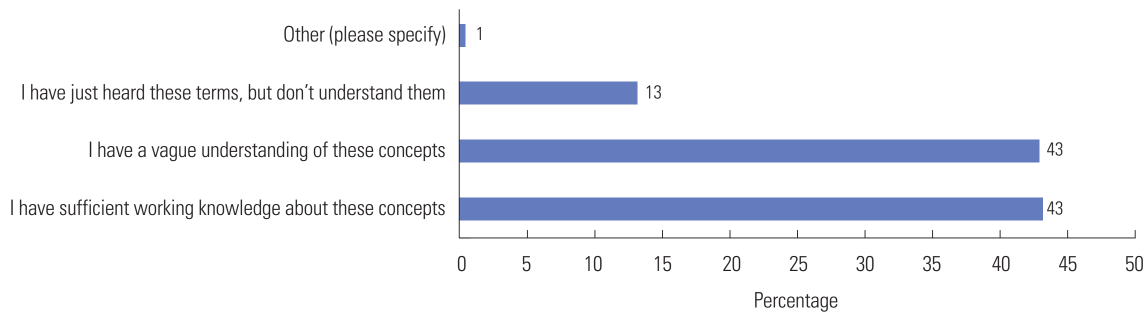

Fig. 1. Understanding of the concepts of artificial intelligence, machine learning, internet of things, clustering, and other related topics.

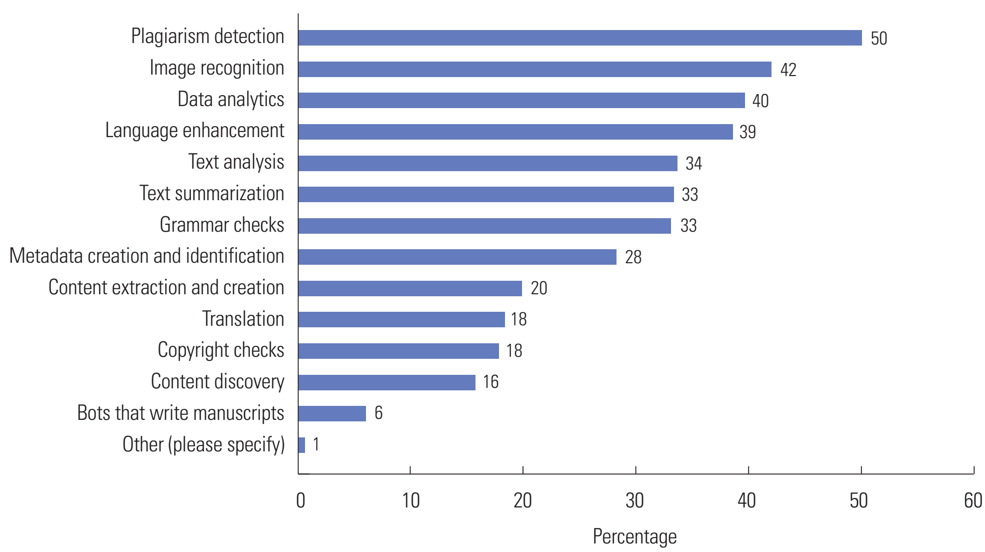

Fig. 2. Different artificial intelligence tools used by respondents.

oretical understanding of the concept, they had not yet applied it in a working environment. Predictably, plagiarism detection was the most widely known application, which was recognized by about 50% of respondents (Fig. 2). Image recognition (42%) was another fairly widely known application of AI, followed by data analytics (40%), language enhancement (39%), text analysis (34%), text summarization (33%), and metadata creation (28%). Bots that write manuscripts are a relatively new application that only a few participants (6%) were aware of. Other responses included automated reasoning and logic.

How has AI revolutionized academic publishing?

The answers to question 3, "What are the benefits of implementing AI in research and publishing?," are presented in Fig. 3. Among the perceived benefits of AI, automation of repetitive tasks (57%), reduction of overall cost and time (52%), and improved quality of the output (50%) were the most prominent responses. The responses to question 4, "What do you anticipate to be the primary obstacle in implementing AI?," are given in Fig. 4. The lack of competency in understanding AI (42%), difficulties in integrating AI-based solutions into existing IT infrastructure (41%), and the lack of technical expertise and specialized equipment/software (38%) were stated as the major challenges. Consequently, respondents suggested that academic institutions or publishers must invest in additional training (39%) or rely heavily on AI-trained staff (35%) to implement and use AI-based tools. Furthermore, the cost of implementation (upfront investment) and maintenance, uncertain return on investment, lack of standards, and other legal and compliance issues were also identified as challenges faced by the respondents. Moreover, 35% of respondents said that the primary reason for not adopting AI was the fact that their organizational culture had not yet recognized the need for it. Overall, there did not seem to be a single dominant reason for the limited use of AI; instead, multiple concerns contributed to this factor. Another obstacle specified was the instability of internet connections. The next question (question

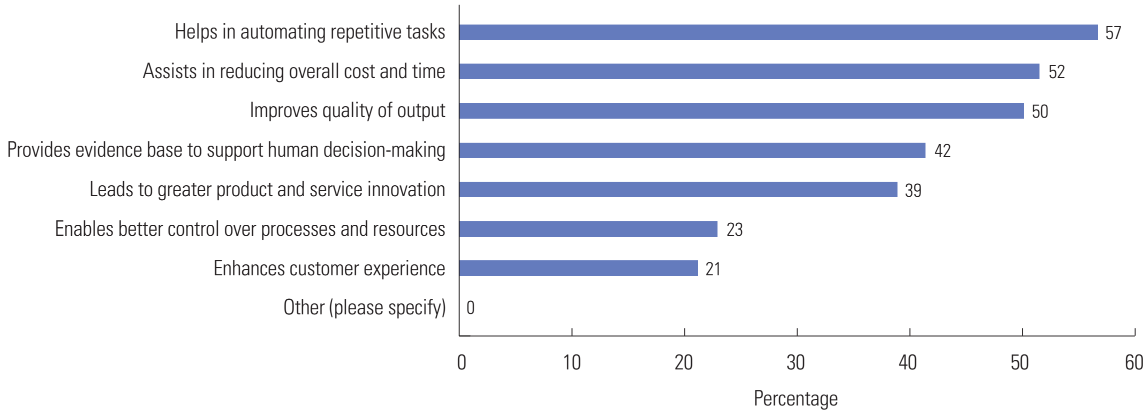

Fig. 3. Benefits of implementing artificial intelligence in research and publishing.

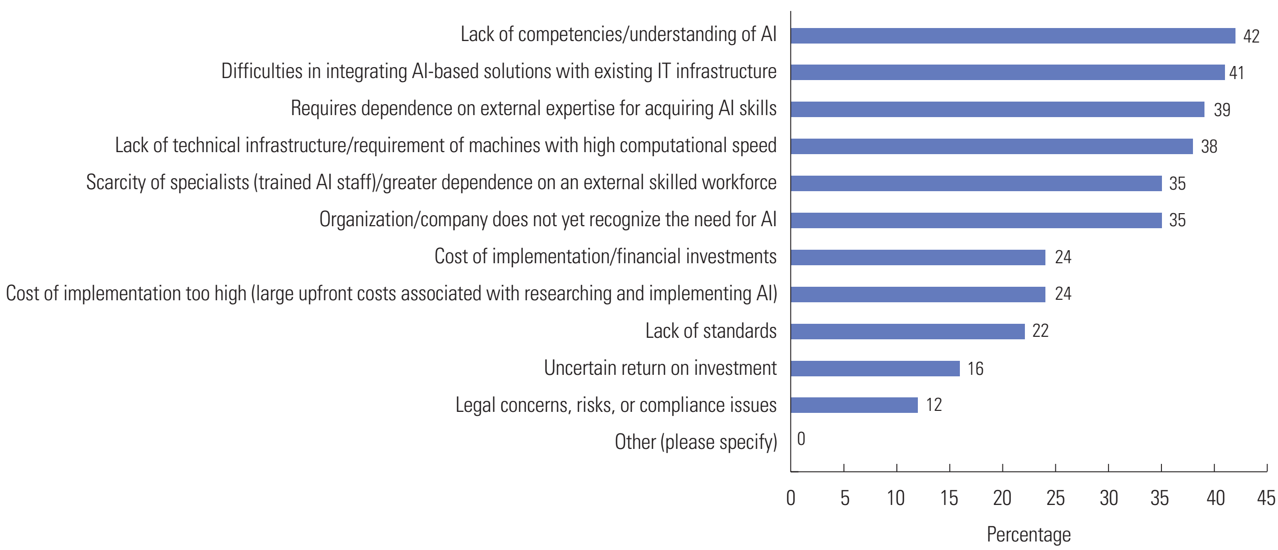

Fig. 4. Key concerns associated with artificial intelligence (AI).

5) in this section aimed to understand the areas where AI would require improvement: "Which problems in academic publishing will be difficult to solve using AI?" The identification of predatory publishers (57%), the problem of data fabrication or fake data (44%), and review bias (46%) were reported to be the most pressing challenges, followed by the problem of inaccurate translations (32%).

Prospects of AI

This section of the survey focused on the expectations/requirements of respondents to use AI tools more effectively. In this section, we wanted to determine whether any specific AI assistance was required by the academic community. The responses to question 6, "What kind of AI assistance or access do you need in your current role?," are shown in Fig. 5. Most responses (>40%) suggested the need for AI tools that could help them with global demographic analysis, perform automated text analysis, and monitor for copyright infringement. A significant number of participants also proposed developing AI-powered tools that could perform predictive analysis (35%) and manage royalties (25%). Some participants also mentioned that they would need assistance for translation and understanding machine learning and the scope of AI in the academic publishing domain. The answers to question 7, "Do you or your department need expert advice on how you can use AI to facilitate your publication journey?," are presented in Fig. 6. The most response (77%) from our survey participants was that they needed expert advice on how to successfully and effectively implement AI to ease their publication journey. However, about 18% mentioned that they might require AI assistance in the near future.

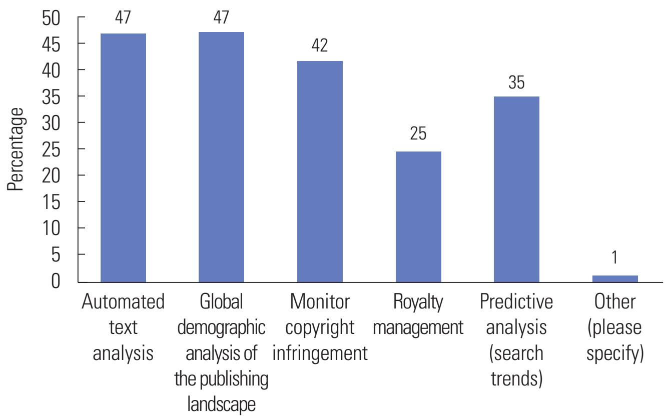

Fig. 5. Artificial intelligence assistance required by respondents.

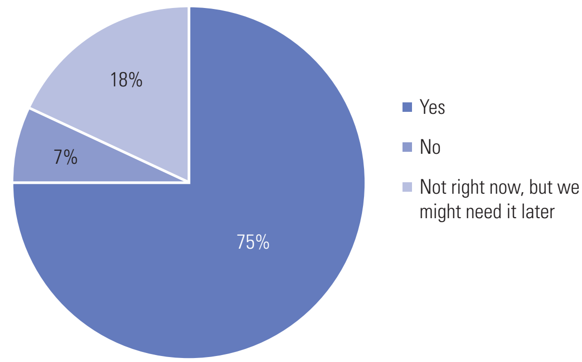

Fig. 6. Expert advice on how to use artificial intelligence to facilitate the publication journey.

Discussion

Interpretation

Considering demographics, women are still underrepresented in fields such as computing, information technology, engineering, mathematics, and physics. According to the data released in the World Economic Forum's Global Gender Gap Report 2021, globally, only 32% of AI professionals are female [4]. This report validates the gender disparity seen among our survey participants. Furthermore, the respondents primarily belonged to the age groups of 18–34 and 35–54 years, which presently constitute the largest consumer groups for AI. Majority of the respondents were observed to be academics from research institutions and organizations. Hence, the results provide a fair understanding of the usage and impact of AI tools at present. Meeting authors' and researchers' needs and expectations would present a strong case for adopting and improving AI in the academic publishing landscape.

The majority of the respondents identified in the survey were graduates, postgraduates, or researchers. Their digital experience will help push the boundaries of AI. This survey reveals that AI-powered plagiarism detection tools are widely used and provide a hassle-free solution for academics and professionals in the publishing industry. Accurate comprehension and dissemination of scientific literature are crucial aspects of academic writing and publishing. Sifting through the millions of available documents, such as review articles, research papers, or patents, to extract key information relevant to one's research is a challenge. Software that assists in image recognition, language enhancement, and the creation of summaries and metadata is also among the widely known applications of AI in academic publishing. Respondents were also aware of tools that help in performing data analytics tasks such as automatic tagging, identification of entities, and the identification of metadata such as title and author. AI-powered bots are now assisting in the composition of the first draft of manuscripts, thereby revolutionizing scientific writing. In recent years, various support services that use AI technology for manuscript writing have become increasingly available [5]. AI-based applications are being developed to assist authors and publishers in performing activities with minimal human intervention and greater efficiency. For example, significant efforts have been made to automate parts of the peer review process, and recent years have seen the application of AI in assisting the peer review process. The ever-increasing growth in manuscript submissions has necessitated peer review automation, and improving the automation level of peer review has gained increasing attention over the past few years [6,7]. Knowledge and integration of AI applications into online publishing platforms will help create highly advanced and focused tools.

Some of the key benefits of AI tools identified by the respondents are relatively straightforward processes such as finding potential peer reviewers, scanning articles suitable for manuscript submission, and identifying language or grammatical errors. These tools enable researchers and publishers to rapidly complete routine or mundane tasks with the aid of a machine. It is important to focus on research that not only makes AI more capable but also maximizes its societal benefit. Evidence from the survey suggests that the lack of AI skills and difficulties in the application of AI solutions to existing infrastructure are the most common hurdles. To overcome the expertise issue, researchers and publishers could consider collaborating with external research organizations (for acquiring AI training, skills, and technology). The lack of awareness of the potential benefits and applications of AI also appears to be a significant barrier to the large-scale adoption of AI. Research organizations can achieve the most significant performance improvements when humans and machines work together. Thus, realizing this immense potential of AI, research organizations must take the initiative to recruit skilled training staff and expertise to achieve the desired outcomes.

AI-assisted tools are redefining the scholarly landscape. Academicians must be aware of what is unfolding before them and what preceded them. Making data-driven decisions is the need of the hour. With text analysis, global demographic analysis, and predictive analysis, researchers can use AI tools to convert unstructured text into meaningful data. Most of our survey participants agreed that AI has the potential to augment the academic publishing process. However, many institutions and organizations are still in the nascent stage in this regard. They are unaware of how to implement AI solutions in their workflow and where to begin. We think that there is a pressing need for focused webinars, conferences, and workshops to support and facilitate researchers' understanding and usage of AI tools and algorithms in practice. These sessions must also provide insights into the impact of AI technologies on academic institutes and research organizations, the implications AI will have for the publishing processes, and the ways in which its performance can be enhanced.

Limitations and suggestions for further studies

While the survey was globally accessible, we found that Australia/Oceania had the lowest participation (3%). In contrast, Africa showed greater participation (9%), reflecting the fact that it is joining the global AI revolution [8], followed by Europe (8%) and South America (4%). As a next step, we plan to conduct additional surveys focusing on the identification of malpractice with AI, its integration with research and publishing demands, and awareness of trends in AI to derive comprehensive worldwide conclusions. As the AI landscape changes, there is also merit in assessing the detrimental and disruptive role AI can play in research integrity, science communication, and scholarly publishing.

Conclusion

The results of this survey provide interesting insights into how AI-supported innovations are perceived and used by key stakeholders in the academic ecosystem, such as publishers, editors, reviewers, authors, and many more. Academic stakeholders are already experimenting with AI tools to improve the current workflow and efficiency. Most of the survey respondents have claimed that a major limitation to implementing AI is the lack of knowledge, trained in-house staff, and resources. The ever-increasing demand for quality publications in the race to"publish or perish" will undeniably increase the adoption of AI in academic publishing. As technology improves, not only will it assist in increasing efficiency and reducing costs in the current research ecosystem, but it might also transform the world of research completely. This study outlines the challenges currently faced by the consumers of AI-based tools in academia and suggests possible ways to support a smooth transition. This can be best achieved by educating and creating awareness to ease the possible fears and hesitation, and to actualize the promising benefits of AI.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Supplementary Material

Supplementary material is available from the Harvard Dataverse at https://doi.org/10.7910/DVN/DTHJDG.

Suppl. 1. Survey form of the questionnairs.

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Original Article

How open access diamond journals comply with industry standards exemplified by Plan S technical requirements

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Abstract

Purpose: This study investigated how well current open access (OA) diamond journals in the Directory of Open Access Journals (DOAJ) and a survey conform to Plan S requirements, including licenses, peer review, author copyright, unique article identifiers, digital archiving, and machine-readable licenses.

Methods: Data obtained from DOAJ journals and surveyed journals from mid-June to mid-July 2020 were analyzed for a variety of Plan S requirements. The results were presented using descriptive statistics.

Results: Out of 1,465 journals that answered, 1,137 (77.0%) reported compliance with the Committee on Publication Ethics (COPE) principles. The peer review types used by OA diamond journals were double-blind (6,339), blind (2,070), peer review (not otherwise specified, 1,879), open peer review (42), and editorial review (118) out of 10,449 DOAJ journals. An author copyright retention policy was adopted by 5,090 out of 10,448 OA diamond journals (48.7%) in DOAJ. Of the unique article identifiers, 5,702 (54.6%) were digital object identifiers, 58 (0.6%) were handles, and 14 (0.1%) were uniform resource names, while 4,675 (44.7%) used none. Out of 1,619 surveyed journals, the archiving solutions were national libraries (n = 170, 10.5%), Portico (n = 67, 4.1%), PubMed Central (n = 15, 0.9%), PKP PN (n = 91, 5.6%), LOCKSS (n = 136, 8.4%), CLOCKSS (n = 87, 5.4%), the National Computing Center for Higher Education (n = 6, 0.3%), others (n = 69, 4.3%), no policy (n = 855, 52.8%), and no reply (n = 123, 7.6%). Article-level metadata deposition was done by 8,145 out of 10,449 OA diamond journals (78.0%) in DOAJ.

Conclusion: OA diamond journals' compliance with industry standards exemplified by the Plan S technical requirements was insufficient, except for the peer review type.

Keywords

Archives; Access to information; Metadata; Diamond open access; Publishing

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This is an abridged form of a preprint entitled "Compliance: How OA diamond journals comply with industry standards exemplified by Plan S technical requirements" in the OA Diamond Journals Study available at https://doi.org/10.5281/zenodo.4558704. The author of the preprint is Jan Erik Frantsvåg (jan.e.frantsvag@uit.no) at the University Library of Tromsø, UiT The Arctic University of Norway, Norway.

Introduction

Background/rationale

A large-scale survey was conducted on open access (OA) diamond journals from June 2020 to February 2021 by a consortium of 10 organizations to facilitate an understanding of the present situation of OA diamond journals throughout the world.

Objectives

This study aimed to identify whether OA diamond journals were compliant with the standards specified in the Plan S technical requirements. Specifically, the following were analyzed for adherence to the industry standards: licenses; peer review; author copyright; unique article identifiers; digital archiving; machine-readable licenses; author identifiers; self-archiving policy; full texts in JATS XML; compliance with OpenAIRE metadata standards; linking to data, code, and other research outputs; standards of the Initiative for Open Citations; and Creative Commons license types.

Methods

Ethics statement

This was a literature database and survey-based study on journal publishing, and no sensitive personal information was included in the survey items. No approval by the Institutional Review Board was required. Participants agreed to participate in the survey voluntarily.

Study design

This was a cross-sectional descriptive study based on a literature database search and survey.

Setting

From mid-June to mid-July 2020, an online survey listing 94 questions collected data on the different components of diamond journals. Information in the Directory of Open Access Journals (DOAJ) was also searched. The structure and questions of the survey are available from the previous article on the landscape of OA diamond journals [1] (Suppl. 1). The analysis was based on data from two datasets: DOAJ metadata, which contained a large amount of information about DOAJ journals; and survey data, in which journals not in DOAJ had given much of the same information present in the DOAJ metadata, as well as some more, and where DOAJ journals had given information not found in the DOAJ metadata. Several comparisons were made between survey journals and DOAJ journals, as well as between OA diamond and article processing charge (APC)-based journals in DOAJ. APC-based journals were not asked to participate in the survey. In instances where the DOAJ metadata contained no relevant cinformation, a comparison was made between survey journals that were also listed in DOAJ and those not listed in DOAJ. The other aspects of the setting were also the same as in the previous article on the landscape of OA diamond journals [1].

Participants

The total number of surveyed journals was 1,619, consisting of 532 journals not listed in DOAJ, and 1,087 journals listed in DOAJ. The number of DOAJ journals analyzed was 14,368. Out of them, 10,449 (72.7%) were OA diamond journals. These data are the same as in the previous article on the journal landscape [1].

Variables

The variables were the items of the survey questionnaire.

Data sources/measurement

The data sources and measurements were the same as in the previous landscape article, including survey, database analysis, and literature review [1]. Raw response data from the survey participants are available from Dataset 1, with a readme text containing the variable list for the survey data file in Dataset 2. Data files for Figs. 1–18 are available in Suppl. 2.

Bias

The potential sources of bias were also the same as in the previous study [1]. Different circumstances and motivations of journals to participate in the survey may have been a source of bias in participation.

Study size

Study size estimation was not done because this was not a randomized experimental study, but rather a study based on voluntary participation.

Statistical methods

Descriptive statistics were applied for the interpretation of the results.

Results

Scientific and editorial quality

Compliance with COPE principles (source: survey Q52)

Plan S requirements specify "a solid system in place for review according to the standards within the relevant discipline and guided by the core practices and policies outlined by the Committee on Publication Ethics (COPE)." COPE represents good standards for review and other editorial practices, and issues guidelines and other resources to help editors. Out of 1,417 surveyed journals, 1,137 (70.2%) reported following the COPE guidelines, whereas 51 journals (3.1%) did not (Fig. 1).

Information on the peer review procedure (source: DOAJ, survey Q26)

In DOAJ, all journals except one indicated that they conducted peer review in a form that meets Plan S requirements. Fig. 2 shows the distribution of the various types of reviews listed by the journals over the two categories of journals (OA diamond and APC-based). Blind and double-blind reviews were the most frequently used types, totaling more than 80% for both journal groups. A comparison of the answers between journals in DOAJ and journals not in DOAJ is presented in Fig. 3. Double-blind peer review was performed by more than 50% of journals in both groups and emerged as the predominant review process by a wide margin. All review processes used by both DOAJ and survey journals that answered this question were Plan S-compliant.

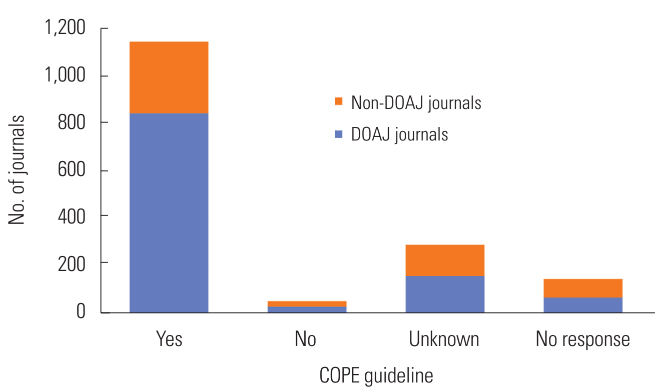

Fig. 1. Compliance with Committee on Publication Ethics (COPE) principles. DOAJ, Directory of Open Access Journals.

Information on editorial management and submission/rejection (source: DOAJ, survey Q50)

In the survey, Q50 asks, "Does the journal publish annually at least basic statistics, covering in particular: …," with five options plus an "other" alternative. Nearly half of all journals did not publish any of the statistics offered as an alternative. Still, some of them had some information under "other," which included various published information, predominantly usage statistics (Fig. 4). Journals in DOAJ selected more than one answer more frequently (39%) than OA diamond journals (23%). Responses of "blank" and "none" were also higher for survey-only journals than for DOAJ journals in the survey.

Technical requirements and recommendations

Persistent identifiers (source: DOAJ, survey Q42)

A persistent identifier (PID) is an identifier that remains constant over time and always points to the resource referred to,

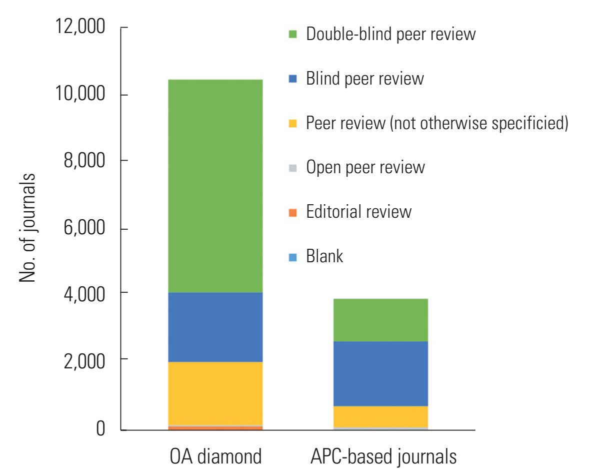

Fig. 2. Review types used by journal groups in Directory of Open Access Journals (DOAJ). OA, open access; APC, article processing charge.

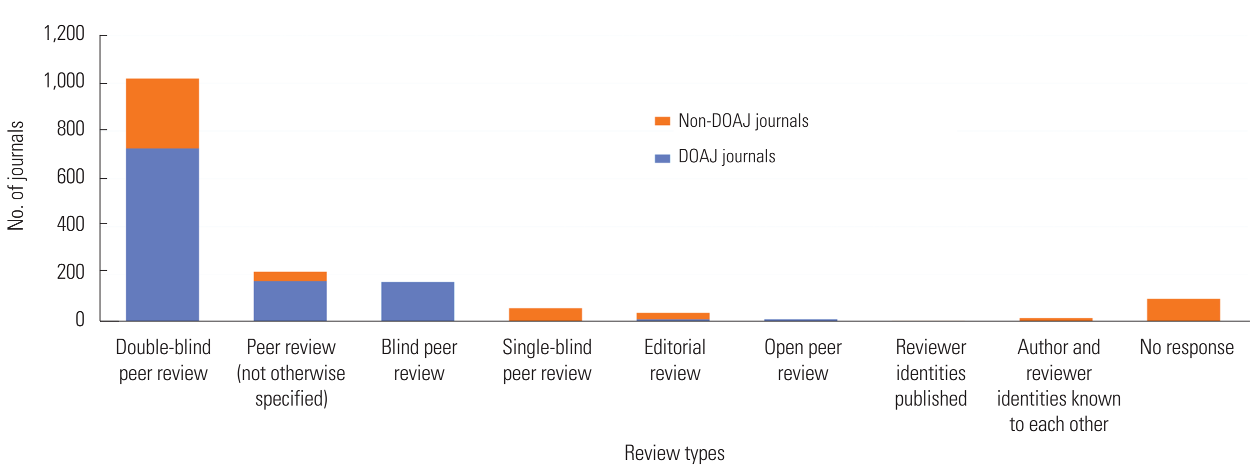

Fig. 3. Review types used by survey journals organized by those in Directory of Open Access Journals (DOAJ) and those not in DOAJ.

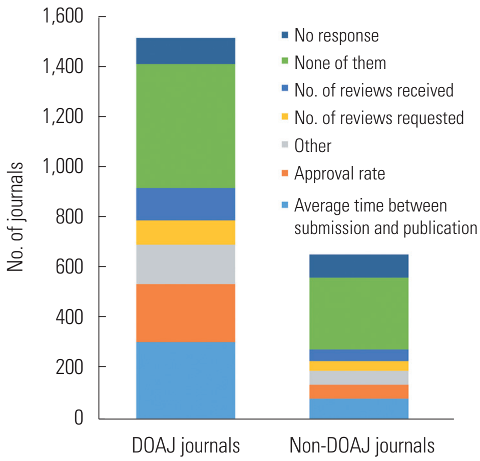

Fig. 4. Basic statistics published on editorial management related to submission and rejection. DOAJ, Directory of Open Access Journals.

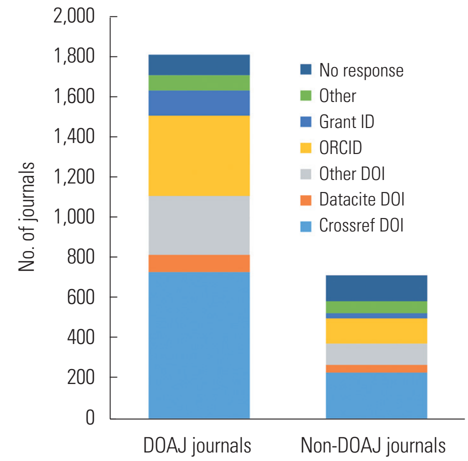

Fig. 6. Use of article identifiers by journal category in the survey. DOAJ, Directory of Open Access Journals; DOI, digital object identifier.

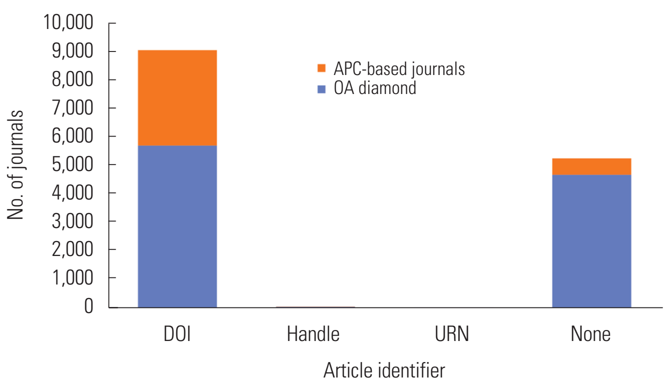

Fig. 5. Use of article identifiers by journal category in Directory of Open Access Journals (DOAJ). DOI, digital object identifier; URN, uniform resource name; APC, article processing charge; OA, open access.

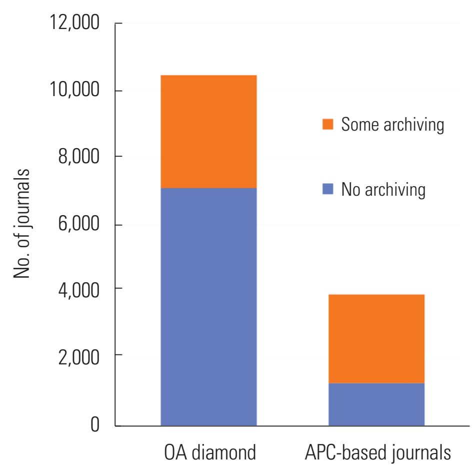

Fig. 7. Archiving in place by journal category in Directory of Open Access Journals (DOAJ). OA, open access; APC, article processing charge.

irrespective of renaming or moving to new domains or URLs. In DOAJ, only PIDs for articles are listed in the journal metadata. In total, 9,037 out of the 14,368 DOAJ journals (62.9%) offered article PIDs in the form of digital object identifiers (DOIs) (Fig. 5). Among 3,919 APC-based DOAJ journals, 3,335 (85.0%) had DOIs. Uniform resource names (URNs) were used in 14 journals and handles in 65 journals.

The use of PIDs was the theme for Q42 in the survey. A journal could check more than one answer, so the numbers did not add up to the total number of journals surveyed. The DOAJ journals in the survey scored higher for Crossref DOIs, other DOIs, ORCIDs, and grant IDs, while survey-only journals had a higher percentage of Datacite DOIs and other PIDs (Fig. 6). Journals using other DOIs mentioned handles, mEDRA, and Researcher IDs. In total, 960 journals (59.3%) in the survey used Crossref DOIs, while 124 (7.7%) mentioned Datacite DOIs and 400 (24.7%) stated that they used other DOIs (Fig. 6).

Long-term digital preservation or archiving (source: DOAJ, survey Q28)

A total of 3,361 OA diamond journals out of 10,449 (32.1%) appeared to satisfy this requirement, as well as 2,639 of the 3,919 APC-based journals (67.3%) (Fig. 7). An interesting observation is that 6,000 journals reported some form of archiving in place.

In the survey, journals could choose more than one option; hence, the numbers do not equal the total number of journals surveyed. The majority of survey journals had no archiving policies (855 of 1,619 respondents) (Fig. 8). In addition, only 381 respondents used a standard archiving system (LOCKSS, PKP PN, CLOCKSS, and Portico) that would comply with cOAlition S requirements. Local solutions such as national libraries (170 respondents) were frequently quoted.

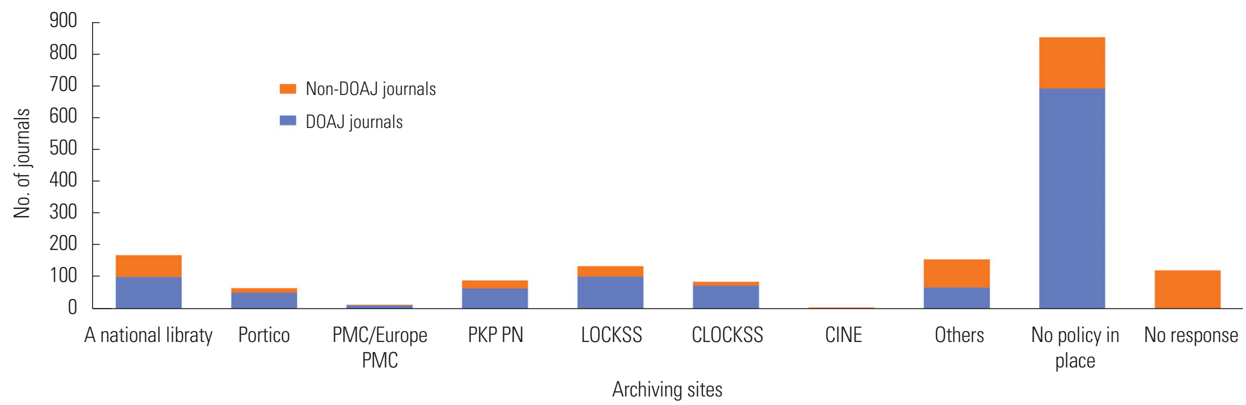

Fig. 8. Archiving solution by journal category in the survey. PMC, PubMed Central.

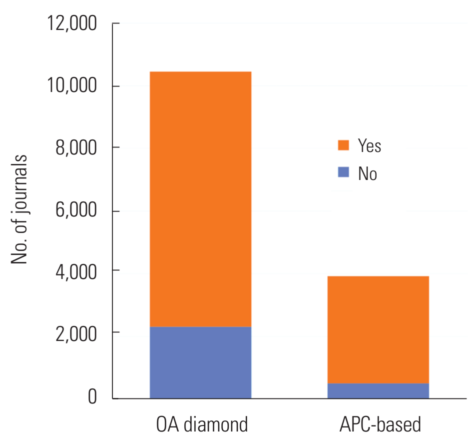

Fig. 9. Article-level metadata deposition in Directory of Open Access Journals (DOAJ) by journal category. OA, open access; APC, article processing charge.

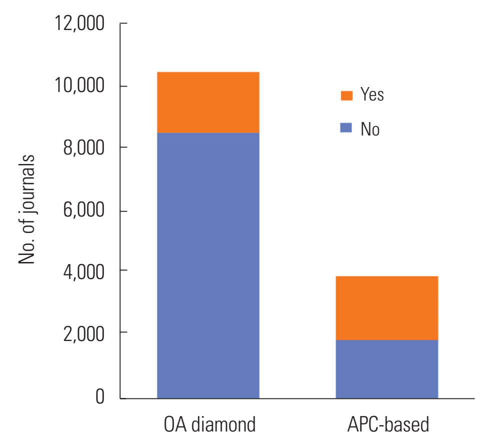

Fig. 10. Self-archiving policy in Sherpa Romeo by journal category. OA, open access; APC, article processing charge.

Machine-readable metadata in CC0 (source: DOAJ)

Most DOAJ journals deposited article-level metadata in DOAJ. However, it is unclear from the data to what extent this is a continuing process for individual journals or a one-off or rare occurrence. It was found that 2,304 out of 10,449 OA diamond journals (78.0%) in DOAJ had deposited one or more article-level records compared to 3,420 out of 3,919 APC-based journals (87.3%) (Fig. 9). This high deposit rate suggests that DOAJ could be the best way to solve this requirement for many OA diamond journals.

Author and grant PIDs

Information about the author and grant PIDs was not available in DOAJ metadata. The subsection "Persistent identifiers (PIDs)" above contains information about the use of ORCID among survey journals. Only 135 journals out of 1,619 surveyed journals (32.4%) used ORCID (Fig. 6).

Self-archiving policy in Sherpa Romeo (source: DOAJ)

Sherpa Romeo is the only self-archiving policy service accepted by Plan S. Some journals used other services. Of DOAJ diamond journals, 1,942 out of 10,449 (18.6%) had a policy to use Sherpa Romeo, compared to 2,041 out of 3,919 APC-based journals (52.1%) (Fig. 10).

Full text in JATS XML (source: DOAJ, survey Q27)

Many journals offered full text in multiple formats. Here, only PDF, XML, and HTML formats were considered. Plan S recommends "a machine-readable community standard format such as JATS XML."

PDF was the most common format, used by more than 99% of all OA journals. OA diamond journals were slightly less likely to offer this format. Still, 98.9% of such journals offered PDF (Table S1). XML was used by 859 of the 10,449 DOAJ OA diamond journals (8.2%) compared to 815 of the 3,919 APC-based journals (20.8%) (Table S2). A total of 1,674 of the 14,368 DOAJ journals (11.7%) produced full-text XML, and larger

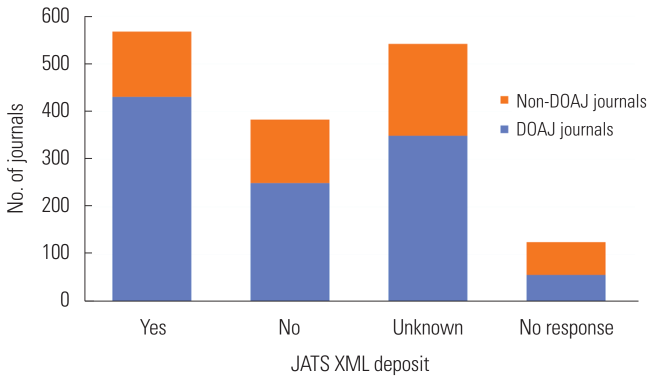

Fig. 11. JATS XML automatic deposit by journal type in the survey. DOAJ, Directory of Open Access Journals.

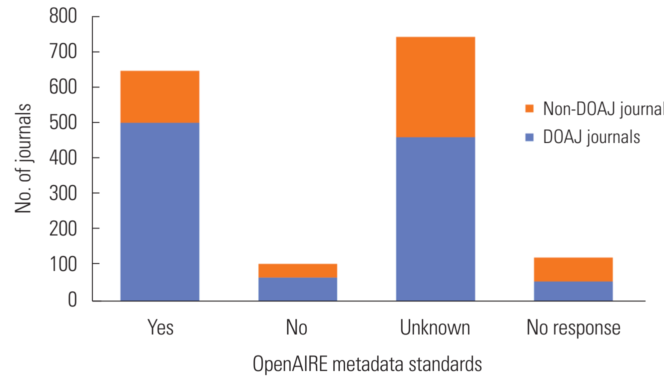

Fig. 12. OpenAIRE metadata standards compliance by survey journal category. DOAJ, Directory of Open Access Journals.

journals were more likely to offer full text in XML. HTML is another full-text format that could satisfy the Plan S requirement (Table S3). It was found that 22.9% of DOAJ OA diamond journals used the HTML format compared to 59.7% of APC-based journals. Table S4 shows the numbers of DOAJ journals offering either XML or HTML. Among the DOAJ OA diamond journals, 25.6% offered XML and/or HTML compared to 63.4% of APC-based journals.

The full-text formats by survey journal category are presented in Table S5. The results generally conform to what was found in DOAJ, but there are some differences. PDF was offered by only 78.2% of the survey-only journals, compared to 99.1% of all DOAJ journals. A higher percentage of survey journals provided XML—including both the survey DOAJ journals and survey-only journals—than the DOAJ OA diamond journals (8.2%). The same was the case for HTML, which was offered by 22.9% of DOAJ OA diamond journals. More than 30% of survey journals offered HTML and/or XML, compared to 25% of DOAJ OA diamond journals.

Automatic deposit of JATS XML in an author-designated repository (source: survey Q47)

While the information on author-designated repositories was not available in the DOAJ metadata, the survey data showed that the JATS XML compliance rate was 35.1% (Fig. 11). However, since more than 40% of journals responded either "unknown" or "no answer," it is difficult to draw exact conclusions on the actual status. DOAJ journals in the survey were more compliant with JATS XML automatic deposit than survey-only journals, but both groups had an "unknown" share of around one-third (Fig. 11).

Compliance with OpenAIRE metadata standards (source: survey Q46)

Although no information was available on compliance with OpenAIRE metadata standards in DOAJ, we found the following in the survey data: the compliance rate was over 40%, but nearly 50% of responses were "unknown" or "no answer." The fact that only 6.5% of respondents answered "no" can be interpreted as a positive sign, as shown in Fig. 12. Survey journals in DOAJ were more compliant than survey-only journals; the latter group had a higher rate of "unknown" or "blank" answers.

Does the journal require linking to data, code, and other research outputs? (source: survey Q540)

Although no information was available in DOAJ on whether journals required links to data, code, and other research outputs, from the survey data, we found that nearly half of respondents reported not requiring this, versus 24.8% that did. Despite more than 25% of answers being "unknown" or "no," this points to a low level of compliance. DOAJ journals in the survey were slightly more compliant than survey-only journals (Fig. 13).

Does the journal provide openly accessible data on citations according to the standards of the Initiative for Open Citations? (source: survey Q55)

No information was available in DOAJ on whether journals provided openly accessible data on citations. Fewer than 25% of journals in the survey did indeed provide such citations, indicating a low level of compliance (Table S6). DOAJ journals in the survey were somewhat more compliant than survey-only journals.

Copyright and licensing

Is the license made visible or embedded in the article? (source: DOAJ, survey Q19)

DOAJ asks journals whether a machine-readable CC license is embedded or displayed in articles. Assuming that all jour-

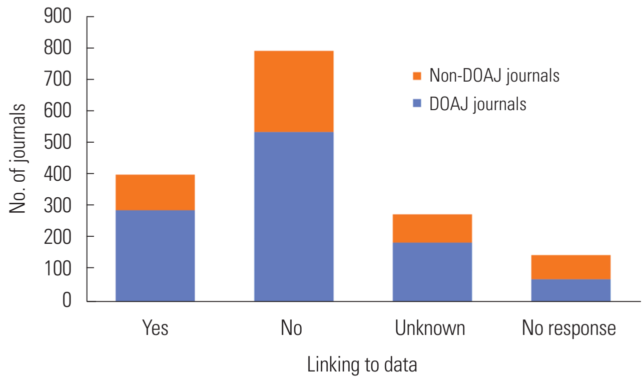

Fig. 13. Journal requirements on linking to data by survey journal category. DOAJ, Directory of Open Access Journals.

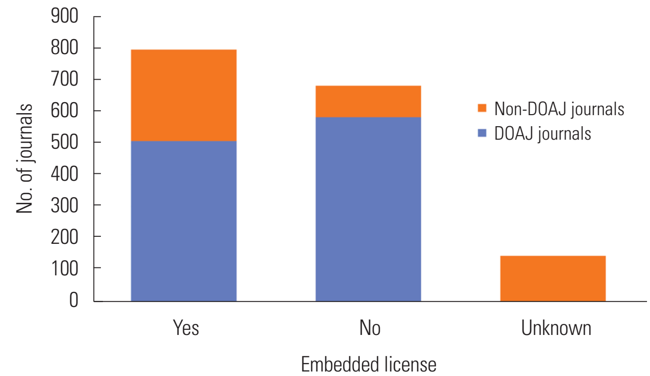

Fig. 15. Embedded licenses by survey journal category. DOAJ, Directory of Open Access Journals.

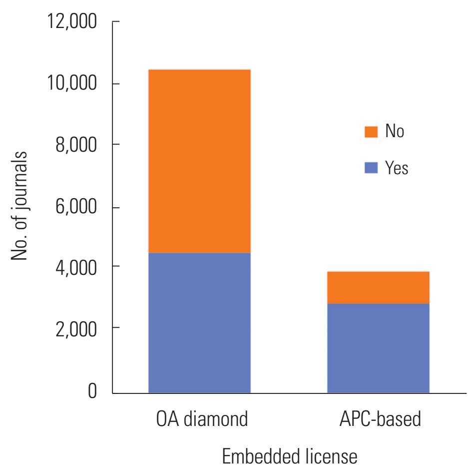

Fig. 14. Embedded licenses by journal category in Directory of Open Access Journals (DOAJ). OA, open access; APC, article processing charge.

nals that have answered "yes" are indeed compliant with the Plan S requirement, 43.4% of DOAJ OA diamond journals were found to be compliant compared to 73.6% of APC-based ones (Fig. 14). A more detailed analysis showed that compliant journals were, on average, larger than noncompliant ones. Hence, 49% of articles in OA diamond journals were published in compliant journals, versus 86.4% of APC-based articles.

In the survey, 793 of 1,619 journals (49.0%) stated that they embedded or displayed licenses in the article. Survey-only journals were more compliant (53.9%) than DOAJ journals (46.6%) in the survey, and DOAJ journals in the survey were also more compliant than OA diamond journals in DOAJ (43.4%) (Fig. 15).

To what extent do OA journals allow reuse and remixing of content, and which CC licenses do they use? (source: DOAJ, survey Q20, Q59)

DOAJ asks journals to list their most restrictive license. We know, though, that some journals allow a number of licenses to be chosen. Although certain journals limit the choices, some alternatives are allowed for authors to choose if mandated by funders. DOAJ is working on allowing journals to list a number of licenses for the author to choose. The listing of the most restrictive license in DOAJ metadata makes it likely that the compliance rate is higher than seen in Fig. 16. We assume that cOAlition S is satisfied if a Plan S-compliant license is available to the author, without all content in the journal being compliant.

Among DOAJ OA diamond journals, 44.2% satisfied the Plan S requirement (CC BY, CC BY-SA, or CC0), while 57.1% of APC-based journals complied. CC BY was the most widely used license; it was used by more than half of APC-based journals and 37.4% of DOAJ OA diamond journals. Some journals listing a restrictive license may also offer a compliant license, but DOAJ asks journals to list only the most restrictive license, which is often the least Plan S-compliant option (Fig. 16).

The NC clause is a significant problem for compliance. CC BY-NC and CC BY-NC-SA licenses, where the NC clause is the reason for the license being noncompliant, were applied by 27.8% of DOAJ OA diamond journals and 26.8% of APC-based journals. If OA diamond journals chose not to use the NC clause, 72.1% of DOAJ OA diamond journals and 80.9% of APC-based journals would be compliant. Furthermore, 23.6% of DOAJ OA diamond journals and 17.3% of APC-based journals used the CC BY-NC-ND license, where both the NC and the ND clauses represent a problem for compliance. The CC BY-ND license (which can be accepted as an individual exception) was used by only 1.4% of all OA diamond journals and hardly any APC-based journals. In the complete survey data, we found that 1,350 of 1,619 journals (83.4%) reported allowing reuse in accordance with a CC license or a license with a similar condition (Table S7).

It should be noted that, in the survey, unlike in DOAJ, jour-

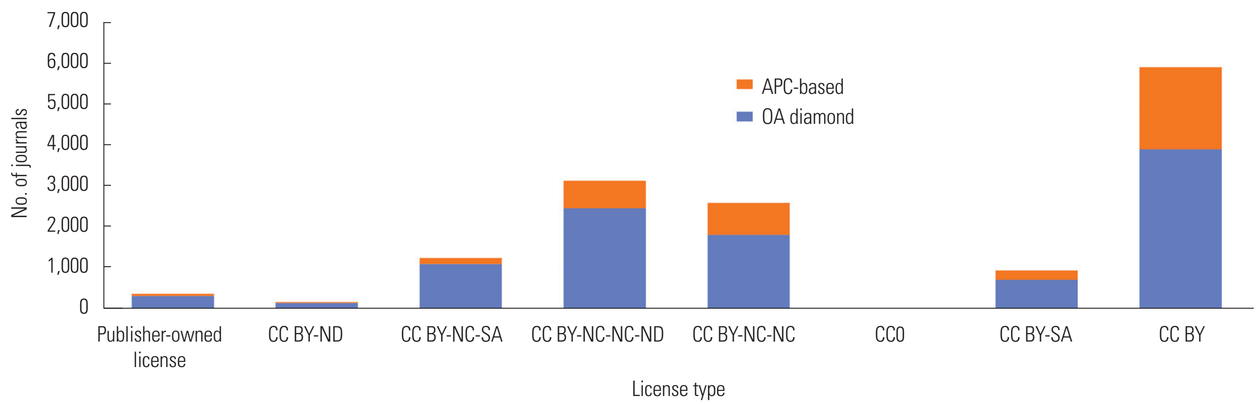

Fig. 16. License types by journal category in Directory of Open Access Journals (DOAJ). APC, article processing charge; OA, open access.

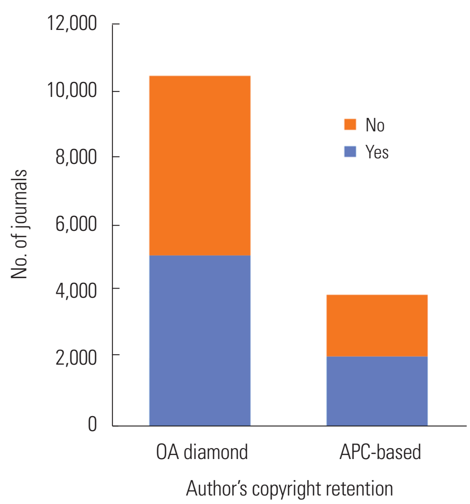

Fig. 17. Author copyright retention policy by journal category in Directory of Open Access Journals (DOAJ). OA, open access; APC, article processing charge.

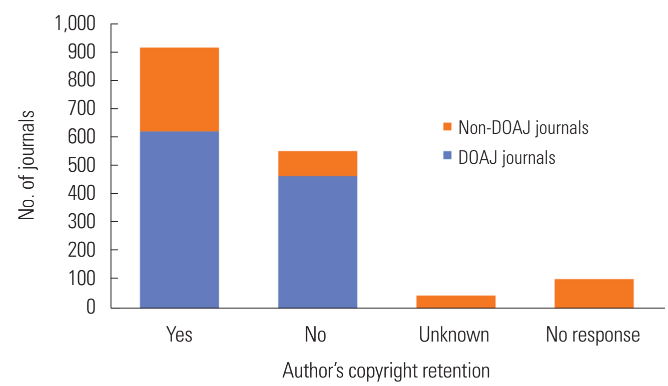

Fig. 18. Survey journals that allow authors to retain copyright without restrictions by journal group. DOAJ, Directory of Open Access Journals.

nals could list more than one license. Hence, the 1,350 journals listed 1,363 responses to this question, and the sum of percentages reflect this. Of the 1,350 respondents that replied "yes" to Q20, 48 did not provide information about their license. CC BY was the most widely used among survey journals, with CC BY-NC-ND in second place. Nearly 50% of these journals were compliant with the Plan S requirements.

To what extent is copyright retention without restrictions allowed, and if not, what plans to introduce this? (source: DOAJ, survey Q22)

Among the DOAJ OA diamond journals, 48.7% stated that authors hold the copyright without restrictions compared to 53.0% of APC-based DOAJ journals (Fig. 17). OA diamond journals were slightly less compliant (48.7%) than APC-based journals (53.0%).

In the survey, Q22 asked whether the journal allows authors to retain copyright without restrictions. DOAJ journals in the survey allowed author copyright retention to a somewhat larger extent than survey-only journals; DOAJ journals had a compliance rate of 57.2% compared to 55.3% for survey-only journals (Fig. 18). Unlike the previously discussed technical questions, this policy question had few "unknown" or "blank" answers. A majority of responses were positive, meaning that the journal conformed to Plan S requirements.

Those who did not answer "yes" to the above question were asked in Q23 to indicate whether they intended to allow authors to retain copyright in the future. The responses indicated that not many journals plan to change their policies to align better with Plan S requirements (Table S8).

Discussion

Key results

This study investigated how well journals in DOAJ and the survey conformed to Plan S requirements and recommendations. Six requirements were confirmed based on the DOAJ metadata, which included license, peer review, author copyright, article permanent ID, permanent preservation, and machine-readable license. Peer review was the one requirement that all but one journal satisfied. Permanent preservation was the requirement with the lowest compliance among journals, at 28.9%, and only 19.1% for OA diamond journals (Table S9). APC-based journals met more requirements than OA diamond journals. The journals that met few criteria were predominated by OA diamond journals, while APC-based journals predominated among the journals that satisfied all requirements.

Interpretation

The most striking difference in peer review requirements is that double-blind peer review was more commonly used by OA diamond journals, while APC-based journals more commonly used blind peer review (Fig. 2). However, this phenomenon might have been more a matter of semantics than reality, as labels for authors' and reviewers' anonymization processes vary over time [2]. For small journals, the expense of DOI deposits to Crossref is a problem (Fig. 6). The DOI deposition cost to Crossref is USD 1 per article; however, the annual membership fee to Crossref is USD 275 per year, which may be burdensome to small societies or institutions. The publisher pays the annual fee, so that many journals could be covered by a single annual fee if appropriately organized. One method is for an organization, such as a publishing company or an editor's organization, to sponsor publishers of small journals.

As for digital archiving, the Plan S requirement for content archiving is unclear as to what services conform to the requirement (Fig. 8). Journals need guidance on what is meant more specifically by archiving in this context, what possibilities exist, and how journals can use archives at low or no cost. Some groups of journals might need financial support to find a working solution to the archiving requirement.

DOAJ metadata do not provide information on whether the journal makes article-level metadata available under a CC0 license (Fig. 9). However, if a journal deposits article-level metadata with DOAJ, the metadata are made available under a CC0 license in various ways, including API, OAI-PMH, and a full data dump of all journal metadata. Therefore, journals depositing article-level metadata with DOAJ fulfill the article metadata requirement. cOAlition S requires these metadata to include funding information, but such information is not yet generally available in DOAJ.

A more detailed analysis indicated that larger journals tended to offer XML or HTML to a more considerable extent than smaller ones. Even among APC-based journals with income that can be used to pay for XML or secure in-house competence, XML is only offered by a fifth of them. This means that full-text JATS XML is still not a concern for many OA journals.

The low adherence of OA diamond journals to industry standards, especially to the Plan S technical requirements, might originate from the publishers' or editors' lack of knowledge and skills in journal publishing. Out of the items analyzed, full-text JATS XML file production and DOI deposit require payment. Archiving also requires a fee if the journal is archived in Portico, LOCKSS, or CLOCKSS. Archiving in a country's national library usually requires no cost if the library has an archiving policy. All other items can be easily adopted if the publisher or editor understands the above requirements. Other descriptions or policies can be easily achieved by the editor or publisher through prompt action. It is necessary to inform OA diamond journal publishers about the relevant knowledge and technologies in light of their incomplete adherence to industry standards (Table S9).

Comparison with previous studies

The literature has shown that so-called international standards (COPE, International Committee of Medical Journal Editors [ICMJE]) were far from universally practiced. For example, "top-ranked" or Web of Science (WoS)-endorsed journals, even when they formally declared that they followed standards, had various authorship policies [3,4], as well as distinct duplicate and salami-slicing policies—or even no policies at all [5]. However, those three studies were not large-scale investigations. There is no previous study directly comparable to the present study.

Limitations

There may have been sampling bias as a limitation of voluntary participation.

Generalizability

These large-scale survey results may be able to provide information on the current status of adherence to the Plan S requirements of OA diamond journals throughout the world.

Conclusion

It was found how well journals in DOAJ and in the survey conformed to Plan S requirements and recommendations. In general, smaller journals scored lower on these criteria than larger ones, and OA diamond had poorer results than APC-based journals. Structurally, smaller journals are more likely to be OA diamond, so these results imply that the same factors may manifest themselves in various ways. Size relates to the likelihood and operational need for gaining competence—that is, the larger the journal, the larger the need for competence, and the better the chances of achieving competence.

APCs enable the journal to pay costs and buy competence, either by outsourcing functions or by hiring persons in the organization. This situation does not mean that APCs are the solution, but it indicates that funding beyond in-kind contributions must be considered vital to ensure strong and healthy OA diamond journals. It also points to a need for journal owners of all kinds to organize journals so that resources are pooled, and competence is built up collectively among many journals.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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OPERA, Open Access Scholarly Publishing Association (OASPA), SPARC Europe, Directory of Open Access Journals (DOAJ), Utrecht University Library, Redalyc/AmeliCA, UiT The Arctic University of Norway, and Ligue des Bibliothèques Européennes de Recherche-Association of European Research Libraries (LIBER) supported this research by providing personnel, databases, or systems.

Data Availability

This dataset contains data used by and partly generated by the OA Diamond Journals Study on open access journals that do not charge authors. It contains the data files themselves, as well as some readme texts with variable lists available from https://doi.org/10.5281/zenodo.4553103. All data are available for reuse under a CC0 license. Additionally, an online version of the survey results (excluding DOAJ data and excluding free text answers) is available from SurveyMonkey https://ko.surveymonkey.com/results/SM-5RY8WNNP7/.

Dataset files are available from https://doi.org/10.7910/DVN/HVGNGY.

Dataset 1. Raw response data from the survey participants of 94 questions for open access diamond journals' status from June 2020 to February 2021 without identifying information and without free-text answers (CSV). This dataset includes, for some questions, data from DOAJ for journals present in that database.
Dataset 2. Readme text with the variable list for the survey data file (TXT).

Supplementary Materials

Supplementary files are available from https://doi.org/10.7910/DVN/HVGNGY, https://doi.org/10.7910/DVN/HENMEI.

Suppl. 1. Survey form of 93 questions in PDF format for open access diamond journals' status from June 2020 to February 2021.
Suppl. 2. Data for Figs. 1–18.

Supplementary tables
Table S1. PDF as a full-text format by DOAJ journal category
Table S2. XML as a full-text format by DOAJ journal category
Table S3. HTML as a full-text format by DOAJ journal category
Table S4. HTML or XML as a full-text format by DOAJ journal category
Table S5. Survey full-text format by survey journal category
Table S6. Citations made available according to I4OC standards by survey journal category
Table S7. Survey journals applying Creative Commons licenses
Table S8. Survey journals that plan to allow authors to retain copyright without restrictions
Table S9. DOAJ journals conforming to Plan S requirements by DOAJ journal category (percentages)

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Original Article

Changes in the absolute numbers and proportions of open access articles from 2000 to 2021 based on the Web of Science Core Collection: a bibliometric study

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Abstract

Purpose: The ultimate goal of current open access (OA) initiatives is for library services to use OA resources. This study aimed to assess the infrastructure for OA scholarly information services by tabulating the number and proportion of OA articles in a literature database.

Methods: We measured the absolute numbers and proportions of OA articles at different time points across various disciplines based on the Web of Science (WoS) database.

Results: The number (proportion) of available OA articles between 2000 and 2021 in the WoS database was 12 million (32.4%). The number (proportion) of indexed OA articles in 1 year was 0.15 million (14.6%) in 2000 and 1.5 million (48.0%) in 2021. The proportion of OA by subject categories in the cumulative data was the highest in the multidisciplinary category (2000–2021, 79%; 2021, 89%), high in natural sciences (2000–2021, 21%–46%; 2021, 41%–62%) and health and medicine (2000–2021, 37%–40%; 2021, 52%–60%), and low in social sciences and others (2000–2021, 23%–32%; 2021, 36%–44%), engineering (2000–2021, 17%–33%; 2021, 31%–39%) and humanities and arts (2000–2021, 11%–22%; 2021, 28%–38%).

Conclusion: Our study confirmed that increasingly many OA research papers have been published in the last 20 years, and the recent data show considerable promise for better services in the future. The proportions of OA articles differed among scholarly disciplines, and designing library services necessitates several considerations with regard to the customers' demands, available OA resources, and strategic approaches to encourage the use of scholarly OA articles.

Keywords

Data management; Information services; Open access; Public access; Open science

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Introduction

Background

The current status of open access (OA) initiatives has been criticized by a number of stakeholders, one of whom has pointed out that "the current journal market is failing to operate optimally—particularly in relation to journal access and the cost of Gold OA" [1]. Slow progression, increasing costs, and resistance from researchers and publishers are issues related to OA compliance [2,3]. These negative views on OA are based on its production side, where the increased production of OA scholarly articles has been counteracted by the simultaneous increase in subscription-based publications. The increase in scholarly publications, including both subscription-based and OA journals, has resulted in growing subscription costs for libraries and article processing costs for authors aiming to publish OA articles [4].

OA for scholarly information has been a key agenda for knowledge production and exchange since the 2002 Budapest initiative [5]. The international community has made efforts to spread the OA campaign so that anyone can freely use research results without any economic, legal, and technical barriers [6–8]. On November 23, 2021, the United Nations Educational, Scientific and Cultural Organization (UNESCO) Recommendation on Open Science [9] was adopted by 193 member countries, including South Korea. The US governmental policy has been enhanced by removing the current 12-month embargo period on making federally funded research publications publicly accessible earlier [10].

To present a professional advisory opinion on establishing a national OA policy in Korea, the authors recently published a report analyzing the current OA status of scholarly publishing and its general principles, focusing on future practical tasks and the roles of various officials by synthesizing discussions about achieving OA [11]. As an extension of our report, this research will demonstrate some practical ways to implement OA services and formulate the further development of the government's current OA policies [12].

This study investigated aspects of public library services for scholarly information, such as why and for whom these services are necessary and what their requirements are. More specifically, this study focused on the amount of available OA articles, which is the starting point of public services providing scholarly OA information. The content quality, subject domains, document types, and users' preferences have to be considered when assessing the quantity of OA resources. Moreover, different types of OA involve different routes of access, such as gold OA, hybrid gold OA, and access through institutional repositories of public platforms for OA articles, which must be incorporated into the public database search.

Objectives

This study aimed to identify changes in the number and proportion of OA articles from 2000 to 2021 based on the Web of Science (WoS) Core Collection [13]. Specifically, first, changes were analyzed according to document type. Second, changes in the six major categories of research were investigated; and third, annual trends in OA and non-OA documents were traced.

Methods

Ethics statement

Neither approval by the Institutional Review Board nor obtainment of informed consent was required since this was a literature-based study.

Study design

This was a descriptive study based on a bibliometric analysis of the literature database.

Outcomes

The analysis involved querying the database for the number of documents available as OA at the production level. The absolute number and proportion of OA articles were used as basic parameters. The time of document production was categorized into two data sets: the cumulative data from 2000 to 2021 and 1-year data from 2021. Furthermore, the document type selection and subject domains for analysis were considered as parameters. Different types of OA have different access routes, and production and availability were studied as basic infrastructure for designing search and service systems.

Data sources/measurement

Database for the collection of scholarly information

We used WoS [13] to collect data on scholarly publications. The documents indexed in this database are considered to have met the selection criteria and been certified as having a representative level of quality. The classification system of the academic disciplines and document types used in the database was applied; no exclusions or additions were made.

Assessment of the types of documents

We checked the number of documents available based on the 43 types of documents in the WoS database. The four main types—articles, proceedings papers, review articles, and letters—were analyzed. We found that a reasonable set of documents consisted of the aforementioned four main types. Thereafter, we sorted these four types by research discipline. The other 39 types were analyzed in a similar way.

Discipline-based quantitation of OA documents

The classification system of academic domains was adopted from that of WoS. A total of 254 disciplines were grouped into 25 subcategories, which were further grouped into six categories: (1) multidisciplinary; (2) health and medicine; (3) natural sciences, including environmental science, agriculture, and geoscience; (4) social sciences and others, including education, law, economics, and management; (5) engineering; and (6) humanities and arts. The numbers and proportions of OA articles were displayed according to the long-term trends of 22 years (2000–2021) and recent statistics of 2021. An additional analysis of the OA status of multidisciplinary science journals was conducted.

Annual trends in OA and non-OA documents

Detailed data on the trends on a yearly basis were shown for selective representative disciplines. The yearly trends were analyzed and discussed.

Bias

There was no bias in selecting the target articles.

Study size

No sample size estimation was required since this study included all target journals in two databases.

Statistical methods

Descriptive statistics were used for the data analysis.

Results

Assessment of the types of documents and OA

Articles were the most common document type. In total, 10.6 million articles were available as OA, corresponding to 35.6% of all produced research articles between 2000 and 2021 (Table 1).

The proportion of OA among articles in 2021 was higher, at 49.5%. Proceedings papers, which are often produced in the engineering discipline, were the second most common document type. Slightly fewer than 1 million proceedings papers were OA, and they accounted for 13.9% of all produced papers of this type; however, this percentage increased to 24.9% in 2021.

We selected four types of documents, articles, proceedings

Table 1. Document types and the numbers of total and OA documents between 2000 and 2021 and in 2021

Document type	2000–2021		2021	
	OA	Total	OA	Total
Major document type	12,424,254 (32.4)	38,392,794	1,521,946 (48.0)	3,169,557
Article	10,606,776 (35.6)	29,763,437	1,251,966 (49.5)	2,530,247
Proceedings paper	993,209 (13.9)	7,170,262	35,689 (24.9)	143,224
Review article	798,786 (43.2)	1,849,038	133,613 (59.9)	223,222
Letter	279,927 (28.0)	999,665	30,763 (49.0)	62,797
Others	1,362,775 (12.9)	10,581,479	142,251 (27.0)	527,383
Meeting abstract	390,880 (7.0)	5,555,017	27,973 (12.3)	228,172
Editorial material	673,357 (31.2)	2,154,842	70,794 (45.5)	155,582
Book review	54,867 (3.4)	1,615,365	6,175 (9.3)	66,082
News item	44,609 (9.6)	462,845	2,043 (15.6)	13,073
Correction	170,345 (52.4)	324,825	26,209 (74.4)	35,219
Early access	41,312 (27.0)	153,211	35,965 (27.6)	130,091
Biographical item	19,258 (16.3)	118,063	1,715 (34.3)	4,994
Poetry	391 (0.3)	116,131	36 (0.9)	3,926
Book chapter	12,571 (18.6)	67,619	899 (19.2)	4,673
Art exhibit review	111 (0.2)	53,606	11 (0.6)	1,708
Other	9,120 (5.1)	180,279	2,270 (32.7)	6,938
Total	13,787,029 (28.2)	48,974,273	1,664,197 (45.0)	3,696,940

Values are presented as number (%) or number only.
OA, open access.

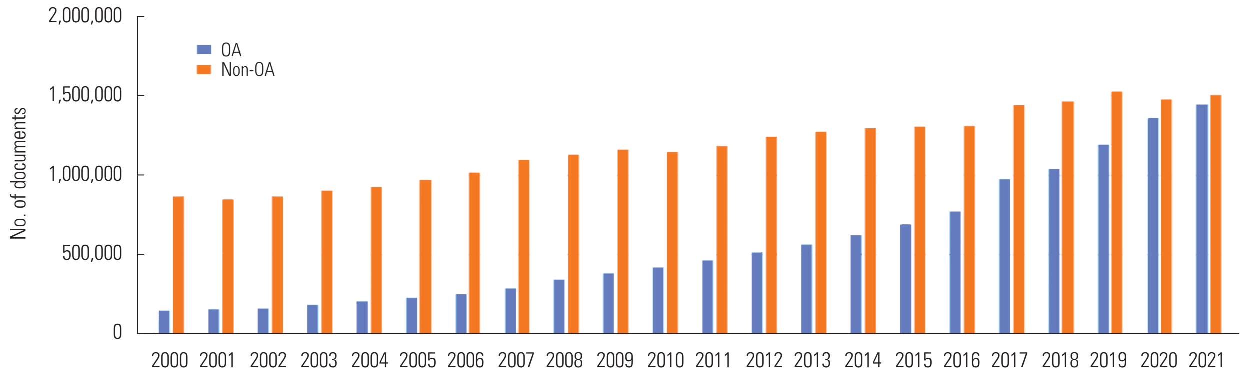

Fig. 1. Four major document types (articles, proceedings papers, review articles, and letters) and the numbers of open access (OA) and non-OA documents between 2000 and 2021.

papers, review articles, and letters, as the key sets for our data retrieval. These document types encompassed 90.1% of all OA documents between 2000 and 2021 and 91.5% of all OA documents in 2021. OA documents of these four types accounted for 32.4% of all publications between 2000 and 2021 and 48.0% in 2021.

The annual trends in OA and non-OA documents among the four major document types (Fig. 1) and among all types of documents (Fig. S1) are shown. The numbers (proportions) of 1-year production of OA documents in 2000 and 2021 were 148,642 (14.6%) and 1,521,946 (48.0%), respectively. The total number of both non-OA and OA documents increased from 2000 to 2021; however, the increment rate was higher for OA documents (×10.2) than for the total number (×3.1) and non-OA documents (×1.9).

Discipline-based quantitation of OA documents

The numbers and proportions of OA articles among the total publications are shown for six categories, 25 subcategories, and 254 disciplines. The numbers and proportions of OA are displayed in the form of long-term trends between 2000 and 2021 and the recent statistics from 2021. The data and interpretation of the data are shown for six categories, and a total list of six categories and 25 subcategories are shown in Table 2.

Multidisciplinary sciences: the numbers and proportions of OA documents

This category corresponds to a single discipline: multidisciplinary sciences. The proportions of OA articles were 79% between 2000 and 2021 and 88.6% in 2021 (Table 2). The annual trends in OA and non-OA articles in the multidisciplinary sciences discipline showed a rapid increase in OA articles from 2008 to 2011 (Fig. 2). To explain this increase, data regarding the top 20 journals (based on the number of published articles) in this discipline are displayed. These include the numbers of total and OA documents and their proportions between 2000 and 2021 and 2021, along with the year that the journal was first indexed in the database (Table S1). Among the top 20 journals, nine journal titles are recently founded OA journals. Four journals—*PLoS One, Scientific Reports, Proceedings of the National Academy of Sciences of the United States of America*, and *Nature Communications*—published 74.4% (2000–2021) and 63.4% (2021) of all published OA articles in this discipline. A total of 686,485 documents were available as OA articles, and they constituted useful OA resources for every subject domain. The proportion of OA documents in *Nature* in 2021 was high (62.3% among all types of documents). The proportion of OA documents limited to the “article” type was higher (Fig. S2).

Health and medicine: the numbers and proportions of OA documents in four discipline subcategories

This category comprises many different health and medicine disciplines, classified into four subcategories (Table S2). The proportions of OA articles were 37% to 40% between 2000 and 2021 and 52% to 60% in 2021 (Table 2). Detailed data on four subcategories are shown in Tables S3–S6. The annual trends in OA and non-OA articles in the discipline of infectious diseases showed a rapid increase in OA documents in the most recent 10 years, whereas the number of fee-based articles was stationary (Fig. 3). The recent increase in OA articles is seen in almost every discipline, including oncology (Fig. S3).

Natural sciences: the number and proportion of OA documents in seven subcategories

Seven subcategories in the natural sciences category showed relatively high numbers of total and OA articles (Table S7). The most recent data from 2021 showed proportions of 41% to 62%, and the long-term trends between 2020 and 2021 presented proportions ranging from 21% to 46% (Table 2). Two

Table 2. List of six categories and 25 disciplinary subcategories and the numbers of OA and total documents in 2000–2021 and 2021

Category	No. of disciplines	2000–2021		2021		Data table
		OA	Total	OA	Total	
Multidisciplinary (sciences)	1	686,445 (79.0)	868,859	78,565 (88.6)	88,683	Table S1
Health and medicine						
General	8	651,253 (40.6)	1,603,834	96,328 (60.6)	158,997	Table S3
Basic	12	915,685 (39.9)	2,295,253	103,462 (56.6)	182,939	Table S4
Clinical	13	1,601,713 (40.5)	3,956,573	209,337 (60.8)	344,556	Table S5
Oran systems	21	1,750,733 (37.4)	4,675,775	177,316 (52.1)	340,186	Table S6
Natural sciences						
Biosciences	23	2,362,519 (45.6)	5,184,878	234,480 (62.3)	376,198	Table S9
Chemistry	9	834,015 (21.4)	3,895,728	127,198 (41.0)	310,400	Table S10
Mathematics	5	637,140 (44.4)	1,434,463	59,396 (54.6)	108,706	Table S11
Physics and astronomy	12	1,564,141 (33.4)	4,685,703	131,878 (48.4)	272,246	Table S8
Environmental science	4	463,807 (31.3)	1,479,662	87,502 (49.6)	176,498	Table S12
Geoscience	6	299,490 (31.1)	963,123	35,759 (46.2)	77,389	Table S13
Agriculture, fishery, and forestry	11	427,452 (28.9)	1,477,346	55,098 (45.2)	121,890	Table S14
Social sciences and others						
General	18	359,693 (26.3)	1,368,694	45,918 (41.6)	110,474	Table S16
Psychology	11	292,831 (31.8)	921,275	34,277 (44.1)	77,712	Table S17
Education and ethics	5	162,213 (24.9)	651,781	23,799 (41.6)	57,218	Table S18
Law, economics, management	8	342,027 (23.8)	1,440,011	43,776 (36.2)	120,813	Table S19
Engineering						
General	12	579,970 (33.4)	1,735,150	83,271 (39.0)	213,787	Table S21
Architecture, urban planning, and construction	6	114,478 (19.7)	580,902	15,260 (31.4)	48,643	Table S22
Computer	9	712,959 (18.0)	3,954,395	84,288 (36.9)	228,652	Table S23
Major	16	1,206,647 (17.1)	7,058,382	171,621 (34.3)	500,285	Table S24
Materials	10	632,433 (20.2)	3,129,774	94,708 (36.4)	259,976	Table S25
Humanities and arts						
General	7	103,800 (22.2)	468,470	14,978 (37.9)	39,530	Table S27
Literature	10	19,770 (11.6)	171,127	2,864 (28.8)	9,957	Table S29
History	6	66,306 (19.7)	336,673	8,994 (36.9)	24,362	Table S28
Arts	8	108,873 (19.3)	564,252	13,267 (34.7)	38,240	Table S30

Values are presented as number (%) or number only.
OA, open access.

subcategories, biosciences and mathematics, showed high proportions (44%–46%) of OA. Four subcategories—physics, environmental, geoscience, and agriculture/fishery—had OA proportions of 29% to 33%, and the chemistry subcategory showed the lowest proportion (21%). Details of the subcategories are shown in Tables S8–S14.

Particle physics and astronomy/astrophysics are known as fields in which OA research predominates, and the proportions of OA articles in 2021 were 88% and 83%, respectively (Table S8). The annual trends in astronomy/astrophysics showed a rapid shift to OA publishing from 2005–2006, and OA publications have thereafter predominated, accounting for 80% or more in recent years (Fig. 4). The annual trends in applied physics show a definitive transformation of fee-based publishing to OA publishing (Fig. S4)

Data on 23 disciplines within the natural sciences showed

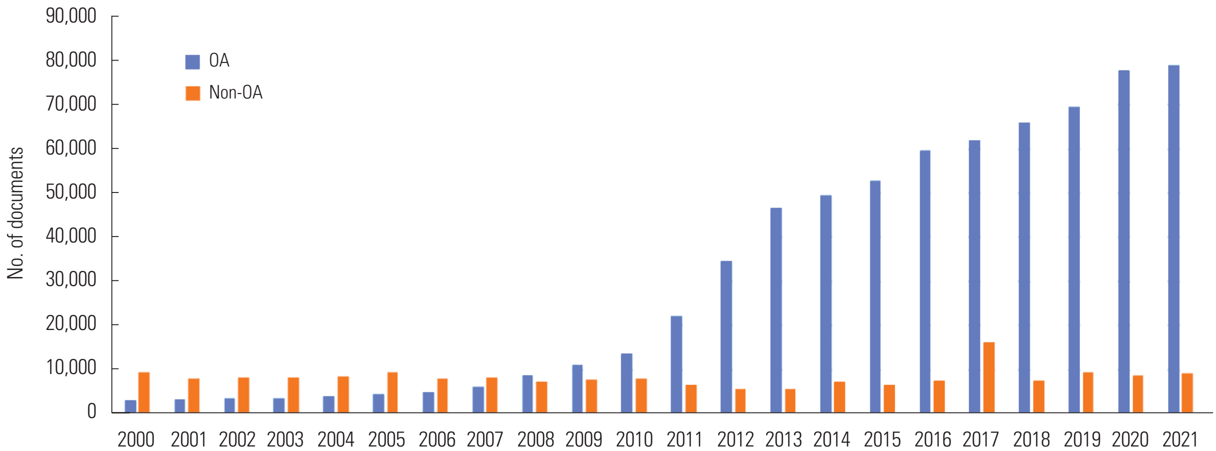

Fig. 2. The multidisciplinary sciences discipline and the numbers of open access (OA) and non-OA documents between 2000 and 2021.

Fig. 3. The discipline of infectious diseases and the numbers of open access (OA) and non-OA documents in 2000–2021.

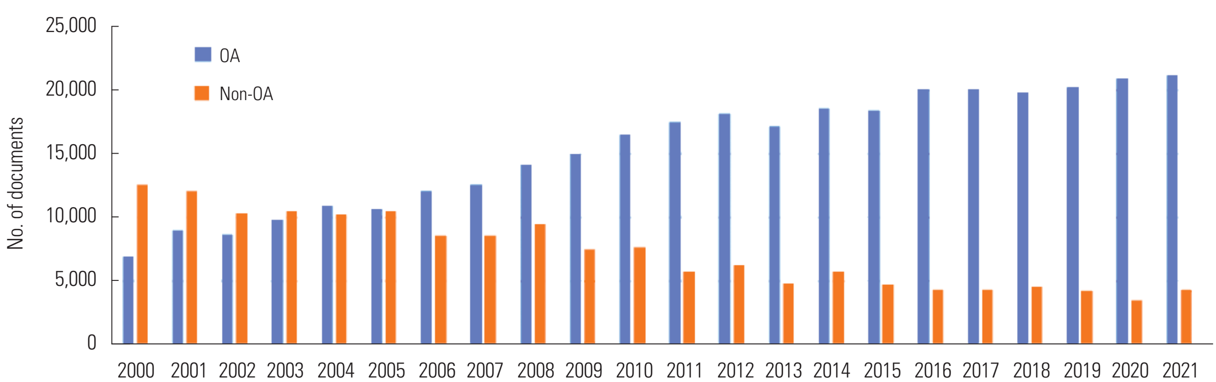

Fig. 4. The discipline of astronomy/astrophysics and the numbers of open access (OA) and non-OA documents between 2000 and 2021.

that the subcategory of biosciences had the highest proportions of OA among the seven subcategories at 45.6% between 2000 and 2021 and 62.3% in 2021 (Table S9). Two disciplines (microbiology and virology) within the biosciences subcategory of the natural sciences had high proportions of OA documents, exceeding 60%. The annual trends in the numbers of OA and non-OA documents in the microbiology subcategory (Fig. S5) showed a predominance of OA articles over non-OA articles, and the pattern was similar to that of infectious diseases (Fig. 3). The discipline of biochemistry/molecular biology also showed an increase in OA articles, although the baseline of fee-based documents remained constant (Fig. S6).

Fig. 5. The discipline of economics and the numbers of open access (OA) and non-OA documents between 2000 and 2021.

The subcategory of chemistry showed a relatively low, but increasing, OA proportion (Table S10). The subcategory of mathematics showed a high OA proportion, similar to that of biosciences (Table S11). The subcategory of environmental sciences also showed a high proportion, but considering the common demands related to environmental issues, the figures were lower than expected (Table S12). However, the analysis of annual trends showed a recent rise in OA articles in the environmental sciences discipline (Fig. S7). The subcategory of geoscience had 30% of resources available as OA, corresponding to the middle of the natural sciences category (Table S13). The agriculture, fishery, and forestry subcategory showed a moderate penetration of OA (Table S14). The annual trends in dairy animal science and food science/technology showed a recent rise in OA articles (Figs. S8, S9). A few subcategories within the same category showed lower proportions; however, the total numbers of articles were small in these subcategories, suggesting selection bias.

Social sciences and others, including education, law, economics, and management: the numbers and proportions of OA documents in four subcategories

This category comprises four subcategories: social sciences; psychology; education; and law, economics, and management (Table S15). These subcategories have the common features of basic and applied social sciences. The proportions of OA articles were 23% to 32% between 2000 and 2021 and 36% to 44% in 2021 (Table 2). Detailed results for the four subcategories are shown in Tables S16–S19. Eight disciplines in the subcategory of law, economics, and management showed similar OA proportions and increasing trends over time (Table S19). The annual trends in OA and non-OA articles in the economics discipline are shown in Fig. 5. The annual trends in OA and non-OA articles in five disciplines—education/educational research, business finance, management, political science, and law—are shown in Figs. S10–S14.

Engineering: the numbers and proportions of OA documents in five subcategories

This category comprises several different domains of engineering, classified into five subcategories (Table S20). The proportions of OA articles were 17% to 33% between 2000 and 2021 and 31% to 39% in 2021 (Table 2). The details of the five subcategories are shown in Tables S21–S25. At least 16 disciplines in the subcategory of major engineering showed similar figures of OA proportions and increasing trends over time (Table S24). The annual trends in OA and non-OA articles in the discipline of electrical/electronic engineering are shown in Fig. 6. The OA trends in nanotechnology/nanoscience are presented in Fig. S15.

Humanities and arts: the numbers and proportions of OA documents in four subcategories

The category of humanities and arts consists of an arbitrary list of disciplines with low OA penetration (Table S26). The most recent data from 2021 showed 29% to 38% penetration, and the long-term trends between 2020 and 2021 ranged from 12% to 22% (Table 2). Detailed data are shown in Tables S27–S30.

Among the 10 disciplines in the humanities and arts, the lowest OA was found for literature, with proportions of 11.6% between 2000 and 2021 and 28.8% in 2021 (Table S29). Three subcategories—general humanities, history, and arts—showed proportions of 19% to 22% between 2000 and 2021 and 34% to 38% in 2021. The annual trends in the literature disciplines in a 22-year period are shown in Fig. 7. The number of non-OA articles in literature remained stationary, while that of OA articles has been increasing gradually. The annual trends in linguistics have shown increases in both OA and fee-based articles (Fig. S16).

Annual trends in OA and non-OA documents

Four patterns are recognized in the annual trends of OA and non-OA documents.

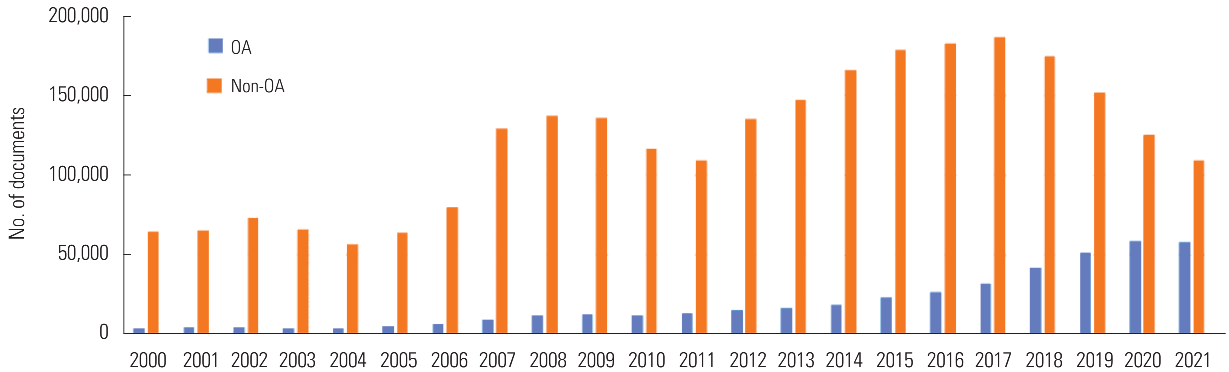

Fig. 6. The discipline of electrical/electronic engineering and the numbers of open access (OA) and non-OA documents between 2000 and 2021.

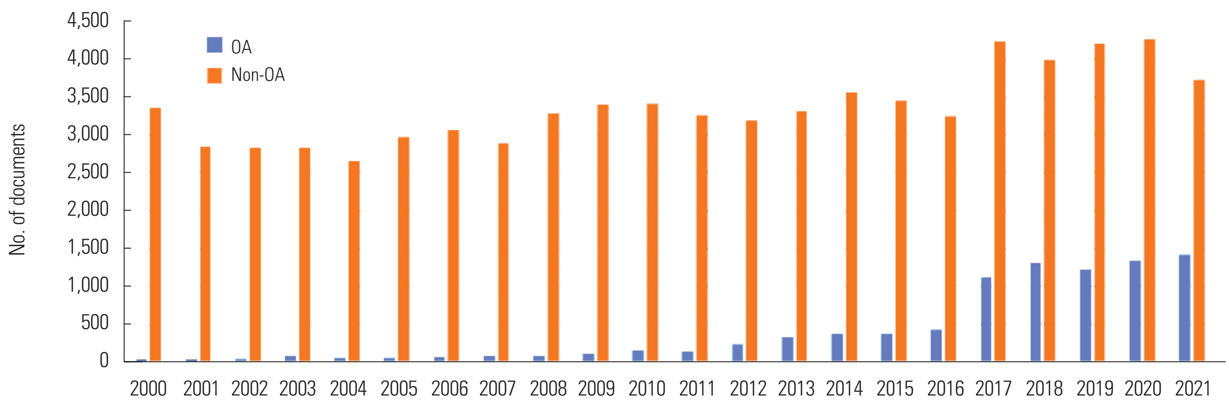

Fig. 7. The discipline of literature and the number of open access (OA) and non-OA documents between 2000 and 2021.

Transformative pattern

A rapid increase in OA documents coupled with a rapid decrease in non-OA documents means that fee-based journals have been transformed into OA journals or authors have chosen OA publishing. Examples of this pattern are furnished by astronomy/astrophysics (Fig. 4), electrical/electronic engineering (Fig. 6), applied physics, and education/educational research (Figs. S4, S10)

Rapid increase in OA and a plateau in non-OA documents

A rapid increase in OA publications with a stationary pattern in non-OA documents was the most common pattern in the categories of health and medicine and natural sciences. The expansion of these academic domains is evident, and most new articles are published in newly established OA journals. Multidisciplinary sciences, infectious diseases, and microbiology provide examples of this pattern (Figs. 2, 3, S5). The amount of non-OA documents published in traditional journals remained constant in those disciplines. Some disciplines have strong fee-based journals with a high number of publications, so the relative proportion of non-OA documents remains high. Oncology, biochemistry, molecular biology, and agriculture–dairy animal sciences are examples (Figs. S3, S6, S8).

Increases in both OA and non-OA documents

Increases in both OA and non-OA documents were observed in domains where the amount of publications has recently increased. Examples in the social sciences category include the subcategories of economics, business finance, and law, while some examples in the natural sciences are the subcategories of environmental science and food science/technology. Additional examples of this trend include the subcategory of nanoscience/nanotechnology in the engineering category and the subcategory of linguistics in the humanities.

Other patterns

The fourth pattern involved a minimal increase in OA documents, with non-OA documents remaining the predominant type of publishing. Examples are literature (Fig. 7) and management (Fig. S12). Other nonspecific patterns occurred, which were probably related to the small number of published documents.

Discussion

Key results

The growing trends in the numbers and proportions of OA documents during the study's approximately 20-year period must be recognized. The number of OA articles available on WoS between 2000 and 2021 was 12 million, amounting to 32.4% of all articles. The 1-year data from 2021 was 1.5 million, amounting to 48%. The proportion of OA documents was the highest in the multidisciplinary, natural sciences, and health and medicine categories, in which OA documents comprised 50% or more of the total documents. The categories of social sciences and others, engineering, and humanities and arts had proportions of around 30% to 40%, but these proportions are increasing.

Interpretation

The availability of OA resources can be expressed as the percentage of all documents. Data from previous research have shown different figures depending on the types of resources and years of publication. The proportion stood at 45% among articles published in 2015 and 28% in the cumulative data at the same time [14]. Our equivalent data would be 49.5% in 2021 and 35.6% between 2000 and 2021. However, the time of assessment is an important factor. A dramatic change occurred due to advances in the search function, and we believe that the aggregation of metadata on hybrid gold OA and green OA could uncover those hidden OA documents. Other examples of differences are a reported proportion 14% in 2019 [15] versus 48.4% in 2021 (current study) in the physics and astronomy subcategory. This difference is partly explained by the inclusion of only gold OA in the study of Demeter et al. [15], whereas our data include other types of OA. The details of document types were not explained. Thus, we selected only the four types necessary for services. The absolute number and proportional data among all resources were analyzed. We found that an optimal denominator was critical for our assessment of the proportion. For example, the document type was one of the important criteria for selecting document types for the denominator. Four document types (articles, review articles, proceedings papers, and letters) were chosen for the data pool of our denominator [16]. The annual trends used for evaluation were simplified to 2000–2021 and 2021, and an annual comparison between OA and non-OA was added for individual subjects.

The academic discipline was an important parameter for our assessment of the proportion of OA documents, reflecting its importance for user services. The domains of research subjects can be defined in different manners, and the details of the scope, level, and other service-related factors should be critically reviewed.

The most significant result of this study was the high rate of OA documents in the multidisciplinary category. This category did not show OA predominance group until 2009, when a rapid surge in OA documents was observed (Fig. 2). Two OA journals, *PLoS One* and *Scientific Reports*, were the definitive leading cause of this change. We also found a major change in researchers' publishing patterns. Domain-specific research was gradually replaced by interdisciplinary or multidisciplinary research, and multidisciplinary journals are more often selected by authors for publication. An increase in OA documents was also noted in premium scholarly journals, such as *Nature* (Fig. S10) and *Science*. We believe that these journals have been influenced by the OA mandate policy in developed countries in the West. The best research papers supported by the governmental research funds of top-ranked countries are published in these top journals as hybrid gold OA. The documents in this multidisciplinary category are a fundamental resource for new OA-based library services.

Significant trends for OA were also observed in the health and medicine category. The public demands for health and well-being reflect this trend. Authors willingly share their research, and health professionals feel satisfaction if they become well-known for their scientific excellence. The high rates of OA in articles on infectious diseases and general healthcare are manifestations of the authors' willingness to share. The participation of medical and healthcare professionals as volunteers for ancillary services, in addition to OA scholarly library services, is also expected.

Among the seven subcategories in the natural sciences category, biosciences and astronomy/physics had high proportions of OA publishing. Biosciences have a few overlapping features with healthcare and medicine, and basic and applied health researchers including students will benefit from OA articles on biosciences. The discipline of astronomy/physics is a peculiar case. Researchers in high-energy physics and astrophysics initiated their own OA projects and since 2014, have made collective efforts on OA. The Sponsoring Consortium for Open Access Publishing in Particle Physics (SCOAP3) covers more than 11 journals, books, and repositories [17]. However, chemistry and industry-oriented sciences showed lower proportions of OA.

Documents in the engineering category had relatively low OA proportions, and authors in these disciplines often worry about intellectual property rights when their articles are freely available. Although improving trends were observed during the study period (extending through 2021), the numbers are still lower than those in the categories of natural sciences and health and medicine. Within engineering, the multidisciplinary category showed a relatively high proportion of OA documents

(57% in 2021). High OA proportions were further observed in marine and ocean engineering, metallurgy, and biomedical engineering. Low OA proportions were noted in chemical, geological, and environmental engineering.

Academic documents in the categories of "social sciences and others" and "humanities and arts" are published more often as monographs than as journal articles. Users favor electronic or analog versions of books, and digital transformation in these subject domains has been slower. It is necessary, however, to keep old literature available online so that it can be searched by those who want to obtain the corresponding knowledge in detail. Wikipedia and other types of online resources are used for these subjects, and OA documents will add more value to these existing knowledge resources.

Library services using OA resources are the ultimate goal of current OA initiatives [18]. The production of OA documents is important, and the visibility of those open documents can be enhanced by the development of research technologies [19] and timely library services for various types of users not limited to academic scholars. This study assessed the fundamental infrastructure for OA scholarly information services.

Limitations

The availability of the full text of those OA documents may be different among individuals because different types of OA require different routes for access. This study does not guarantee that users all have access to these OA documents. The Unpaywall [20], Google Scholar, and Scholytics services will help access the full text of those OA documents.

The complexity of OA document production and use is not covered in this article. The value of the conceptual status of journal goods from the viewpoint of Ostrom [21] and library services are summarized in our previous research report [11], Table S31, and Fig. S17.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Supplementary Materials

Supplementary files are available from https://doi.org/10.7910/DVN/W4EVZI.

Supplementary tables

Table S1. Publication titles (publication years) and the numbers of total and OA documents of top 20 journals in the multidisciplinary science discipline between 2000 and 2021 and 2021
Table S2. Health and medicine category
Table S3. Eight disciplines in the general health subcategory and the numbers of total and OA documents in 2000–2021 and 2021
Table S4. Twelve disciplines in the basic health subcategory and the numbers of total and OA documents in 2000–2021 and 2021
Table S5. Thirteen disciplines in the health, clinical medicine subcategory and the numbers of total and OA documents in 2000–2021 and 2021
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Table S7. Natural science category
Table S8. Twelve disciplines in the physics and astronomy subcategory and the numbers of total and OA documents in 2000–2021 and 2021
Table S9. Twenty-three disciplines in the biosciences subcategory of the natural sciences and the numbers of total and OA documents in 2000–2021 and 2021
Table S10. Nine disciplines in the chemistry subcategory of the natural sciences and the numbers of total and OA documents in 2000–2021 and 2021
Table S11. Five disciplines in the mathematics subcategory of the natural sciences and the numbers of total and OA documents in 2000–2021 and 2021
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Table S13. Six disciplines in the geosciences subcategory and the numbers of total and OA documents in 2000–2021 and 2021
Table S14. Eleven disciplines in the agriculture, fishery, and forestry subcategory and the numbers of total and OA documents in 2000–2021 and 2021
Table S15. Social sciences and others category
Table S16. Eighteen disciplines in the general social sciences subcategory and the numbers of total and OA documents in 2000–2021 and 2021
Table S17. Eleven disciplines in the psychology subcategory and the numbers of total and OA documents in 2000–2021 and 2021
Table S18. Five disciplines in the education and ethics subcategory and the numbers of total and OA documents in 2000–2021 and 2021
Table S19. Eight disciplines in the law, economics, and management subcategory and the numbers of total and OA documents in 2000–2021 and 2021
Table S20. Engineering category.
Table S21. Twelve disciplines in the general engineering subcategory and the numbers of total and OA documents in 2000–2021 and 2021
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Table S23. Nine disciplines in the computer engineering subcategory and the numbers of total and OA documents in 2000–2021 and 2021
Table S24. Sixteen disciplines in the major engineering subcategory and the

numbers of total and OA documents in 2000–2021 and 2021

Table S25. Ten disciplines in the materials engineering subcategory and the numbers of total and OA documents in 2000–2021 and 2021

Table S26. Humanities and arts category

Table S27. Seven disciplines in the general humanitiessubcategory and the numbers of total and OA documents in 2000–2021 and 2021

Table S28. Six disciplines in the history subcategory and the numbers of total and OA documents in 2000–2021 and 2021

Table S29. Ten disciplines in the literature subcategory of the humanities and the numbers of total and OA documents in 2000–2021 and 2021

Table S30. Eight disciplines in the arts subcategory and the numbers of total and OA documents in 2000–2021 and 2021

Table S31. The four types of economic status of journal goods according to Ostrom

Supplementary figures

Fig. S1. Total numbers of open access (OA) and non-OA documents with all 43 types of documents in years 2000–2021.

Fig. S2. Yearly numbers of open access (OA) and non-OA documents in Nature.

Fig. S3. The discipline of oncology and the numbers of open access (OA) and non-OA documents in 2000–2021.

Fig. S4. The discipline of applied physics and the numbers of open access (OA) and non-OA documents in 2000–2021.

Fig. S5. The discipline of microbiology and the numbers of open access (OA) and non-OA documents in 2000–2021.

Fig. S6. The discipline of biochemistry/molecular biology and the numbers of open access (OA) and non-OA documents in 2000–2021.

Fig. S7. The discipline of environmental science and the numbers of open access (OA) and non-OA documents in 2000–2021.

Fig. S8. The discipline of agriculture–dairy animal science and the numbers of open access (OA) and non-OA documents in 2000–2021.

Fig. S9. The discipline of food science technology, and the numbers of open access (OA) and non-OA documents in 2000–2021.

Fig. S10. The discipline of education/educational research and the numbers of open access (OA) and non-OA documents in 2000–2021.

Fig. S11. The discipline of business finance and the numbers of open access (OA) and non-OA documents in 2000–2021.

Fig. S12. The discipline of management and the numbers of open access (OA) and non-OA documents in 2000–2021.

Fig. S13. The discipline of political science and the numbers of open access (OA) and non-OA documents in 2000–2021.

Fig. S14. The discipline of law and the numbers of open access (OA) and non-OA documents in 2000–2021.

Fig. S15. The discipline of nanoscience/nanotechnology and the numbers of open access (OA) and non-OA documents in 2000–2021.

Fig. S16. The discipline of linguistics and the numbers of open access (OA) and non-OA documents in 2000–2021.

Fig. S17. A scholarly information system bridges the supply side to the customers' side.

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Original Article

Comparison of the open access status and metrics of Scopus journals published in East Asian countries: a descriptive study

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Abstract

Purpose: The objective of this study was to compare Scopus journals published in East Asian countries—China, Japan, South Korea, and Taiwan—in terms of their open access status and metrics and to explore the implications of those findings for South Korea.
Methods: To conduct this study, we selected four East Asian countries: China, Japan, South Korea, and Taiwan. We used journal information provided by SCImago Journal Rank (SJR) and Scopus. The following parameters were analyzed for journals published in East Asian countries: open access status, subject categories, quartiles, number of published documents, h-index, publishers, and citation rate.
Results: In all East Asian countries, numerous commercial publishers publish journals. One exception is Science Press, a Chinese government-sponsored publisher, which published the largest number of journals in the East Asian region. Japan had the highest median number of years covered by SJR. However, the proportion of Q1 journals in Japan was the lowest of the East Asian countries. South Korea had the highest proportion of Q1 journals in the country's total journal production. Publishers in South Korea published more open access journals than any other East Asian country. Despite publishing a high proportion of prestigious journals, South Korea lagged behind China and Japan in the number of Scopus-indexed journals.
Conclusion: The findings indicate that South Korea has made significant progress in locally producing influential journals over the years. However, more efforts to publish international journals are required for South Korea to increase the number of Scopus journals.

Keywords

East Asian countries; Journal publishing; Publishers; Scopus; SCImago Journal Rank

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Introduction

Background/rationale

East Asian countries—including, most notably, China, Japan, South Korea, and Taiwan—are among the most important countries in the world regarding trade and technology. Like many other countries, these East Asian countries compete to increase their scientific innovation and research output [1]. One way to increase a country's scientific output is to encourage local publishers to publish international journals.

In South Korea, the Korean government has supported Korean journals through the National Research Foundation of Korea (NRF) in recent decades. The NRF's Korean Citation Index (KCI) is important for Korean journals, although it mainly aims to support Korean domestic research regardless of its inclusion in international databases [2]. As pointed out by Shin [3], the number of English-language international journals should be increased in order to publish a large number of prestigious international journals.

From this standpoint, it would be useful to compare and analyze the journals published in East Asian countries using various journal indicators to assess the current status of journal publishing. Many previous studies have examined the research output of Asian countries [4–6]. However, except for Lin [7] and Xia et al. [8], comparative studies on academic journals published in East Asian countries are difficult to find. The results of this study will help to identify the weaknesses and strengths of each Asian country in journal publishing.

Objectives

The objective of this study was to compare Scopus journals published in East Asian countries in terms of their open access (OA) status and metrics.

Methods

Ethics statement

This study was conducted based on bibliographic data provided by Scopus and SCImago Journal Rank (SJR). Neither approval of the Institutional Review Board nor informed consent was required.

Study design

This was a quantitative descriptive analysis comparing journals published in East Asian countries.

Data sources/measurement

To conduct this study, we selected four East Asian countries—China, Japan, South Korea, and Taiwan—and downloaded various journal information from SJR. SJR could be used as a proxy for journals published in Scopus, since it contains information on journals indexed in Scopus. Among the journals indexed in both Scopus and SJR in 2021, the distribution of journals published in East Asian countries was as follows: 749 journals in China, 400 journals in Japan, 297 journals in South Korea, and 98 journals in Taiwan. Based on the downloaded data, we analyzed the journals published in these East Asian countries in terms of OA status, subject categories, quartiles, number of published documents, h-index (journal), publishers, and citation ratio. The years covered were not provided by SJR but were calculated using the coverage years. We also analyzed the subject categories of the journals published in East Asian countries using the All-Science Journal Classification (ASJC) codes. All journals indexed by Scopus are categorized using the ASJC codes, which represent the subject categories of Scopus-indexed journals. We extracted the ASJC codes from the Scopus journal list published in October 2021. The R language (R Foundation for Statistical Computing) was used to join the information between the Scopus journal list and the SJR journal data and to analyze the journal data. A list of the journals and their attributes is provided in Dataset 1.

Statistical methods

Descriptive and comparative analyses were performed using Microsoft Excel (Microsoft Corp) and the R language ver. 4.2.2. One-way analysis of variance (ANOVA) was performed to determine whether differences among the four East Asian countries in quartile, h-index, total documents, and the 2-year citation ratio were statistically significant.

Results

OA journals versus non-OA journals

We examined the OA status of journals published in East Asian countries (Table 1). SJR uses the OA status of its published journals from the Directory of Open Access Journals (DOAJ) and the Directory of Open Access Scholarly Resources (ROAD) [9]. These listed journals are considered "fully" OA and not hybrid. By offering OA options to the authors, hybrid journals publish some, but not all, articles as OA. Table 1 illustrates that China had the lowest proportion of OA journals compared to the other nations. As a result, China had the greatest relative percentage (84.8%) of non-OA (subscription) journals produced among the other countries. In contrast, South Korea published the highest number (159 journals, 53.5%) of OA journals. Thus, the relative proportion of non-

Table 1. OA versus non-OA status of journals

Journal type	China (n=749)	Japan (n=400)	South Korea (n=297)	Taiwan (n=98)
OA	114 (15.2)	95 (23.8)	159 (53.5)	36 (36.7)
Non-OA (subscription)	635 (84.8)	305 (76.3)	138 (46.5)	62 (63.3)

Values are presented as number (%).
OA, open access.

Table 2. Quartiles of journals published in the four East Asian countries

Quartile	China (n=749)	Japan (n=400)	South Korea (n=297)	Taiwan (n=98)
Q1	100 (13.4)	34 (8.5)	45 (15.2)	10 (10.2)
Q2	106 (14.2)	77 (19.3)	93 (31.3)	14 (14.3)
Q3	198 (26.4)	115 (28.8)	95 (32.0)	27 (27.6)
Q4	310 (41.4)	171 (42.8)	62 (20.9)	46 (46.9)
NA	35 (4.7)	3 (0.8)	2 (0.7)	1 (1.0)

Values are presented as number (%).
NA, not available.

Table 3. Mean values of various journal indicators and one-way analysis of variance results

Indicator	China	Japan	South Korea	Taiwan	F-statistic	P-value
Quartile	3.01	3.07	2.59	3.12	15.38	<0.001
H-index	20.64	26.97	20.96	17.37	11.54	<0.001
Total document[a]	166.79	66.55	75.53	55.31	72.00	<0.001
2-Year citation[b]	1.57	0.99	1.68	1.02	8.46	<0.001

[a]The total number of published documents in 2020; [b]No of citations/no. of documents.

OA journals published in South Korea was lower (46.5%) than in other countries. The chi-square test was performed to determine whether the difference in OA status among the four East Asian countries was statistically significant. The chi-square statistic was 168.5, and the P-value was <0.001; thus, the result was significant at P<0.05.

In this study, the OA status of journals published in South Korea was manually checked (December 15–20, 2022). As shown in Dataset 1, a substantial number of "non-OA" journals published in South Korea according to the initial analysis were actually OA journals or could be categorized as OA journals. There were a few journals transitioning from non-OA to OA. A journal that is categorized as "free" can be considered an OA journal because its articles are publicly accessible on its website or through other portals. Most of these journals do not claim to be OA and do not have explicit statements to that effect in their copyright transfer agreements. The OA status as determined using SJR differs substantially from the actual current status. In total, 52 Korean journals indexed in Scopus as non-OA could have been classified as OA, while 39 (28.3%) could have been classified as "free."

Analysis of basic journal indicators

Table 2 shows the quartiles of journals published in East Asian countries. The SJR score is calculated by assigning weights to bibliographic citations based on the importance of the journals that issued them [10]. The quartile status is useful because it is a field-normalized indicator that reflects the SJR scores in that field. SJR divides its indexed journals into four quartiles: Q1, Q2, Q3, and Q4. China published the most Q1 and Q4 journals when compared to other nations. However, South Korea had the highest proportion (15.2%) of Q1 journals relative to the country's total journal production. Taiwan published the fewest Q1 journals (10 journals), but Japan published the lowest proportion (8.5%) of Q1 journals relative to the country's total journal production.

Table 3 shows various indicators of journals published in East Asian countries. These include the quartile, h-index, total number of publications in 2020, and the 2-year citation ratio. Consistent with Table 1, the average quartile of journals published in South Korea was the highest (2.59), whereas the average quartile of journals published in Taiwan was the lowest (3.12). It is worth noting that a lower average quartile value indicates a higher quartile. Regarding the h-index of journals, Japan ranked first, while Taiwan ranked last. China published the most journal documents (166.79) in 2020. In terms of the 2-year citation ratio, South Korea ranked first (1.68), whereas Japan ranked last (0.99).

One-way ANOVA was performed to determine whether various obtained results differed significantly among the East Asian countries, and the statistical test revealed the following: (1) the difference in journal quartiles between the East Asian countries was statistically significant (F(3, 1,499)=15.38, P<0.001); (2) the difference in the h-index between the East Asian countries was statistically significant (F(3, 1,540)=11.54, P<0.001); (3) the difference in the total number of published documents between the East Asian countries in 2020 is statistically significant (F(3, 1,540)=72.00, P<0.001); and (4) the difference in the 2-year citation ratio between the East Asian countries was statistically significant (F(3, 1,540)=8.46, P<0.001).

Top publishers

Table 4 shows the top 10 publishers in the East Asian countries that published the largest number of journals. As shown, many top journal publishers in East Asian countries are global commercial publishers from Western countries. These include Elsevier, Wiley-Blackwell, and Springer Nature. Science Press, partly owned by the Chinese Academy of Sciences [11], published the largest number (90 journals) of journals in China. Techno-Press, a Korean commercial publisher of international journals and conference proceedings, published the largest number (14 journals) of journals in South Korea. Except for Techno-Press, other top publishers in South Korea published only a small number of Scopus-indexed journals.

Table 4. Top 10 publishers with the largest number of journals

Publisher	No. of journals
China	
Science Press	90
Chinese Medical Journals Publishing House Co, Ltd	43
AME Publishing Company	32
KeAi Communications Co	31
Higher Education Press	17
Springer Nature	16
Chinese Academy of Sciences	14
Zhonghua Yixeuehui Zazhishe/Chinese Medical Association Publishing House	11
Tsinghua University Press	8
Science in China Press	6
Japan	
Springer Nature	51
The Institute of Electrical Engineers of Japan	7
Elsevier	5
Kyoto University	5
Kyushu University	5
Maruzen Co, Ltd/Maruzen Kabushikikaisha	5
Wiley-Blackwell	5
Fuji Technology Press	4
Igaku-Shoin Ltd	4
Architectural Institute of Japan	3
South Korea	
Techno-Press	14
Springer Nature	5
Elsevier	4
Korean Institute of Electrical Engineers	3
Korean Institute of Metals and Materials	3
Korean Society of Mechanical Engineers	3
Korea Distribution Science Association (KODISA)	2
Korean Association of Medical Journal Editors	2
Korean Dermatological Association	2
Korean Mathematical Society	2
Taiwan	
Elsevier	8
Tamkang University	7
National Taiwan Normal University	5
Academia Sinica	4
National Taiwan University	3
Academy of Taiwan Information Systems Research	2
National Cheng Kung University	2
National Taiwan University of Science and Technology	2
Springer Nature	2
Taiwan Association of Engineering and Technology Innovation	2

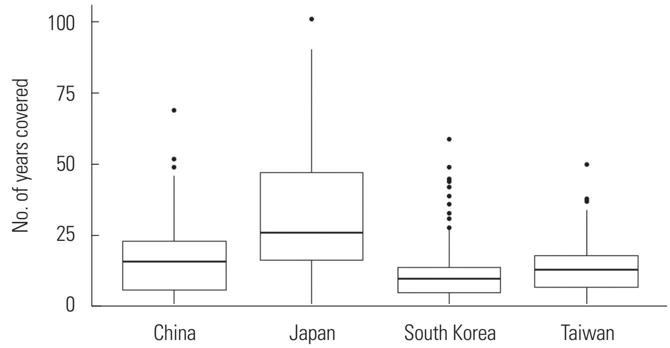

Fig. 1. Number of years covered by SCImago Journal Rank.

Another notable publishing pattern in South Korea is that no university press was found among the top 10 publishers. The top publishers in South Korea are commercial publishers, nonprofit institutions, associations, and societies.

Number of years covered

Fig. 1 is a boxplot exhibiting the number of years covered by SJR, which is equivalent to the number of years covered by Scopus. The median number of years covered by SJR was highest for Japanese journals and lowest for South Korean journals. The low number of median years covered in Korean journals suggests that most journals published in Korea have been indexed in SJR only in recent years, whereas the high number of median years covered in Japanese journals suggests that a substantial number of Japanese journals indexed by SJR are much older than the journals published in other countries. Although older journals tended to have a higher h-index, the number of years covered by SJR was inconsistent with the average journal h-index shown in Table 3. South Korea ranked last in terms of years covered but second in terms of the h-index in East Asian countries.

Subject area analysis

Fig. 2 shows the subject categories of journals published in East Asian countries and their frequencies. The ASJCs shown in Fig. 2 correspond to 27 major subject categories. The number of minor subject categories within major subject categories may range from 00 to 49, and the major subject categories are shown as "**". Each country publishes SJR-indexed journals in different subject categories. The percentage of journals published in a subject category was analyzed relative to other categories within a country. The number of journals and the percentage of journals published by subject area within a country varied widely. The highest percentage (17.6%) of journals in a country published in the category of engineering (ASJC code, 22**) was found in China, while the percentage of journals published in medicine (ASJC code, 27**) was

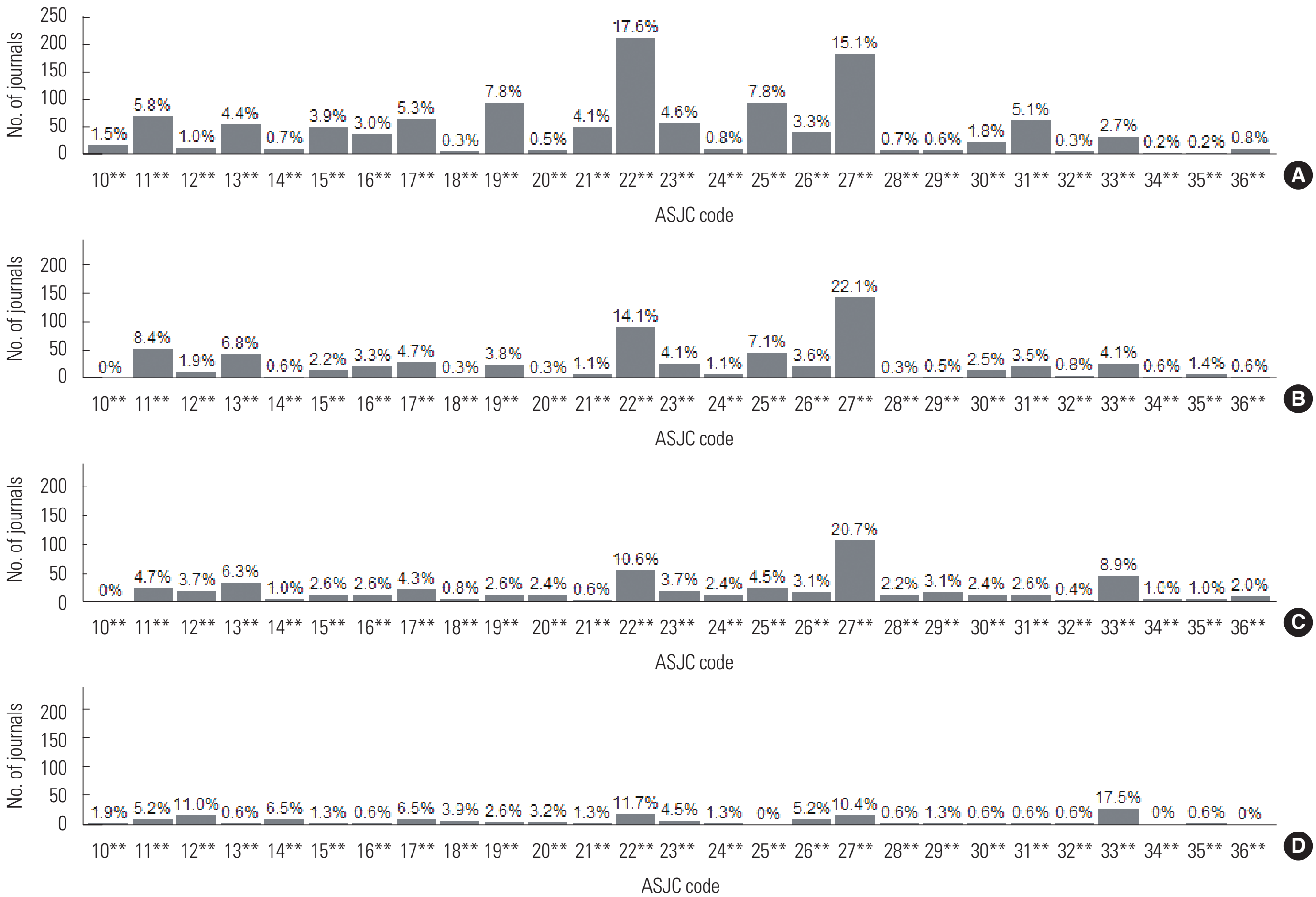

Fig. 2. Number of journals published by subject categories. (A) China. (B) Japan. (C) South Korea. (D) Taiwan. All-Science Journal Classification (ASJC) codes: 10, multidisciplinary; 11, agricultural and biological sciences; 12, arts and humanities; 13, biochemistry, genetics and molecular biology; 14, business, management and accounting; 15, chemical engineering; 16, chemistry; 17, computer science; 18, decision sciences; 19, earth and planetary sciences; 20, economics, econometrics and finance; 21, energy; 22, engineering; 23, environmental science; 24, immunology and microbiology; 25, materials science; 26, mathematics; 27, medicine; 28, neuroscience; 29, nursing; 30, pharmacology, toxicology and pharmaceutics; 31, physics and astronomy; 32, psychology; 33, social sciences; 34, veterinary; 35, dentistry; 36, health professions. **Major subject categories.

highest in Japan (22.1%) and South Korea (20.7%). Taiwan published the highest proportion (17.5%) of journals published in the social sciences (ASJC code, 33**). In the arts and humanities (ASJC code, 12**), China published a relatively low proportion of journals in the country, while Taiwan published a relatively high proportion (11.0%). South Korea has published 45 journals (8.9%) in the social sciences (ASJC code, 33**), corresponding to the largest number of journals published among East Asian countries.

Discussion

Interpretation

As shown by Johnson et al. [12], journal production in East Asian countries lags far behind Western countries, such as the United States and the United Kingdom. Each East Asian country showed a distinctive pattern in terms of the indicators analyzed in this study. Overall, journals published in Japan had the highest number of years covered and the highest h-index, but low SJR scores. The high number of median years covered suggests that most journals published in Japan are well-established. Taiwan ranked last in publishing Scopus-indexed journals, but it has the smallest population of these countries.

As for subject areas, the findings of this study indicate that all of the East Asian countries place more effort into publishing journals related to science and technology. China seems particularly strong in publishing journals in some fields, such as engineering. South Korea has more journals in the social sciences, but it lags far behind China in international journal publishing in an important science and technology category—namely, engineering. The findings also show that China is relatively weak in publishing journals in the humanities compared to other fields, based on the relative percentage of journals published in this country. South Korea publishes the most social science journals, though Taiwan publishes the most in terms of the proportion of journals published in this country.

Regarding journal type, South Korea is a competitive producer of prestigious journals in East Asia. The relatively high proportion of South Korea's OA journals is consistent with previous research [3] in that journals published in South Korea have been switching over to OA. The fact that South Korea has published more OA journals than other East Asian countries may have contributed to more citations. Despite publishing a high proportion of prestigious journals, South Korea lags behind China and Japan in the publication of Scopus-indexed journals. In terms of journal publishers, the most noticeable difference between South Korea and China is that, unlike in South Korea, a government-owned publisher (Science Press) has led journal production in China.

Limitations

This study was limited to journals indexed in Scopus. We did not consider journals indexed in other databases. Furthermore, this study relied on journal information provided by SJR. OA journals listed in SJR were identified based on DOAJ and ROAD. Regarding South Korea, although many local OA journals were not listed in these databases, the published journal articles are generally freely available under the Creative Commons Attribution License [13]. Thus, there is actually a larger number of OA journals in South Korea than indicated in the SJR.

Conclusion

The results show that South Korea has made significant progress in creating important local journals over time. To increase the number of Scopus journals, South Korea needs to make more efforts to publish international journals. In addition, many OA journals published in South Korea are still not registered with DOAJ. Publishers should immediately register their journals with DOAJ to be recognized as OA journals.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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The authors received no financial support for this article.

Data Availability

Dataset file is available from the Harvard Dataverse at https://doi.org/10.7910/DVN/KI6VS2.

Dataset 1. A list of the journals and their attributes collected from SCImago Journal Rank and Scopus.

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Original Article

Current status and demand for educational activities on publication ethics by academic organizations in Korea: a descriptive study

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Abstract

Purpose: This study aimed to examine the following overarching issues: the current status of research and publication ethics training conducted in Korean academic organizations and what needs to be done to reinforce research and publication ethics training.
Methods: A survey with 12 items was examined in a pilot survey, followed by a main survey that was distributed to 2,487 academic organizations. A second survey, which contained six additional questions, was dispatched to the same subjects. The results of each survey were analyzed by descriptive statistical analysis, content analysis, and comparative analysis.
Results: More than half of the academic organizations provided research and publication ethics training programs, with humanities and social sciences organizations giving more training than the others ($\chi^2=11.190$, df = 2, P = 0.004). The results showed that research and publication ethics training was held mostly once and less than an hour per year, mainly in a lecture format. No significant difference was found in the training content among academic fields. The academic organizations preferred case-based discussion training methods and wanted expert instructors who could give tailored training with examples.
Conclusion: A systematic training program that can develop ethics instructors tailored to specific academic fields and financial support from academic organizations can help scholarly editors resolve the apparent gap between the real and the ideal in ethics training, and ultimately to achieve the competency needed to train their own experts.

Keywords

Publication ethics; Ethics education; Academic journals; Research ethics; Need assessment

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Introduction

Background

The importance of education on research and publication ethics cannot be overemphasized. In particular, periodic training programs on publication ethics at academic organizations are essential requirements [1]. Furthermore, training for novice editors is even more important in Korea because editors are often appointed to serve short terms. However, research has yet to be conducted on how research and publication ethics education is practiced in academic societies. By examining the situation and methodology of research and publication ethics desired by academic organizations, more effective methods for research and publication ethics training can be suggested.

Objectives

In this study, we examined the current status of research and publication ethics training conducted in Korean academic organizations and what needs to be done to strengthen these education programs. The first objective was to identify the current status of research and publication ethics training, including the following: educational training on research and publication ethics implementation by academic field; topics of training; frequency of training per year and average hours per session; and training methods. The second objective was to assess needs for reinforcing research and publication ethics training, such as topics to be strengthened in ethics training; desired training methods; different opinions among academic fields; the necessity of instructor training programs; challenges in becoming an instructor; and requests for government or institutional support to train instructors.

Methods

Ethics statement

This study was approved by the Institutional Review Board (IRB) of Hallym University (No. HIRB-2022-008). Informed consent was obtained from participants before starting the online survey.

Study design

This was a survey-based descriptive study.

Setting

To investigate the current status of and needs for research and publication ethics training activities in Korean academic organizations focusing on research, the authors developed a survey with a total of 12 items (nine items with three subitems). The first survey was conducted as a pilot questionnaire among the 14 executive board members of the Korean Council of Science Editors (KCSE). Then, a revised version of the first survey was then distributed to 2,487 academic organizations that published scholarly journals listed in the Korea Citation Index (KCI) from May 17 to 19, 2022 (Suppl. 1). Based on the first results, a second survey with six other questions was added and distributed online from July 29 to August 6, 2022 to the same research subjects. The research subjects received emails inviting them to participate in the online survey, which was done through Google and SurveyMonkey.

Participants

The target subjects of the main survey were the editors of the 2,487 academic organizations that published the scholarly journals listed in the KCI at the time of the study. There were no exclusion criteria. The email addresses of the editors were obtained from the National Research Foundation of Korea.

Variables

The variables were items of the survey questionnaires, including the execution of training, topics, frequency; training methods, invitation of experts, and expected programs.

Data sources/measurement

The content of the first and the second survey was validated by the authors and four other external experts, including board members of the KCSE. Reliability testing of both surveys was not done because the item options were not on a Likert scale.

Study size

No study size estimation was done before the survey. All target journal editors were invited to answer the questionnaires.

Bias

There was no bias in selecting participating organizations.

Statistical method

The survey results were analyzed for activity status and needs for research and publication ethics training. Frequency analysis, multiple response analysis, and descriptive statistical analysis were conducted, and to evaluate differences among the organizations the chi-square test was performed using the IBM SPSS ver. 20.0 (IBM Corp). Content analysis was performed on the responses to the free statements.

Results

Participants

In the first survey, 322 academic organizations responded (response rate, 12.9%). In the second survey, 343 out of 2,487 (13.8%) responded (Table 1).

Current status of research and publication ethics training

Educational training on research and publication ethics implementation by academic field

It was found that 189 academic organizations (58.7%) provid-

Table 1. Field and distribution of responses to needs assessment surveys on the current status of research and publication ethics education activities in scholarly journals in Korea

Academic field	Frequency of responses (%)	
	First round	Second round
Science and technology	145 (45.0)	143 (41.7)
Humanities and social sciences	163 (50.6)	185 (53.9)
Arts and physical education	14 (4.3)	15 (4.4)
Total	322 (100)	343 (100)

Table 2. Training on research and publication ethics implementation by academic field in Korea

Implementation of research and publication ethics training	Academic field			Total
	Science and technology	Humanities and social sciences	Arts and physical education	
Yes (%)	71 (49.0)	107 (65.6)	11 (78.6)	189 (58.7)
No (%)	74 (51.0)	56 (34.4)	3 (21.4)	133 (41.3)
Total (%)	145 (100)	163 (100)	14 (100)	322 (100)

Table 3. Topics of research and publication ethics-related educational training (multiple responses) by academic organizations in Korea

Educational topic	Academic field (no. of responses)			Frequency (%)
	Science and technology	Humanities and social sciences	Arts and physical education	
Basic concepts of research and publishing ethics and research integrity	52	80	9	141 (19.2)
Research misconduct and questionable research practice	43	82	10	135 (18.4)
Research and publication ethics misconduct cases/countermeasures	35	47	4	86 (11.7)
Good scientific writing	36	39	5	80 (10.9)
Editor's (Editor-in-chief/Associate editor, etc.) ethical activities	26	43	1	70 (9.5)
Copyright	19	35	4	58 (7.9)
Conflict of interest	20	26	1	47 (6.4)
Peer review ethical activities	21	22	2	45 (6.1)
IRB/IACUC	19	16	4	39 (5.3)
Predatory journals	9	15	1	25 (3.4)
National R&D Innovation Act	5	4	0	9 (1.2)
Total	285	409	41	735 (100)

IRB, Institutional Review Board; IACUC, Institutional Animal Care and Use Committee.

ed education (Table 2). The difference in the implementation of education according to the academic field was statistically significant ($\chi^2 = 11.190$, df = 2, P = 0.004), with humanities and social sciences organizations giving more training than the others. In the science and technology field, the majority of academic organizations offered education.

Topics of research and publication ethics-related educational training

Table 3 shows the survey results on educational topics conducted by academic organizations. Multiple response analysis was performed by asking all the educational topics conducted. The most common educational topic was "basic concepts of research and publishing ethics and research integrity" (141 responses), followed by "research misconduct and questionable research practices" (135 responses).

Frequency of training on research and publication ethics at academic organizations per year and average hours per session

Academic societies conducted research and publishing ethics education during 2021 an average of 1.67 times, from a minimum of 1 to a maximum of 10 times (Fig. 1). The most frequently performed number of times was once a year. The average time per session was more than 1 to less than 2 hours, and on average, the training sessions lasted for 1.66 hours of training (Fig. 2).

Research and publication ethics training methods

The most frequently implemented training method was "lecture" (119 responses, 40.5%) (Table 4). At humanities and social sciences organizations, case- or problem-based training was the most frequent training method after lectures. Other

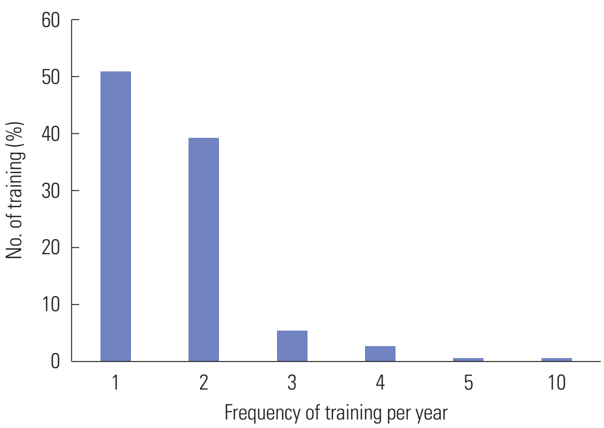

Fig. 1. Annual number of research and publication ethics.

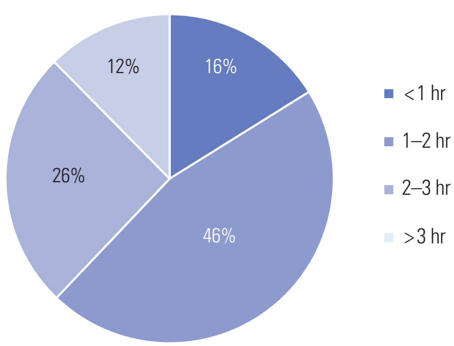

Fig. 2. Annual average training hours of research and publication ethics.

methods included distributing handouts and emails, and studying guidelines for research ethics, such as publication ethics regulations and social networking services.

"Utilization of experts within the society" (133 responses, 51.8%), "distribution of research ethics-related data" (85 responses, 33.1%), and "invitation of external experts or requests to specialized institutions" (39 responses, 15.1%) were the most frequently implemented delivery methods. If organizations used external help, their goal was to receive specific answers, as shown in Table 5.

For organizations that responded "invitation of external experts or requests to specialized institutions," the KCSE was the most commonly mentioned external institution. Other opinions included intramural experts, invitation of academic experts, conference presidents, researchers from other universities, university professors, and research integrity center training videos.

Needs assessment for reinforcement of research and publication ethics training

Topics to be strengthened for ethics training

The following topics were identified as needing to be strengthened for ethics training: "research and publication ethics misconduct cases/countermeasures" (174 responses, 17.4%), "research misconduct and questionable research practices" (158 responses, 15.9%), and "basic concepts of research and publication ethics and research integrity" (142 responses, 14.3%). By academic field, the natural sciences and humanities and social sciences showed the highest number of responses for "research and publication ethics misconduct cases/countermeasures," and the most common response for arts and sports organizations was "research misconduct and questionable research practices." The three most important topics to be dealt with in research and publication training were "plagiarism" (305 responses, 29.8%), "duplicate publication" (174 responses, 17.0%), and "falsification and fabrication" (144 responses, 14.2%), followed by "citation" (130 responses, 12.8%), "au-

Table 4. Research and publication ethics training methods (multiple response) by academic organizations in Korea

Training method	Academic field (no. of responses)			Frequency (%)
	Science and technology	Humanities and social sciences	Arts and physical education	
Lecture	40	70	9	119 (40.5)
Seminar/symposium	27	27	5	59 (20.1)
Case or problem based	19	33	1	53 (18.0)
Workshop	21	14	3	38 (12.9)
Discussion	7	14	2	23 (7.8)
Metaverse	1	1	-	2 (0.7)
Total	115	159	20	294 (100)

Table 5. Specific invited external experts or institutions (multiple responses) for training on research and publication ethics by academic organizations in Korea

External institution/expert	Academic field (no. of responses)			Frequency (%)
	Science and technology	Humanities and social sciences	Arts and physical education	
Korean Council of Science Editors	13	4	-	17 (40.4)
Korean University Council of Research Ethics	4	5	2	11 (26.2)
Korean Association of Medical Journal Editors	7	-	-	7 (16.7)
Korea Institute of Human Resources Development in Science and Technology	2	3	2	7 (16.7)
Total	26	12	4	42 (100)

Table 6. Desired research and publishing ethics training method (multiple responses) by academic organizations in Korea

Training method	Academic field			Frequency (%)
	Science and technology	Humanities and social sciences	Arts and physical education	
Case-based discussion	70	77	4	151 (34.7)
Lecture	60	65	8	133 (30.6)
Workshop	38	52	1	91 (20.9)
Problem-based learning	21	23	2	46 (10.6)
Metaverse	2	6	6	14 (3.2)
Total	191	223	21	435 (100)

thorship and contributorship" (122 responses, 11.9%), "copyright" (81 responses, 7.9%), "conflict of interest" (38 responses, 3.7%), and "IRB/IACUC" (28 responses, 2.7%).

Desired research and publishing ethics training methods

The most desired training method was "case-based discussion" by as reported by 151 organizations (34.7%). "Lecture" appeared next, with 133 responses (30.6%). Similar results were found for each academic field (Table 6).

Publication ethics differences among academic fields

The majority (273 responses, 79.6%) answered "no" to the question asking if the relevant academic organization has characteristics of publishing ethics that are different from other academic fields. Other notable remaining responses related to whether approval from the IRB or IACUC (Institutional Animal Care and Use Committee) was needed.

Necessity of research and publication ethics instructor training programs

In total, 197 organizations (61.2%) answered "yes" regarding the necessity of research and publication ethics instructor training programs, and no statistically significant differences were found among academic fields ($\chi^2 = 1.485$, df = 2, P = 0.476).

Challenges in becoming an instructor for research and publication ethics

The most common response regarding challenges in becoming an instructor on research and publication ethics was instructor-related factors (81.6%), followed by learner-related factors (10.4%) and environmental factors (6.0%).

Table 7 shows the details of instructor-related, learner-related, and environmental factors. As for learner-related factors, the deepest concern was people's lack of interest in or concentration on education related to research and publishing ethics

Table 7. Challenges regarding with becoming a research and publication ethics instructor by academic organizations in Korea

Category	Frequency (%)
Learner factor	
Lack of interest in ethics education	41 (7.0)
Level of learners' understanding	13 (2.2)
Lack of ethical consciousness	3 (0.5)
Custom	4 (0.7)
Instructor factor	
Lack of expertise (content)	440 (74.8)
Content selection	15 (2.6)
Teaching method	10 (1.7)
Competence in teaching	8 (1.4)
Maintaining of objectivity	7 (1.2)
Environmental factor	
Lack of learning effect	15 (2.6)
Lack of training programs/materials	14 (2.4)
Training hour	6 (1.0)
Miscellaneous	12 (2.0)
Total	588 (100)

(7.0%). This was followed by challenges related to whether learners could understand the material properly due to diverse levels of comprehension (2.2%). The most common instructor-related factor was the lack of expertise in learning content (74.8%), followed by concerns about content selection (2.6%).

The survey also asked for unrestricted feedback on training topics and contents, which are thought to be crucial for training ethics instructors. The responses were classified through content analysis. The most common opinion was "cases of misconduct of research ethics" (n = 17), followed by "IRB/IACUC" (n = 12), "authorship and contributorship" (n = 11), "copyright" (n = 10), and "research ethics misconduct countermeasures" (n = 8).

Request for government or institutional support related to training instructors

A total of 275 responses (80.2%) were collected from 343 academic organizations, excluding insincere and invalid responses. The results are presented in Table 8. Most academic organizations (8.7%) pointed out that instructors should have proper professionalism, while some responses (1.8%) preferred to grant accredited qualifications. The responses also pointed out that sufficient cases should be covered during the training, and realistic content should be included. Further-

Table 8. Requests for government or institutional support for the training of instructors by academic organizations in Korea

Category	Frequency (%)
Instructor	
Recurrent training	
Recurrent/supplement training	15 (5.5)
Diversity of instructors	
Reinforcement of professionalism (certification course)	24 (8.7)
Training of instructors tailored to the academic field	16 (5.8)
Developing sufficient number of instructors (pool management)	8 (2.9)
Considering the region	2 (0.7)
Learning content and material	
Learning material	
Manualization of training program	6 (2.2)
Producing learning materials	4 (1.5)
Learning content	
Plagiarism	10 (3.6)
Reality-reflecting practical training	6 (2.2)
Trends and issues	6 (2.2)
Reflecting international trends	3 (1.1)
Copyright	2 (0.7)
Authorship	2 (0.7)
Institional review board	2 (0.7)
Teaching method	
Case-based learning	25 (9.1)
Online	25 (9.1)
Various program	11 (4.0)
Systematic curriculum development	4 (1.5)
Training sessions during academic conferences	3 (1.1)
Financial support	
Instructor fee, training fee	35 (12.7)
Open free lectures	4 (1.5)
Miscellaneous	
Various institutional support	13 (4.7)
Sufficient publicity	8 (2.9)
Establishment of a specialized (advisory) institution	5 (1.8)
Development of standards	4 (1.5)
Education for the next generation	3 (1.1)
Strong penalty for violations	3 (1.1)
Improve awareness	2 (0.7)
Cooperation with affiliated organizations	2 (0.7)
No instructor training required	2 (0.7)
Others	20 (7.3)
Total	275 (100)

more, instructor training should target people specializing in the relevant academic field or those with knowledge of field practices, such as academic editors, to deliver more effective lecture content. As training methods, case-based learning and online education, including video training, were requested.

Discussion

Interpretation

People have often assumed that science and technology organizations would have done more research and ethics training than humanities and social sciences, but the survey results showed the opposite (Table 2). It is probable that the science and technology field has already encountered many research ethics problems, while scholars in the humanities and social sciences are paying more attention to research and publication ethics. According to the opinions described in the survey, academic organizations are having difficulty in training instructors or planning various programs on their own; therefore, it is essential to develop training courses for publication ethics instructors to support these organizations.

The frequency of training was mostly once or twice per year, and the training sessions mostly lasted less than 2 hours (Figs. 1, 2). Therefore, it is difficult to say that sufficient training has been provided. While most of the training methods conducted by academic organizations have focused on lectures (Table 4), the respondents expressed interest in case-based or field-oriented programs (Table 6), showing a clear gap between reality and the ideal. Online training was preferred, but the study of Schroter et al. [1], in which half of the respondents had experienced online research ethics education, found that only 31% of the respondents reported that online education was effective. Therefore, we should not solely depend on online training; instead, we should also regard offline training as important method. One of the ways to fill this gap is certainly through government-funded instructor training for each academic field.

The majority of responses stated that an ethics instructor training program was necessary. The responses also emphasized the need for a systematic training program to ensure that the instructors would have adequate training to qualify as field-related experts. In particular, as shown in the survey (Table 8), practical training on topics such as plagiarism and related trends and issues should be taught, along with field cases. However, there were numerous comments on learners' lack of interest in ethics education, and it appears that countermeasures for this need should be prepared, such as offering customized, case-oriented education that would engage learners more effectively and provide meaningful and practical education.

When such an instructor training program is conducted with the support of the government, it should not be a one-time event. Instead, the pool of instructors should be effectively managed, and recurrent and supplemental training needs to be done while taking into account the constantly evolving nature of research and publication ethics. According to the study of Tomić et al. [2], the expert consensus states that "brief or once-in-a-lifetime virtue-based training has been recognized as less effective, the more appropriate direction to acquire research virtues is through continuing education."

The degree of case-oriented education should reflect the characteristics of each academic field. However, the survey suggested that the differences among fields were not significant. For instance, the main difference related to the use of the IRB or IACUC. In light of these results, the content of the basic instructor training course can be covered through a unified approach, but separate training should be provided on the specific cases and examples used in each academic field. The responses included a request to establish a qualification course if necessary (Table 8), which can be read as a call for trust in the expertise of ethics instructors.

Limitations

The main limitation of the study is that it only included responses from academic organizations with publications listed in the KCI. Thus, the opinions of non-registered academic organizations with little government support could not be reflected. The opinions of academies specializing in the arts and physical education were insufficiently represented because they only made up a small percentage of academic journals as a whole. Interdisciplinary fields have also emerged recently, and future research should take into account the inability of this study to precisely distinguish interdisciplinary fields' opinions.

Conclusion

Only 50% of the academic organizations surveyed in this study have provided training on research and publication ethics for their members. Additionally, the training approach most often involved a lecture delivered in a very brief session. This clearly demonstrates the necessity for appropriate training materials and approaches such as case-based discussions dealing with real-world examples, as well as workshops from experts in specific fields. Furthermore, a systematic training program that can develop ethics instructors tailored to specific academic fields, coupled with financial support from academic organizations, could help scholarly editors to resolve the apparent gap between the real and the ideal in ethics training, and finally achieve the competency needed to train their own experts.

Conflict of Interest

Cheol-Heui Yun serves as the ethics editor of *Science Editing* since 2020, but had no role in the decision to publish this article. No other potential conflict of interest relevant to this article has been declared.

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Data Availability

Dataset files are available from the Harvard Dataverse at https://doi.org/10.7910/DVN/GQOLSR.

Dataset 1. Responses to the pilot study.
Dataset 2. Responses to the first and second survey.

Supplementary Materials

Supplementary file is available from https://doi.org/10.7910/DVN/GQOLSR.

Suppl. 1. Items of the first and second survey.

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Original Article

Data sharing attitudes and practices of researchers in Korean government research institutes: a survey-based descriptive study

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Abstract

Purpose: This study explored to what extent and how researchers in five Korean government research institutes that implement research data management practices share their research data and investigated the challenges they perceive regarding data sharing.

Methods: The study collected survey data from 224 respondents by posting a link to a SurveyMonkey questionnaire on the homepage of each of the five research institutes from June 15 to 29, 2022. Descriptive statistical analyses were conducted.

Results: Among 148 respondents with data sharing experience, the majority had shared some or most of their data. Restricted data sharing within a project was more common than sharing data with outside researchers on request or making data publicly available. Sharing data directly with researchers who asked was the most common method of data sharing, while sharing data via institutional repositories was the second most common method. The most frequently cited factors impeding data sharing included the time and effort required to organize data, concerns about copyright or ownership of data, lack of recognition and reward, and concerns about data containing sensitive information.

Conclusion: Researchers need ongoing training and support on making decisions about access to data, which are nuanced rather than binary. Research institutes' commitment to developing and maintaining institutional data repositories is also important to facilitate data sharing. To address barriers to data sharing, it is necessary to implement research data management services that help reduce effort and mitigate concerns about legal issues. Possible incentives for researchers who share data should also continue to be explored.

Keywords

Information dissemination; Open research data; Restricted data sharing; Korean government research institutes; Barriers to data sharing

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Introduction

Background/rationale

Many regulatory efforts to promote data sharing have been made and are underway at the international and national levels for the ultimate purpose of advancing science and research. High-level bodies and funding agencies are the primary contributors to the culture and practice of data sharing [1]. For example, the European Commission implemented the Open Research Data (ORD) pilot in Horizon 2020 (H2020), which requires H2020-funded projects to develop data management plans (DMPs) and provide open access to research data [2]. The principle of ORD is that research data should be "as open as possible, as closed as necessary," and it emphasizes sound data management rather than forcing all research data to be open [3]. The US National Institute of Health (NIH) released a new Data Management and Sharing (DMS) policy in October 2020, effective as of January 25, 2023, which requires all applicants to submit DMS plans if the proposed research generates scientific data. Similar to the principle of ORD, the new NIH policy intends to "encourage data sharing to the extent that it is possible" [4]. In addition, publishers and individual journals influence researchers' data sharing behavior by establishing data sharing policies that encourage or require making data available along with the publication of research articles [5,6]. Data sharing and reproduction is one of the policies on publication ethics that the recently updated version of the Principles of Transparency and Best Practice in Scholarly Publishing asks journals to include [7].

Compared to Europe and the United States' commitment arising from the multiplicity of players in DMS, South Korea remains in the early phases of ORD agenda implementation. A national policy on research data management (RDM) is currently specified in the National Research & Development (R&D) Information Processing Standard. It is an administrative rule enforced by the ordinance of the Ministry of Science and ICT (MSIT) under the National R&D Innovation Act enacted in 2021. However, the policy on RDM is only applied to national R&D projects for which central government agencies consider it necessary to submit DMPs, and data sharing is not even mentioned in the policy [8]. Despite these limitations, government-funded research institutes under the National Research Council of Science and Technology (NST) affiliated with the MSIT have been directly affected by the policy and have gradually adopted DMPs; as of 2021, three of the 25 research institutes under the NST have implemented DMPs and data repositories. These include the Korea Institute of Geoscience and Mineral Resources (KIGAM), the Korea Institute of Oriental Medicine (KIOM), and the Korea Institute of Science and Technology Information (KISTI) [9]. In addition, the Korea Research Institute of Standards and Science (KRISS), another research institute under the NST, operates the National Standard Reference Data Center (NSRDC) [10]. Moreover, the National Institute of Ecology (NIE), a leading government research institute affiliated with the Ministry of Environment, has developed a platform for sharing ecological data named EcoBank [11].

Since the regulatory basis for RDM has been formed in South Korea and corresponding practices have been initiated in several government research institutes, it would be useful to investigate how researchers in the institutes regard data sharing. Such a study would lead to a better understanding of researchers' experiences and what makes them reluctant when considering data sharing. A few studies have examined perceptions and the status of DMS based on surveys and/or interviews of researchers in Korean government research institutes [12-14]. However, the existing studies surveyed researchers in a single institute or were conducted before the regulations of RDM were established. Exploring the attitudes toward data sharing of researchers in multiple government research institutes where RDM practices are implemented will help address researchers' needs regarding their institutes' data management practices.

Objectives

This study examined the current data sharing practices and perceptions of researchers in five Korean government research institutes currently involved in RDM, which are KIGAM, KIOM, KISTI, KRISS, and NIE. The study assumed that researchers of these institutes have a certain level of understanding about data sharing and thus that it would be appropriate to recruit them as survey participants. The research questions were as follows: (1) To what extent do the researchers share their research data? (2) In what ways do they share research data? (3) What challenges do they perceive in relation to data sharing?

Methods

Ethics statement

This study was exempt from deliberation by the Institutional Review Board because there was no collection of sensitive information or individual identification information.

Study design

This is a descriptive study based on an online survey.

Data collection methods

A survey questionnaire was developed based on studies recently performed regarding data sharing and publication [15-17]. The questionnaire consisted of 29 questions in four areas: (1) research data creation and management; (2) data sharing and publication; (3) perceptions of data publication; and (4) demographic information. SurveyMonkey was used to construct an online questionnaire, and a link was distributed via a discussion forum on the homepage of each of the five government research institutes from June 15 to 29, 2022. As a result, 224 responses were collected and used for the analysis. Almost all responses were complete, except for eight responses that failed to provide demographic information.

Units of study

The unit of study in this research was the individual, since the survey data were collected from 224 researchers employed in the five Korean government research institutes.

Data analysis

This study focused on analyzing responses concerning the extent, methods, and barriers to data sharing. Descriptive statistical analyses were performed to compare the survey responses in terms of whether and to what extent respondents shared research data, which of the various ways of sharing data they utilized, and the challenges they perceived.

Results

Participants

The demographics of the respondents are presented in Table 1. The majority of respondents were men and had doctoral degrees. Most were in their 30s or 40s. Regarding the disciplines of the respondents, most were in 56 information communications technology (25.9%), 38 biological science (17.6%), 21 public health and medicine (9.7%), and 16 earth science (7.4%). In total, 24 disciplines were reported by the respondents (Fig. 1).

The extent of data sharing

Out of 224 respondents, 180 (80.4%) answered that they had experience collecting or creating research data. Among those 180 researchers, 32 mentioned that they had never shared their research data; thus, the remaining 148 respondents had shared at least some of their data (Table 2). Only seven respondents stated that they shared all of their data, while the majority shared some or most of theirs.

The 148 respondents with data sharing experience were also asked with whom they had shared research data. As shown in Table 3, sharing data with principal investigators or coinvestigators involved in collecting or creating data received the greatest proportion of the responses (n = 94, 36.3%), followed by sharing data with all participants in research projects where data were collected/created (n = 86, 33.2%). The findings indicate that restricted data sharing—“the exchange of data between the members of a specific group or project consortium to their mutual benefit” [2]—was more common than data sharing on request (n = 60, 23.2%) or making data publicly accessible (n = 19, 7.3%).

Table 1. Demographics of respondents

Category	No. (%)
Age	
20s	21 (9.7)
30s	86 (39.8)
40s	72 (33.3)
50s	31 (14.4)
Above 60s	6 (2.8)
Gender	
Woman	86 (39.8)
Man	130 (60.2)
Degree	
Bachelor's	30 (13.9)
Master's	63 (29.2)
Doctoral	123 (56.9)
Total[a)]	216 (100)

[a)]Eight respondents did not answer demographic questions.

This study also analyzed the responses presented in Table 3 to compare the proportion of respondents who only shared data in a restricted way with those who shared data on request or created an ORD. The responses were collected from a question that allowed multiple answers. Thus, the study identified the number of respondents providing one or two answers who selected only the choices categorized under restricted data sharing. This response type was found to constitute a majority, with a total of 80 such respondents (54.1%) (Table 4). This result indicates that although 148 respondents reported sharing their data, most conducted data exchange with a limited scope (i.e., within a research project) rather than making data available to outside researchers who needed it or to anyone at any time.

Methods of data sharing

In terms of the ways in which the respondents reported sharing their data, 110 responses (44.0%) described sharing data directly to individual researchers on request. Strongly recommended data sharing methods, such as deposition within a data repository, were less likely to be used by the respondents. However, sharing data through an institutional repository or server received the second greatest number of responses (n = 45, 18.0%). This might have resulted from the fact that the research

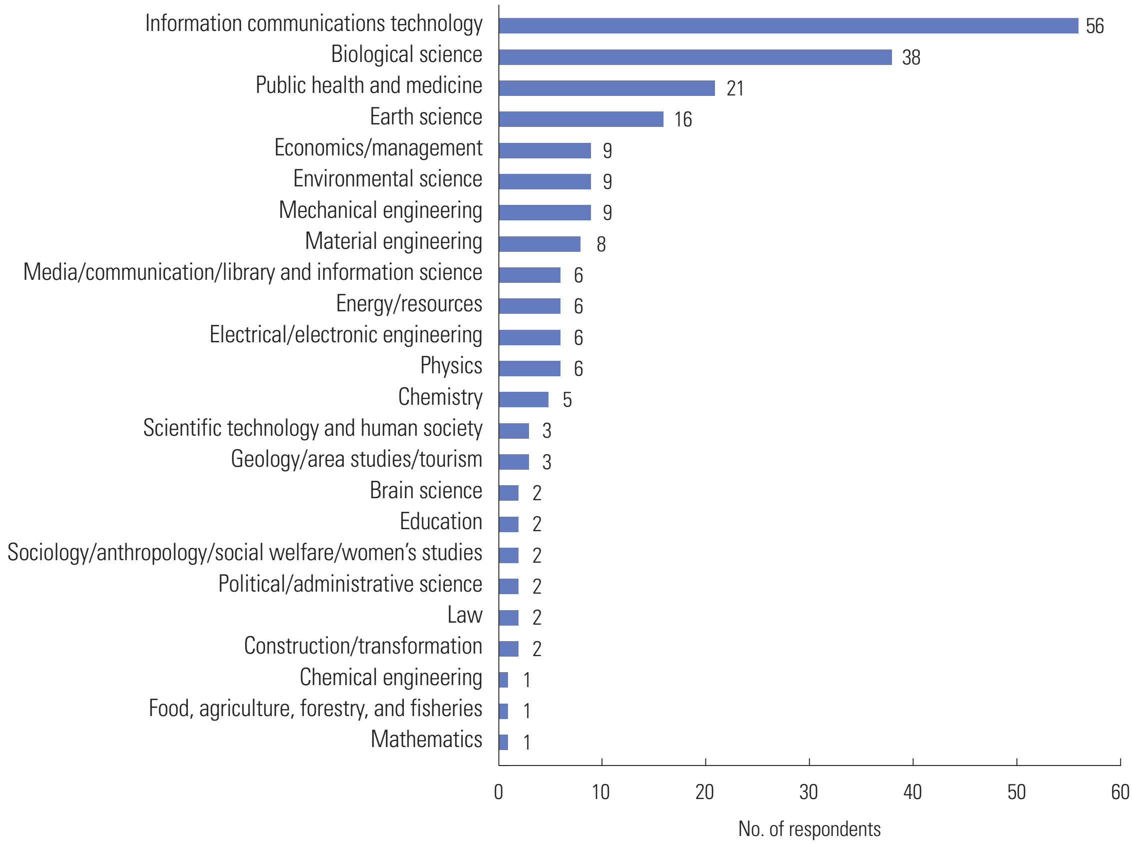

Fig. 1. Respondents' disciplines.

Table 2. The extent of research data that respondents share

Variable	No. (%)
None of my research data	32 (17.8)
Some of my research data	96 (53.3)
Most of my research data	45 (25.0)
All of my research data	7 (3.9)
Total	180 (100)

Table 3. With whom respondents share data

Data sharing type	Answer choices	No. (%)
Restricted data sharing	Principal investigators or coinvestigators involved in collecting/creating data	94 (36.3)
	All researchers who participate in a project where data are collected/created	86 (33.2)
Data sharing on-request	Outside researchers who ask for data	60 (23.2)
Open Research Data	Open data to everyone	19 (7.3)
Total[a]		259 (100)

[a]Multiple answers allowed.

institutes with which these respondents are affiliated have implemented data repositories and DMPs. A personal or research team website was the third most used method of sharing data (n = 40, 16.0%). Sharing data via journals' databases or repositories while publishing research articles also received 37 responses (14.8%). This result highlights the role of journals in facilitating data sharing. Only a small portion of responses indicated sharing data via disciplinary repositories or data journals. These results are illustrated in Table 5.

Barriers to data sharing

One survey question asked about factors that made respondents reluctant to share data. This question was asked of the 180 respondents with experience creating or collecting research data, and multiple answers were permitted. As shown in Table 6, the top three reasons received a similar proportion of responses (around 16%). These reasons were the time and effort required to organize data, unclear copyright or ownership of data, and a lack of reward or recognition for sharing data. The factor of concerns about data having sensitive information was

Table 4. Proportion of respondents who participate in restricted data sharing only versus in other types

No. of responses	Restricted data sharing only	Data sharing on-request or ORD	Total
1	48 (60.0)	16 (23.5)	64 (43.2)
2	32 (40.0)	29 (42.6)	61 (41.2)
3	-	19 (27.9)	19 (12.8)
4	-	4 (5.9)	4 (2.7)
Total	80 (54.1)	68 (45.9)	148 (100)

Values are presented as number (%).
ORD, Open Research Data.

Table 5. How respondents share data

Variable	No. (%)
Share data directly at the request of an acquaintance or individual researcher	110 (44.0)
Through an institutional repository or server	45 (18.0)
Through a personal or research team website	40 (16.0)
Through a database or repository of a journal when publishing a research article	37 (14.8)
Through a data archive or repository in my discipline	11 (4.4)
Through a database or repository of a data journal when publishing a data paper	7 (2.8)
Total[a]	250 (100)

[a]Multiple answers allowed.

Table 6. What makes respondents reluctant to share data

Variable	No. (%)
Time and effort required to organize data	84 (16.7)
Copyright or ownership of data is unclear	83 (16.5)
Lack of adequate reward or recognition for sharing data	81 (16.1)
Data contains sensitive information (e.g., personal information)	77 (15.3)
Data may contain errors	60 (11.9)
No data sharing obligations or related regulations	43 (8.5)
Unable to find the right platform to share my data	35 (7.0)
Perceived lack of need for data	23 (4.6)
No funding for sharing data	17 (3.4)
Total[a]	503 (100)

[a]Multiple answers allowed.

also selected in 77 responses (15.3%), followed by concerns about data having errors (n = 60, 11.9%). Other options selected by participants included no regulations for data sharing (n = 43, 8.5%), the lack of an adequate data sharing platform (n = 35, 7.0%), the perceived lack of need for their data (n = 23, 4.6%), and the absence of funding for sharing data (n = 17, 3.4%) (Table 6).

Discussion

Key results

Among the 148 respondents who had experienced data sharing, the vast majority reported sharing some or most of their data. Sharing data with principal investigators, coinvestigators, or participants in a research project was more common than sharing data with outside researchers on request or creating an ORD. A majority of the 148 respondents with data sharing experience shared data only in a restricted manner. Therefore, the extent of data sharing performed by the respondents is limited in light of international efforts to promote ORD.

The most common method of sharing data was to provide data directly to individual researchers who asked for it, even though funding agencies and journals strongly recommend depositing data in repositories. Yet, institutional repositories or servers were used the second most. This might be because the research institutes with which the respondents were affiliated operated institutional repositories as data sharing platforms. Journals' databases or repositories were also employed; thus, journals' role in promoting data sharing should be recognized.

Various factors that impeded data sharing were identified. The most commonly indicated factor was the time and effort required to organize data, followed by concerns about copyright or ownership of data and lack of reward or recognition for data sharing. Respondents also had concerns about sharing data containing sensitive information and the possibility of errors in their data. Exploring ways to mitigate such barriers to data sharing is necessary at an institutional and national level.

Interpretation

Most respondents with data sharing experience made some or most of their data available to others. This result is similar to that of the study by Tenopir et al. [16], which conducted an international survey of researchers' DMS practices. However, the proportion of respondents in this study who reported sharing all of their data was about four times lower than that of Tenopir et al. [16]. Restricted data sharing was also more common than making data available to outside researchers or everyone. According to the principles of the H2020 ORD pilot and newly released NIH policies, ORD is strongly recommended, but restricted data sharing is reasonable if more value can be provided by restricting data access [2]. Since decisions about access to data are nuanced rather than binary [2], it is important for Korean government research institutes to provide ongoing training and support for affiliated researchers so that they can make informed decisions and adequate justifications if restricted data sharing is needed. In addition, developing an appropriate infrastructure that enables researchers to share and preserve their data is necessary, and funding agencies and journals strongly recommend depositing data into robust repositories [4,5]. Therefore, research institutes should make commitments to implement data repositories and encourage the submission of DMPs to build good DMS practices.

Moreover, a recent systematic review of studies on factors associated with data sharing suggested 11 categories of factors: researcher's background, requirements and formal obligations, intrinsic motivations, facilitating conditions, trust, expected performance, social influence and affiliation, effort, researcher's experience, legislation and regulation, and data characteristics [18]. The findings of this study are mostly related to effort (time and effort required to organize data), legislation and regulation (concerns about copyright or ownership and sensitive information), and expected performance (lack of reward and recognition). To alleviate these factors, it is desirable to develop RDM services for researchers, which will reduce time and save effort in data preparation and organization. Furthermore, training and consultation services regarding copyright and privacy will help researchers better understand legal issues and be less concerned about accidentally violating the law when considering data sharing. Finally, as the lack of incentives has been suggested as a major impediment to data sharing [19], continuing efforts and discussions regarding sufficient rewards for data sharing are required within research institutes and externally in disciplines and governments.

Limitations

This study is based on descriptive statistical analyses only. As such, the results show the current state of data sharing behavior and perception reported by respondents, but an inferential interpretation is not possible.

Conclusion

This study found that survey respondents affiliated with Korean government research institutes commonly performed restricted data sharing. ORD is internationally recommended, but at the same time, restricted data sharing is allowable if it is possible to derive value while maintaining restricted access to data. Providing ongoing training and support for researchers can help them make informed decisions about access to data. It is also important for research institutes to develop and sustain institutional data repositories as a platform for DMS. To address barriers to data sharing, it is necessary to implement RDM services that help reduce the effort required to organize data and provide consultations for copyright and privacy issues. It is also necessary to continue exploring possible incentives for researchers who share data from institutional, disciplinary, and governmental perspectives.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Original Article

Publishing trends of journals and articles in Journal Citation Reports during the COVID-19 pandemic: a descriptive study

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Abstract

Purpose: This study aimed to investigate the changes that occurred in journal and article publishing during the noncontact period that started in 2020 due to COVID-19.

Methods: The integrated journal list in Journal Citation Reports (JCR) 2017–2021 and the search results of Web of Science were analyzed using pivot tables in Microsoft Excel. The articles, citations, impact factor (IF), publishers, open access (OA) status, and compound annual growth rate (CAGR) were investigated using the data.

Results: The CAGRs of articles, citations, and IFs in JCR journals increased throughout the COVID-19 pandemic. Moreover, the increase in OA articles was accompanied by a decreasing share of subscription articles. The top 20 journals in JCR-SCIE (Science Citation Index Expanded), based on the number of articles, accepted OA policies and showed a strong influence, accounting for 7% to 9% of all articles. MDPI and Frontiers were OA publishers included among the top 10 publishers. Large publishers maintained their competitiveness through mergers and acquisitions with OA publishers. Due to the rapid distribution of OA and early access articles as part of the international response to overcome COVID-19, the CAGRs of citations and IFs increased more than that of articles, and the publication and use of journal articles have become more active.

Conclusion: The publication and use trends in JCR journals analyzed herein will provide useful information for researchers' selection of journals for article submission, analyses of research performance, and libraries' journal subscription contracts.

Keywords

Article; COVID-19; Journal impact factor; Open access publishing; Periodicals as topic

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Introduction

Background/rationale

Understanding scholarly communication, including the publication, use, citation, and utilization of articles, is an important factor for journal publishing stakeholders. Analyzing journal publication status by year would make it possible to partially grasp changes in article publishing and publishers. However, analyzing all journals would be a difficult task in terms of data collection, and doing so might cause regional characteristics to be overreflected. Thus, Journal Citation Reports (JCR) is an appropriate tool for analyzing global journal publishing trends, since its journals are evaluated rigorously based on the Web of Science (WoS). Accordingly, the authors have presented articles [1–5] based on the JCR for Science Citation Index Expanded (SCIE) and Social Sciences Citation Index (SSCI).

Until the 2019 version, JCR provided only SCIE and SSCI journal data in WoS. Since the 2020 version, the Arts & Humanities Citation Index (AHCI) and Emerging Sources Citation Index (ESCI) began to be included, albeit without the immediacy index and impact factor (IF). Even if the final publication year has not yet been confirmed, the time when articles are first made available is important for their citation analysis. For early access (EA) articles, the year of online publication has been applied as the publication year since JCR 2020 [6]. During the noncontact period due to COVID-19, when all opportunities for face-to-face communications were closed, journals were the most appropriate means for information sharing, as the rapid distribution of reliable research information was more urgently needed than ever before. In addition, the open access (OA) movement, which began with the goal of sharing articles across borders, became a catalyst for information distribution during the COVID-19 pandemic and led to many changes in journal and article publishing [7]. Accordingly, the authors determined that it was necessary to investigate further the publication trends of journals and articles during the COVID-19 period following previous studies [1–5]. This study was conducted to expand previous research to JCR 2021 data.

Objectives

The COVID-19 pandemic, which has rapidly spread throughout the world since 2020, completely paralyzed not only international travel but also conferences for face-to-face information exchange among researchers. The efforts of researchers and countries to end this pandemic by developing new vaccines and treatments have stimulated intense competition for primacy and rapid distribution of research results. The purpose of this study was to investigate the changes that have occurred in the publication of articles in journals during the noncontact period caused by COVID-19.

Methods

Ethics statement

This was not a study with human subjects, so neither Institutional Review Board approval nor informed consent was required.

Study design

This was a literature database-based descriptive study.

Data collection

JCR 2021 data released in June 2022 was downloaded as a text file. The journal list [5] in JCR 2017 to 2020 and the new JCR 2021 data were combined by unique journal. The same journals were integrated into a single Microsoft Excel (Microsoft Corp) file using journal names and International Standard Serial Numbers, and affiliated publishers were classified by applying subsequent changes according to the holding company, as shown in Suppl. 1.

From the JCR 2017–2021 data, articles, citations, and IFs of journals with one or more citable items (research and review articles in WoS) were analyzed. In order to supplement the OA status of articles according to Unpaywall's OA classification, WoS was searched in December 2022. OA status, implying that articles are usable free of charge at any time, is important for users; therefore, only gold and hybrid OA articles in WoS were classified as OA articles in JCR, with the exclusion of tentative green OA. These collected research data from JCR and WoS were analyzed using pivot tables in Microsoft Excel.

Statistical methods

Data were tabulated based on descriptive statistics, and the proportions of the cells were calculated. The growth rate (%) was calculated annually, and the compound annual growth rate (CAGR) was used to compare the situation before and during the COVID-19 pandemic.

Results

Publishing journals and articles in JCR

Table 1 shows journals, articles, citations, IFs, and publishers in JCR 2017–2021. As AHCI and ESCI journals were added since JCR 2020, the proportion of SCIE articles in JCR was 78.8% in 2021, reflecting a decrease from over 90% prior to the inclusion of those databases. Considering the high overlap of SSCI journals with SCIE (34.7% of SSCI articles), an analysis focusing on SCIE was sufficient to identify publishing trends

Table 1. Journals and articles in JCR

JCR	2017	2018	2019	2020	2021	CAGR to 2019	CAGR to 2021
All							
Item							
Journal	11,559	11,776	12,075	20,418	20,916	2.2	16.0
Article	1,597,875	1,705,575	1,802,408	2,557,584	2,729,153	6.2	14.3
Citation	64,180,698	70,294,170	75,509,184	97,285,376	110,730,545	8.5	14.6
IF	26,960	29,348	31,872	41,247	48,298	8.7	15.7
Publisher	1,824	1,814	1,822	4,293	4,267	–0.1	23.7
Growth (%)							
Journal	-	1.9	2.5	69.1	2.4	-	-
Article	-	6.7	5.7	41.9	6.7	-	-
Citation	-	9.5	7.4	28.8	13.8	-	-
IF	-	8.9	8.6	29.4	17.1	-	-
Publisher	-	–0.5	0.4	135.6	–0.6	-	-
SCIE							
Item							
Journal	8,831	9,028	9,273	9,523	9,524	2.5	1.9
Article	1,463,785	1,568,118	1,661,422	2,017,881	2,150,241	6.5	10.1
Citation	59,258,465	64,821,289	69,669,593	87,051,731	99,045,970	8.4	13.7
IF	22,867	24,850	27,019	34,338	40,543	8.7	15.4
Publisher	1,467	1,474	1,486	1,509	1,484	0.6	0.3
Growth (%)							
Journal	-	2.2	2.7	2.7	0.0	-	-
Article	-	7.1	6.0	21.5	6.6	-	-
Citation	-	9.4	7.5	24.9	13.8	-	-
IF	-	8.7	8.7	27.1	18.1	-	-
Publisher	-	0.5	0.8	1.5	–1.7	-	-
Non-SCIE							
Item							
Journal	2,728	2,748	2,802	10,895	11,392	1.3	43.0
Article	134,090	137,457	140,986	539,703	578,912	2.5	44.1
Citation	4,922,233	5,472,881	5,839,591	10,233,645	11,684,575	8.9	24.1
IF	4,093	4,498	4,853	6,909	7,755	8.9	17.3
Publisher	357	340	336	2,784	2,783	–3.0	67.1
Growth (%)							
Journal	-	0.7	2.0	288.8	4.6	-	-
Article	-	2.5	2.6	282.8	7.3	-	-
Citation	-	11.2	6.7	75.2	14.2	-	-
IF	-	9.9	7.9	42.4	12.2	-	-
Publisher	-	–4.8	–1.2	728.6	0.0	-	-

JCR, Journal Citation Reports; CAGR, compound annual growth rate; IF, impact factor; SCIE, Science Citation Index Expanded.

of journals and articles in JCR. As can be seen in Table 1, a comparison of the CAGR for all journals and non-SCIE journals lost its meaning as JCR's coverage changed since 2020. Considering the further decreases in the CAGRs of journals and publishers in SCIE, with little change in coverage, it is remarkable that articles, citations, and IFs showed an unusual increase of more than 20% in 2020, and the CAGRs through 2021 were higher than those observed until 2019. Although the rate of increase in articles returned to the previous year's level in 2021, the citations and IFs still increased by rates of more than 10%. As the CAGRs of articles, citations, and IFs exceeded 10% over 5 years, all three CAGRs increased more than had been observed until 2019, and article publication and use were more active from 2020 onwards. As a result, the annual number of articles per SCIE journal increased significantly from an average of 166 in 2017 to 226 in 2021.

Large publishers and journals in JCR

Table 2 shows the top 10 publishers based on SCIE articles in JCR 2021. The share of articles, citations, and IFs of the top 10 publishers was about 70%, but the share of articles in 2021 revealed a concentration of over 75%, reflecting an increase of 7% from 2017. Elsevier showed the largest influence, with the highest share of articles, citations, and IFs over the past 5 years. Elsevier, Springer, and Wiley maintained their competitiveness, with a collective share of around 50%. Although their share of articles decreased in 2021 compared to 2017, citations and IFs increased rather more. MDPI and Frontiers, which specialize in OA publishing, entered the top 10 publishers within a short time. In particular, MDPI surpassed Wiley to rank third in the 2021 article share. There was little change in the number of publishers in JCR, but the OA publishing communities experienced fierce competition through mergers and acquisitions (M&As) [8,9] with large publishers; for instance, BioMed Central was acquired by Springer, and Hindawi was acquired by Wiley.

As shown in Table 3, the top 20 journals on the basis of articles were all classified as SCIE in JCR 2017–2021. Among them, 14 journals were OA-specialized journals and the remaining six were hybrid journals. OA journals that published a large amount of OA articles played an important role in the formation of large journals. The number of articles in the top 20 journals gradually increased by 7% to 9% in SCIE, and their CAGR increased from 14% in 2019 to 17% in 2021. The article proportion of eight MDPI journals in SCIE also increased gradually, from 1.1% in 2017 to 2.6% in 2019 and 3.9% in 2021. All seven journals publishing more than 10,000 articles annually in 2021 were OA journals. In the five journals excluding *Scientific Reports* and *PLoS One,* articles surged in 2021 compared to 2017, and their article CAGR was much higher than that of the other top 20 journals. As a result, the number of large journals in SCIE almost doubled from 2017 to 2021; specifically, the number of journals containing more than 1,000 articles per year increased from 145 to 335 and that of journals publishing more than 500 articles per year increased from 453 to 823.

Journals continuously included in JCR

As shown in Table 4, the journals that had been continuously included in JCR 2017–2021 accounted for more than 90% of the share of articles, citations, and IFs until 2019. After the addition of AHCI and ESCI data since JCR 2020, the article share

Table 2. Top 10 publishers in JCR-SCIE

Publisher	Article share (%)		Citation share (%)		IF share (%)	
	2017	2021	2017	2021	2017	2021
Elsevier	25.7	26.3	28.1	29.6	23.3	25.1
Springer	15.2	13.6	12.2	13.4	18.3	20.0
MDPI	1.9	9.7	0.4	2.0	0.5	0.9
Wiley	10.2	9.0	11.0	10.4	12.8	11.1
Taylor & Francis	4.0	3.7	2.3	2.5	5.4	5.3
Institute of Electrical and Electronics Engineers	2.5	3.2	2.3	2.5	2.4	2.3
Frontiers	1.0	3.2	0.3	1.0	0.4	0.6
American Chemical Society	3.1	2.8	5.4	4.7	1.6	1.2
Oxford University Press	2.3	2.0	3.8	3.4	2.9	2.7
Royal Society of Chemistry	2.3	1.8	2.1	2.1	1.1	0.9
Total	68.2	75.3	67.9	71.6	68.7	70.1

JCR, Journal Citation Reports; SCIE, Science Citation Index Expanded; IF, impact factor.

Table 3. Top 20 journals in JCR

Journal	Publisher	Type	2017	2019	2021	CAGR to 2019	CAGR to 2021
Scientific Reports	Springer	OA	24,809	19,873	23,363	–10.5	–1.5
PLoS One	PLoS	OA	20,328	11,244	15,430	–25.6	–6.7
IEEE Access	IEEE	OA	2,221	14,985	12,388	159.7	53.7
Sustainability	MDPI	OA	2,346	7,184	13,769	75.0	55.6
International Journal of Molecular Sciences	MDPI	OA	2,727	6,273	13,382	51.7	48.8
International Journal of Environmental Research and Public Health	MDPI	OA	1,568	5,093	13,064	80.2	69.9
Applied Sciences	MDPI	OA	1,313	5,186	11,798	98.7	73.1
Science of Total Environment	Elsevier	Hybrid	2,717	6,247	9,349	51.6	36.2
Sensors	MDPI	OA	2,945	5,528	8,332	37.0	29.7
Nature Communications	Springer	OA	4,316	5,469	6,938	12.6	12.6
ACS Applied Materials & Interfaces	ACS	Hybrid	4,862	5,181	6,156	3.2	6.1
Energies	MDPI	OA	2,161	4,783	8,369	48.8	40.3
Physical Review B	APS	Hybrid	5,374	5,023	5,042	–3.3	–1.6
RSC Advances	RSC	OA	6,554	4,583	4,036	–16.4	–11.4
Molecules	MDPI	OA	2,223	4,583	7,528	43.6	35.7
Journal of Alloys and Compounds	Elsevier	Hybrid	4,708	4,845	5,990	1.4	6.2
Medicine	Kluwer	OA	3,593	4,464	4,418	11.5	5.3
Materials	MDPI	OA	1,443	4,207	7,713	70.7	52.1
Journal of Cleaner Production	Elsevier	Hybrid	2,741	4,059	5,361	21.7	18.3
Environmental Science and Pollution Research	Springer	Hybrid	2,454	3,097	5,794	12.3	24.0
Total no. of articles	-	-	101,403	131,907	188,220	14.1	16.7
Share of articles in JCR-SCIE (%)	-	-	6.9	7.9	8.8	-	-

JCR, Journal Citation Reports; CAGR, compound annual growth rate; OA, open access; SCIE, Science Citation Index Expanded.

of non-SCIE journals that had been continuously included in JCR decreased significantly, which contributed to a decrease in this proportion among all JCR journals. However, in an analysis limited to SCIE journals that had been continuously included in JCR, although their share of articles and IFs slightly decreased since 2020, their share of citations remained more than 97%. Continuously indexed SCIE journals ultimately accounted for 94.7% of the total JCR articles, and were a great boost to the stable growth of JCR.

OA and subscription articles in JCR

Although JCR has some OA information for each journal, it is difficult to check the current status of all journals. The search results from 2017 to 2021 in WoS, which displays OA status and type for each article, are shown in Table 5. The JCR data are based on WoS, and the two data sources are quite similar. Therefore, the current status of OA articles in JCR was estimated using WoS data. In WoS, the increase in OA articles continued over the past 5 years, with gold and hybrid OA articles showing much higher CAGRs than subscription articles. The CAGR of gold OA was higher than that of hybrid OA in SCIE journals, but the opposite was true for non-SCIE journals. The percentage of gold and hybrid OA articles in WoS was 38.3% in 2021, after entering the 30% range in 2020 for SCIE journals and in 2019 for non-SCIE journals, respectively. As the percentage of OA articles showed a high increase (around 10%) in the 5-year CAGR, the proportion of subscription articles is expected to decrease further.

Discussion

Contribution of OA and EA articles to rapid information exchange during the COVID-19 pandemic

As presented in Table 1, the CAGR of JCR-SCIE articles was over 10%, showing an exceptional surge of over 20% in 2020. Although the number of articles changed slightly by search

Table 4. Continuous journals in JCR

JCR	2017	2018	2019	2020	2021	CAGR to 2019	CAGR to 2021
All (11,079 journals)							
Item							
Article	1,562,770	1,654,595	1,723,391	2,058,916	2,118,676	5.0	7.9
Citation	63,415,537	69,406,900	74,304,193	93,019,897	104,698,313	8.2	13.4
IF	26,313	28,040	29,447	37,219	42,511	5.8	12.7
Share (%)							
Article	97.8	97.0	95.6	80.5	77.6	-	-
Citation	98.8	98.7	98.4	95.6	94.6	-	-
IF	97.6	95.5	92.4	90.2	88.0	-	-
SCIE (8,566 journals)							
Item							
Article	1,441,431	1,528,604	1,595,562	1,881,227	1,948,891	5.2	7.8
Citation	58,767,978	64,149,542	68,705,362	85,282,231	96,378,624	8.1	13.2
IF	22,474	23,848	25,024	30,878	35,558	5.5	12.2
Share (%)							
Article	98.5	97.5	96.0	93.2	90.6	-	-
Citation	99.2	99.0	98.6	98.0	97.3	-	-
IF	98.3	96.0	92.6	89.9	87.7	-	-
Non-SCIE (2,513 journals)							
Item							
Article	121,339	125,991	127,829	177,689	169,785	2.6	8.8
Citation	4,647,559	5,257,358	5,598,831	7,737,666	8,319,689	9.8	15.7
IF	3,839	4,192	4,423	6,341	6,953	7.3	16.0
Share (%)							
Article	90.5	91.7	90.7	32.9	29.3	-	-
Citation	94.4	96.1	95.9	75.6	71.2	-	-
IF	93.8	93.2	91.1	91.8	89.7	-	-

JCR, Journal Citation Reports; CAGR, compound annual growth rate; IF, impact factor; SCIE, Science Citation Index Expanded.

time, the share of OA articles was about 38% in WoS, while their CAGR remained around 20% (Table 5). To understand the status of articles during the COVID-19 pandemic, articles related to COVID-19 (i.e., using terms such as "COVID-19" OR "SARS-CoV-2" OR "Corona virus 2" OR "post covid" OR "chronic covid" in WoS) were searched in December 2022, as shown in Table 6. The percentage of OA articles related to COVID-19 was nearly 50%. In order to end the pandemic, publishers endeavored in several ways to help academics rapidly develop vaccines and treatments, including expanding OA publishing, rapid peer review of articles (most COVID-19 articles were published faster than the journals' average [10]), and article processing charge (APC) discounts for some journals. These collaborative international responses between the publishing industry and academia contributed to the rapid distribution of research information. In this situation, publication and research activities in SCIE journals, including research on COVID-19, were steady even during the noncontact period. In contrast, in non-SCIE journals, which were likely to have been less strongly affected by the pandemic, research activities were reduced, with a lower increase rate of articles than in the past. However, the number of COVID-19–related articles in those journals increased considerably.

Some articles published online may have a difference between the official publication year and the EA year. For EA articles published online in 2020, if their final publication was

Table 5. Estimated OA articles in JCR from search results of WoS

WoS	2017	2018	2019	2020	2021	CAGR to 2019	CAGR to 2021
All							
Article							
Gold	402,581	462,280	574,264	719,423	859,335	19.4	20.9
Hybrid	89,464	100,045	122,371	165,522	201,523	17.0	22.5
Subscription	1,465,693	1,502,796	1,620,709	1,662,777	1,710,623	5.2	3.9
All	1,957,738	2,065,121	2,317,344	2,547,722	2,771,481	8.8	9.1
Growth (%)							
Gold	-	14.8	24.2	25.3	19.4	-	-
Hybrid	-	11.8	22.3	35.3	21.7	-	-
Subscription	-	2.5	7.8	2.6	2.9	-	-
All	-	5.5	12.2	9.9	8.8	-	-
OA							
Article	492,045	562,325	696,635	884,945	1,060,858	19.0	21.2
Percentage	25.1	27.2	30.1	34.7	38.3	9.4	11.1
SCIE							
Article							
Gold	298,715	340,511	430,544	546,536	665,679	20.1	22.2
Hybrid	77,345	87,561	104,225	136,211	157,806	16.1	19.5
Subscription	1,153,967	1,184,390	1,263,342	1,288,056	1,341,645	4.6	3.8
All	1,530,027	1,612,462	1,798,111	1,970,803	2,165,130	8.4	9.1
Growth (%)							
Gold	-	14.0	26.4	26.9	21.8	-	-
Hybrid	-	13.2	19.0	30.7	15.9	-	-
Subscription	-	2.6	6.7	2.0	4.2	-	-
All	-	5.4	11.5	9.6	9.9	-	-
OA							
Article	376,060	428,072	534,769	682,747	823,485	19.2	21.6
Percentage	24.6	26.5	29.7	34.6	38.0	10.0	11.5
Non-SCIE							
Article							
Gold	103,866	121,769	143,720	172,887	193,656	17.6	16.9
Hybrid	12,119	12,484	18,146	29,311	43,717	22.4	37.8
Subscription	311,726	318,406	357,367	374,721	368,978	7.1	4.3
All	427,711	452,659	519,233	576,919	606,351	10.2	9.1
Growth (%)							
Gold	-	17.2	18.0	20.3	12.0	-	-
Hybrid	-	3.0	45.4	61.5	49.1	-	-
Subscription	-	2.1	12.2	4.9	-1.5	-	-
All	-	5.8	14.7	11.1	5.1	-	-
OA							
Article	115,985	134,253	161,866	202,198	237,373	18.1	19.6
Percentage	27.1	29.7	31.2	35.0	39.1	7.2	9.6

OA, open access; JCR, Journal Citation Reports; WoS, Web of Science; CAGR, compound annual growth rate; SCIE, Science Citation Index Expanded.

Table 6. COVID-19 and early access articles in WoS

WoS	COVID-19 article		OA article in COVID-19 (share) (%)		Early access article	
	2020	2021	2020	2021	2020	2021
All	53,151	116,919	22,583 (42.5)	56,010 (47.9)	7,614	55,036
SCIE	34,955	76,486	15,205 (43.5)	38,865 (50.8)	4,179	29,827
Non-SCIE	18,196	40,433	7,378 (40.5)	17,145 (42.4)	3,435	25,209

WoS, Web of Science; OA, open access; SCIE, Science Citation Index Expanded.

Table 7. Duration for publishing articles for KRIBB researchers

KRIBB article	Submit to accept		Accept to publish		Submit to publish	
	Average day	No. of articles	Average day	No. of articles	Average day	No. of articles
Year						
2020	99	690	16	506	117	503
2021	93	611	17	487	108	486
All	96	1,301	17	993	113	989
Publisher						
MDPI	36	274	3	274	39	274
Elsevier	115	266	8	224	123	223
Springer	141	239	26	229	169	228
Wiley	125	92	36	33	172	33
Frontiers	103	59	26	59	129	59
Others	90	371	29	175	124	172

KRIBB, Korea Research Institute of Bioscience and Biotechnology.

not confirmed, JCR started to classify them as 2020 articles since JCR 2020. When the final issue of an EA article is announced, the EA year is changed to the publication year in WoS. As shown in Tables 1 and 5, there was a large difference in the proportional increase of articles in 2020 between JCR and WoS. The introduction of EA articles in JCR 2020 is likely to have had some impact on this difference. As shown in Table 6, WoS was searched in December 2022 to estimate the magnitude of EA articles in JCR. As the search time became more recent, the number of EA articles in WoS decreased. The expansion of online publishing expedited users' access to new research articles. Therefore, OA and EA articles are judged to have influenced the rapid increase of articles, along with the journals continuously included in JCR, large publishers, and large journals. Taking into account the sudden increase of OA articles and CAGRs in citations and IFs since 2020, as shown in Table 1, the increase in OA and EA articles may have contributed to the rapid exchange of research information during the COVID-19 pandemic.

OA journals having both competitiveness and a fast review policy

Driven by researchers' demands for the rapid presentation and sharing of research results despite the burden imposed by APCs, OA-specialized journals with fast review policies have grown rapidly since COVID-19 in JCR, as shown in Table 3. Compared to the journals listed in JCR 2014–2019, which published 128 articles per year [4], some OA-specialized journals have recently been publishing thousands of articles per year. The review quality of some OA journals has even been questioned due to the very rapid screening of articles and frequent publishing of special issues [11]. MDPI, which publishes articles within an average review period of 38 days [12], has more than 205 OA journals in JCR. As presented in Table 2, MDPI quickly became one of the top three publishers and accounted for 9.7% of articles in 2021, but its share of citations and IFs, which are correlated with articles' quality, was still not comparable to those of other large publishers. Table 7 shows the time required for articles from submission to publication according to data from the Korea Research Institute of Bioscience and Biotechnology. MDPI (39 days) completed publication within one-third of the average time for non-MDPI journals (141 days).

Conclusion

The higher growth rate observed for citations and IFs than for journals and articles in JCR shows that there have been changes in article use. The increasing publication of OA and EA articles contributed to the rapid distribution of research information during the noncontact pandemic period. OA articles played a role in the surge of articles, while the proportion of subscription articles decreased. As OA publishing became more active during the COVID-19 pandemic, rapidly growing MDPI became one of the top three publishers, and fierce competition for M&As with OA publishers ensued. The journal industry is predicted to continue changing faster than before. All journal stakeholders need to recognize recent trends in journal publishing and the use of articles. This study provides useful information for tasks such as journal selection for article submission, analyses of article performance, and journal subscription contracts.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Data Availability

Most of the raw data in this paper are various indicators of Journal Citation Reports, which is sold as a paid commercial database; therefore, sharing is not available. Please contact the corresponding author for raw data availability.

Supplementary Material

Supplementary file is available from https://doi.org/10.7910/DVN/5ROUM8.

Suppl. 1. Top publishers' imprints referenced by Scopus's classification and the authors' research.

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Essay

Evolution of Scopus over the next decade, including research performance in South Korea

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Introduction

Scopus has helped the world of research by enabling high-value decisions with confidence. In this essay, I would like to discuss the evolution of Scopus over the next decade. Three specific topics will be covered: first, the power of Scopus with trusted coverage of high-quality content; second, research performance in South Korea (hereinafter, Korea); and third, key research challenges for the future. This discussion will be helpful for researchers and editors to understand Scopus' development and gain more knowledge on its use.

The Power of Scopus with Trusted Coverage of High-quality Content

Scopus was launched as a commercial product in 2004, and there are currently 26,028 active titles in Scopus. The Scopus database was created from different subject specific databases and expanded with additional content over time. Content in Scopus is dating back to as far as 1788 and a backfill project was done to add cited references going back 1970. Scopus is a source-neutral abstract and citation database curated by independent subject matter experts. It features intelligent tools that allow researchers to track, analyze, and visualize scholarly research (Fig. 1). Scopus links with them according to the cited references that connect all the documents. Furthermore, it also profiles the content and creates a full set of profiles, including the author and affiliation. It is possible to find research and understand who has done that research and where it has been done at which institution.

The content in the Scopus database is not selected by Elsevier or the Scopus team itself, but by an external board called the Content Selection Advisory Board (CSAB) (Fig. 2) [1]. CSAB members are experts from all over the world, coming from all different disciplines, and they decide which journals are included in Scopus. Although CSAB members are from all over the world, they are not familiar with every region. Therefore, in some regions, we also have local boards that support the CSAB. One of them is in Korea. We started the Scopus Expert Content Selection and Advisory Committee-Korea (ECSAC-Korea) with the National Research Foundation of Korea in 2011, but in 2019, we transferred the management of that board to the Ko-

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This essay was presented at the 10th Anniversary Conference of the Korean Council of Science Editors through Zoom on September 8, 2021 (Korean standard time).

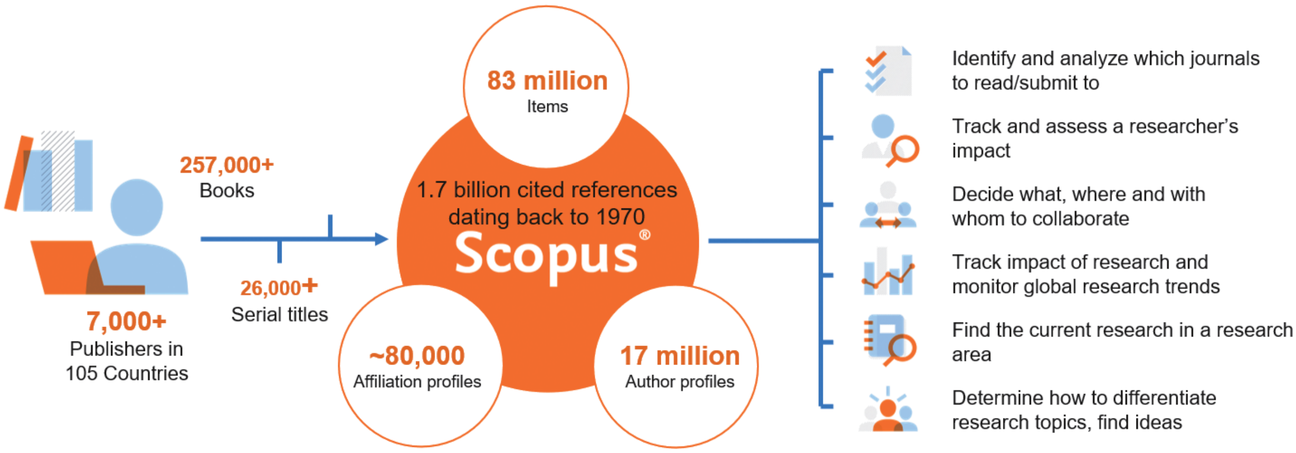

Fig. 1. Sources, amount of items, and profiles in Scopus with its key role in scholarly publishing.

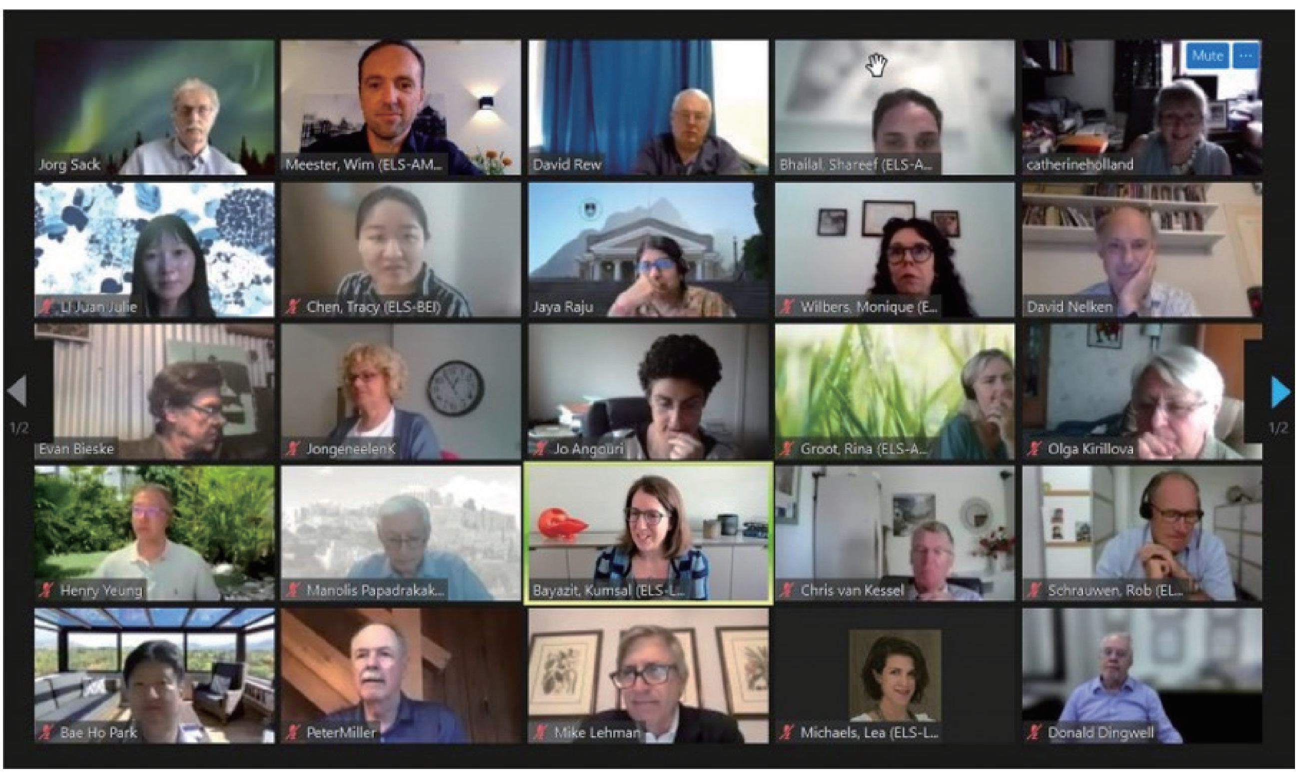

Fig. 2. Screenshot of Scopus Content Selection and Advisory Board (CSAB) members, local board members, and staff who attended the CSAB meeting in 2021.

rean Council of Science Editors (KCSE). The KCSE is now managing the local boards as a partner of Scopus. Professor Hyungsun Kim (Inha University, Incheon, Korea) was the first president of the KCSE to be the local board's chair; now, this responsibility has been handed over to Professor Bae Ho Park (Konkuk University, Seoul, Korea). During the COVID-19 pandemic, a virtual meeting was held with the KCSE, featuring a discussion about the local board for Scopus. Over the past 10 years, many titles from Korea have been suggested to Scopus and reviewed for inclusion in the Scopus database. The CSAB members make those decisions.

Fig. 3 shows the countries where these titles come from, the number of titles accepted, and the number of titles rejected. As for Korea, 176 titles have been accepted for Scopus over the past 10 years. Title review results from Korea are presented in Fig. 4, including the number of titles suggested each year,

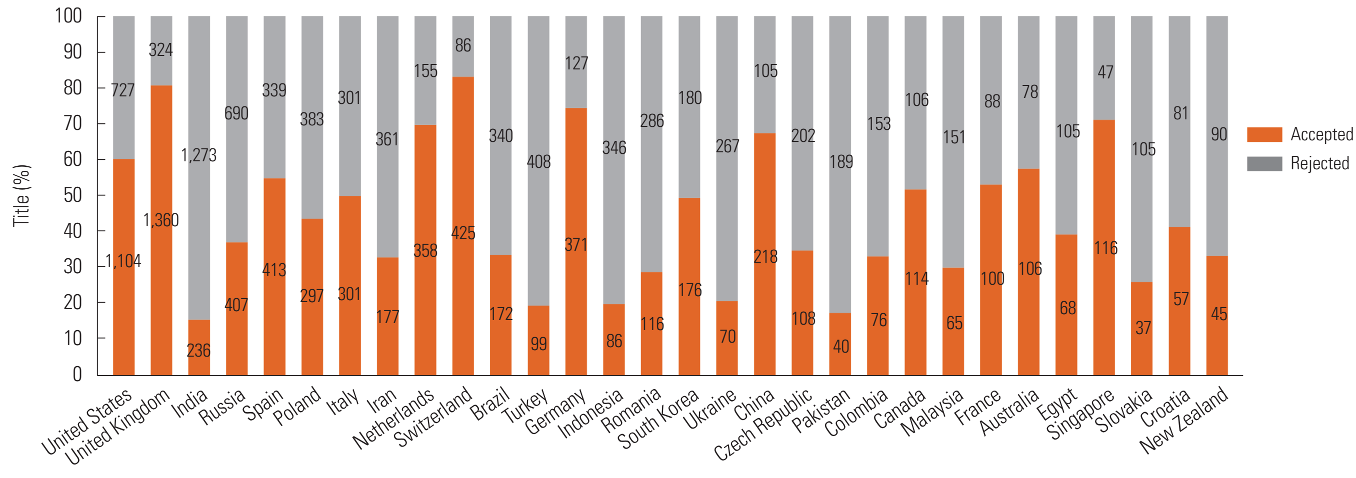

Fig. 3. Scopus journal title review results from the top 30 countries with the most titles reviewed from 2011 to 2021. Numbers represent the amount of titles accepted or rejected for that country. In total 18,176 titles were reviewed (2011–2021 year to date), of which 8,432 (46%) were accepted.

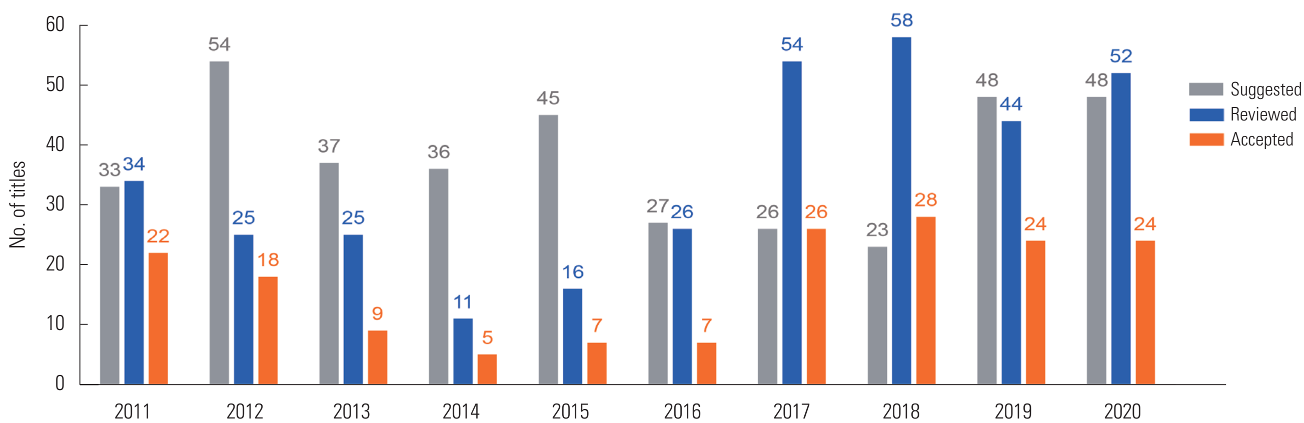

Fig. 4. Scopus journal title review statistics for South Korea (2011–2020). A total of 264 active titles from South Korea based publishers are covered in Scopus.

the number of titles reviewed that year, and the number of titles accepted for inclusion in Scopus. Particularly in the last few years, there has been an increase in the number of titles suggested from Korea, an increase in the number of titles reviewed from Korea, and an increase in the number of titles selected for Scopus from Korea. In total, there are now 264 active journals from Korea in the Scopus database.

The assistance of local boards such as ECSAC-Korea and managing partners like KCSE has been highly successful, increasing the number of titles from Korea that have been accepted for inclusion in Scopus. Given this recent history of title review, we can be confident that even more titles from Korea will be deemed suitable for inclusion in Scopus in the next decade. These titles will also be selected by the CSAB.

How is Korea's Research Performance?

There is interest in understanding Korea's research performance using Scopus data. The first aspect to consider is the scholarly output, including articles, review papers, and conference papers, as well as output per year compared to countries such as Japan, China, India, and Russia. In recent years, output has grown to almost 750,000 items per year. Meanwhile, the number of documents produced by authors in Korea has risen from about 65,000 to around 90,000 per year (Fig. 5). This is promising, although countries like China, India, and Russia have higher growth rates. It is encouraging to see that Korea is investing in science, leading to more articles being produced.

It is also possible to see the output of articles, reviews, and conference papers per year by journal quartile and using the CiteScore journal metrics. The first quartile (Q1) is the high-

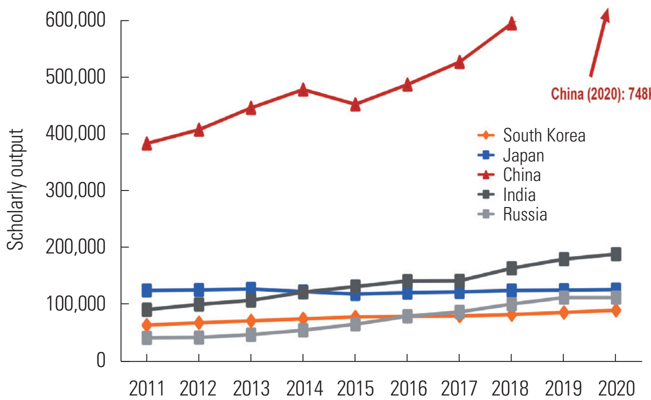

Fig. 5. Scholarly output for South Korea, Japan, China, India, and Russia in Scopus from 2011 to 2020. (source: Scopus data, articles, reviews, and conference papers only; September 2021).

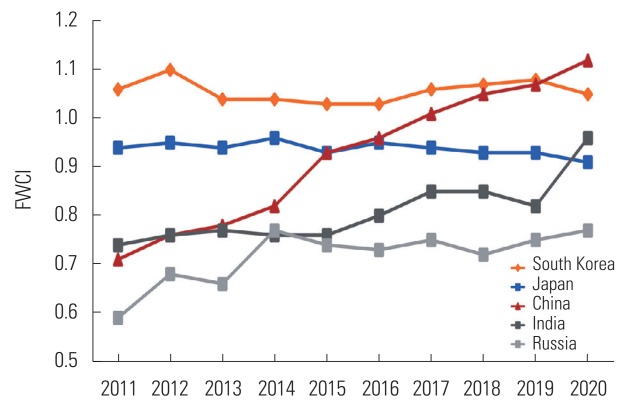

Fig. 7. Field-weighted citation impact (FWCI) for South Korea, Japan, China, India, and Russia in Scopus from 2011 to 2020 (source: Scopus & SciVal data, articles, reviews, and conference papers only; September 2021).

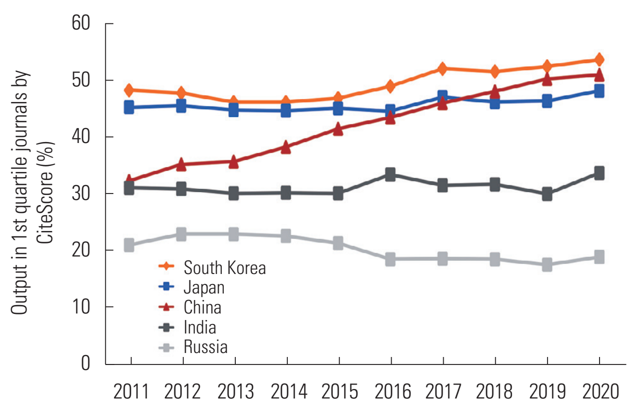

Fig. 6. Output in the first quartile journal by CiteScore (%) for South Korea, Japan, China, India, and Russia in Scopus from 2011 to 2020 (source: Scopus & SciVal data, articles, reviews, and conference papers only; September 2021).

est. Around 50% of the output from Korea has been published in Q1 journals, based on CiteScore. This means that Korean researchers are publishing their articles in top journals. Compared to other countries, this ratio for Korea is the highest. The proportions are growing for other countries, such as China, but remain lower than Korea's (Fig. 6).

I would also like to share the results of the field-weighted citation impact (FWCI), which is the ratio of total citations received to total citations expected based on the average of the subject field [2]. For an FWCI, 1.0 is the average, so anything above 1.0 is above average, and anything below 1.0 is below average. Korea's FWCI is slightly above 1.0, between 1.05 and 1.10. Over the past few years, it has been above the world average and higher than other comparable countries (Fig. 7). In 2020, China's FWCI became slightly higher than Korea's. This is important because the FWCI is an essential metric increasingly used by governments for research assessment. In Korea, the FWCI is also included in research assessment practices. It is encouraging to see that Korea already has a high FWCI, which is expected to grow over the next 10 years.

For more detailed information, please refer to the "Korea Research and Innovation Power House" report published in March 2021 [3]. This report provides more detailed information about Korea's research performance and prospects, as well as essential areas to focus on.

Key Research Challenges for the Future

We are trying to address critical challenges with Scopus: efficiently discovering the most relevant research, identifying experts and collaborators, evaluating and demonstrating impact, research strategy decision-making, and applying and analyzing funding. These challenges are taking place in the research community, and Scopus is trying to address them by providing more signals and data around research.

Incorporation of preprints into Scopus author profiles

We are also focusing on incorporating preprints into Scopus author profiles. Preprints are not peer reviewed, but they are a good indication of what someone is working on and provide an early signal of research in a particular field. This can help researchers understand a specific research field's trends and find potential collaborators. Preprints are only added to the Scopus author profiles and are separated from the regular content.

Incorporation of awarded grants in Scopus author profiles

We have recently started adding awarded grants to the Scopus author profiles. These grants give early signals about a researcher's topic and can be used to find collaborations, identify emerging issues, and support grant submission strategies. Grants are added to the author profiles and separated from other content types. This feature is in an early stage, and we have coverage of funders from the United States. The solution is initially a beta solution for the United States market (approximately 100 funders). Over the next few years, we will expand to include awarded grants from other regions, such as Europe, Australia, New Zealand, and Asia.

Finding experts via the Scopus People Finder

In the next few months and years, we will focus on providing more information about people in Scopus. Scopus is optimized for finding documents and known authors, but we realize that providing more data about researchers would be essential. Therefore, we want to combine these signals and organize them differently through the Scopus People Finder. This will make it easier for people to find researchers and can be beneficial for tasks like reviewing promotions, recruitment, grant applications, and workshops. It will also increase the diversity of the people researchers are working with and help researchers find people with different backgrounds that are still relevant to their research.

Conclusion

The Scopus team has strived to provide valuable literature content and efficient and helpful journal metrics for editors and researchers since 2004. This essay highlighted the evolution of Scopus, focusing on Korean researchers' performance and the platform's future tasks. It also discussed the incorporation of preprints and awarded grants in Scopus author profiles, as well as the introduction of the Scopus People Finder for finding experts. As the needs of Scopus users evolve, more innovative and user-friendly features will be proposed and implemented. As the manager of Scopus, the world's largest indexing database with various journal metrics, I am proud of its achievements. The continuing development of this unique database relies on the suggestions of researchers and editors. I encourage their active participation in the continuous progress of Scopus.

Conflict of Interest

Wim J.N. Meester is a Senior Director of Product Management at Elsevier. No other potential conflict of interest relevant to this article was reported.

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Essay

Format-free submission: gain for some, pain for others?

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Introduction

Many authors find that submitting to a scholarly journal can be difficult. This essay asks how publishers can make the process easier, and responds to concerns of editors that manuscript quality will deteriorate if authors are allowed to submit in any format they wish.

This is the story of a junior researcher, fresh and relatively naive, after they have completed their first research study. With excitement they start mapping out a publication plan. They seek guidance from their supervisor, they draft the manuscript, they obtain input from their collaborators and co-authors, and they eventually have a final draft of a manuscript ready for submission. In their publication plan, they and their co-authors have identified a list of target journals—they will aim first for the most reputed journal in the field, of course, but they have a few other journals in reserve on the list in case they are rejected from the top one. They check the submission guidelines for the first journal and—to their disappointment—they discover that they need to reformat the manuscript to conform to the guidelines.

After a few hours of reformatting and redrafting, and perhaps seeking more input from their co-authors, they eventually submit the manuscript and await the outcome of the editorial process. A few days elapse before they receive a rejection email. Disappointed but undeterred, they prepare to resubmit the manuscript to their next target journal. With a sigh they discover that they need to format their manuscript yet again because this journal has different guidelines. They find a few hours, perhaps late into the evening after a full day working in the lab on their next research project, to reformat and resubmit the manuscript, and they await the next outcome.

And so the process might continue with other journals on the list, until our junior researcher receives the longed-for email, perhaps after peer review and a few rounds of revision, confirming that their article is accepted for publication. However, it has taken them several hours to reach this point—not just in revising the manuscript in line with editorial and peer review feedback, but just to format the manuscript to suit journal styles. Moreover, once the article is accepted, our junior researcher is puzzled to note, upon receiving the article proofs, that the typesetter has reformatted the manuscript once again before publication in the journal. Was their own reformatting really worth the effort? Could they not just have focused solely on the scientific content of the article and left the formatting up to the publisher?

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How Many Hours Researchers Use for Manuscript Formatting

Our junior researcher is not a fiction of the imagination. An article published in 2018 estimated that around 1.5 million hours of researchers' time was spent in formatting [1]. A study published in 2019 found that a typical researcher spends 52 hours per year formatting manuscripts, at an estimated cost of around $2,000/yr [2]. These are truly the "hidden costs of academia" [3]. Why waste a researcher's time on a task that the journal's typesetter can do much more efficiently and more accurately? Researchers are not funded to format manuscripts or, as someone wrote, to be "desktop publishers" [4]; they are funded to conduct research. It is wasteful of time and resources—indeed, one might go so far as to say, it is anti-science—to expect researchers to expend energy on formatting.

Format Free Approaches

A format-free approach has existed since at least 2013, when Elsevier formally launched its "Your Paper, Your Way" initiative [5], the first large-scale rollout by a commercial publisher. Many publishers and journals have since followed: for example, Taylor & Francis offers "format-free submission" [6], and PLOS One offers "format-free initial submission" with formatting only required once the article has been provisionally accepted for publication [7]. At the time of writing, over 680 journals published by Wiley offer "free format". Although a number of Wiley journals offered a format-free approach many years ago, we formalized this in 2019 to provide a uniform approach with consistent guidance for authors adopted by all journals offering free format. All 250 or so journals in the Hindawi portfolio have also offered a format-free approach from inception. The author guidelines explain that manuscripts can be submitted in whatever format the author wishes [8]. Our submission and peer review platform, Research Exchange [9], assumes a format-free approach insofar as it parses submitted manuscript files at submission and extracts all the key metadata, regardless of how the manuscript is formatted. A format-free approach also enables more rapid and seamless transfer between journals, assuming the receiving journal offers free format.

Format-free submission is, unsurprisingly, hugely popular among authors, yielding positive sentiments on social media (indicated by responses and likes) [10–13] and in surveys of authors. It clearly offers them plenty of gain. Not every editor has, however, welcomed the concept of free format with open arms. Given that editors are themselves authors, this seems surprising, not least because editors who support free format often do so because they appreciate the author's pain in the submission process. But researchers who serve as editors face different challenges, not least the need to handle a large volume of submissions effectively. The solution to this is not to require authors to jump through more hoops, but to find effective ways of managing the workload, whether through (for example) more resourcing or through implementing screening software.

Table 1. Concerns raised by editors, and possible responses to those concerns

Concern	Response
Free format encourages a lax, free-for-all approach	Is there any evidence of this, or is it based on supposition? It is in authors' own interests to make their manuscript presentable.
Free format lowers the bar for quality	High-quality research is not always the best presented. What quality do you really want to measure—quality of content or of presentation?
Free format opens the floodgates for many more submissions, and I don't have time to handle them	It should yield more submissions. It can encourage good as well as (potentially) bad submissions. It better supports inexperienced authors and authors from under-represented demographics. There are other strategies for handling an increase in submissions; raising barriers for authors is not an appropriate solution.
Free format makes the job of editing and reviewing more difficult	Is there any evidence for this, or is it based on supposition? Let's rethink what we expect editors and reviewers to spend their time doing. How can artificial intelligence and machine learning technology help?
Our reviewers find it easier to review a manuscript in our journal format	Is there any evidence for this, or is it based on supposition? Reviewers review manuscripts for many different journals as well as preprints, all in different formats. Removing formatting requirements can help reviewers focus correctly on assessing the actual content rather than the presentation.

Concerns Raised by Editors on Free Format Submissions

Table 1 displays a range of concerns that I have heard editors raise, along with suggested responses for countering those concerns. Listening to the experiences of peer editors can also provide effective reassurance that they have little or nothing to lose by offering a format-free approach [14].

Some of this antipathy is based on misconceptions about what a format-free approach entails, and in tackling these I have found it helpful to distinguish between the "content" of a scientific article and the "container"—that is, the way an article is formatted. What is inside the "container" is the critically important element; what the "container" looks like is immaterial. Allowing authors to submit format-free empowers them to focus on the scientific content without the distraction of having also to beautify it. Of course, most authors will want to create a good impression when they submit their manuscript, making an effort to ensure the presentation is acceptable.

As for the "content," it is helpful to think of this in terms of the requirements that any reputable journal might impose. Most important is the need for compliance with high standards of integrity. Manuscripts should include, as applicable, ethical approval statements, conflict of interest disclosures, patient consent, funding statements, acknowledgments, statements of authorship, and so on. Figures should be clear, and references should be complete, and the manuscript should be readable so that it can be assessed easily and fairly by editors and reviewers. If one editor cannot follow the manuscript, and if it presents ethical concerns, these need to be resolved whether or not the journal offers format-free submission.

Conclusion

Format-free submission is unquestionably here to stay. As consumers of publishing services, authors have great power in choosing where to submit their research for publication. Journals which make efforts to attract authors, by implementing initiatives such as a format-free submission, will grow stronger at the expense of journals which require authors to clear strictly unnecessary hurdles. Moreover, journals offering format-free submission empower researchers to spend time and money conducting more research, for the greater scientific good.

Conflict of Interest

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Essay

Looking back on my journey as the Editor-in-Chief of *Animal Bioscience*

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Introduction to *Animal Bioscience*

Animal Bioscience (*AB*) is an international journal first published in 1988 under the title *Asian-Australasian Journal of Animal Sciences* (*AJAS*) by the Asian-Australasian Association of Animal Production Societies (AAAP). Since then, it has continued its publication journey. The current journal title was adopted in 2021. I was invited to become the Editor-in-Chief (EIC) of *AJAS* in 2001, which has been my second job since then and my sole volunteer activity after retirement from Seoul National University in 2013.

According to a previous report [1], the idea of an official international journal publication was not well accepted initially by the AAAP member countries, perceiving no real need for such a journal and the absence of a firm belief in the success of such publication activities in Asia. However, a few dedicated frontier scientists led by Professor. In K. Han, the first EIC, turned *AJAS* into one of the most respected global journals in the animal science category. As expected, collecting the manuscripts during the early days was challenging. The journal received less than 50 manuscripts in the first year. However, the annual count rose to almost 1,000 in a few years. Presently, authors from more than 50 countries have chosen *AB* to report their research work. China and Korea are the major contributing countries, similar to the case with many other international journals. Approximately 70% of submissions are from the AAAP member countries, with the remaining 30% from the non-AAAP region.

The journal has made a tremendous improvement in citation frequency. When first indexed by the SCIE in 1997, the impact factor (IF) of *AJAS* was below 0.1, which increased to 2.7 in 2021. The total number of citations in the first year was less than 100, increasing to almost 9,000 in 2021, an approximately 100-fold increase over the past 25 years [2]. Since *AB* began to publish articles with a new title in 2021 and IF is calculated based on citations in the last 2 years, the first IF of *AB* will be released sometime in June 2023. The IF of *AB* will likely be lower than that of *AJAS* in the next few years due to the shorter exposure time of *AB*. However, it will not influence the combined journal IF significantly.

Major Turning Points for Journal Advancement

During the last 20-some years, while I have been in the position of EIC of *AJAS* and *AB*, a

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marked advancement has been made in the reputation of the journal. I consider the following few key events contributed the most to this advancement.

Online journal publication

I must consider the adoption of the online journal publication platform in 2006 as the most important event, which greatly influenced almost every aspect of journal publication. One of the major tasks in 2001, as I began my EIC term, was reducing the workload of handling hard-copy manuscripts and responding to authors mostly via hard-copy letters. Commercial online platforms were not used widely in Korea in those days. We had instead to commission a local information technology company to develop a system for manuscript handling system. Needless to say, as a result, the platform helped speed up the entire manuscript handling process with much more satisfaction from all stakeholders, including authors, reviewers, editors, and staff. I, with the other editorial members, noticed a sizable increase in manuscript submission with much easier recruitment of reviewers after the initiation of the online submission system. I am sure that recent high international journal exposure and citation frequency is mainly thanks to the shift from conventional hard copy to an online submission system. Of course, the system saved much of my own time, enabling me to devote myself to other matters, such as the long- and short-term planning of the affairs of *AB*. I recall the original online system was replaced by the new current submission system in 2014.

New publication technologies

Another issue was keeping pace with the ever-developing publication technology. Frankly, although I did not have much experience in journal publication and editing when I was asked to take the EIC position, I knew that tremendous developments were occurring worldwide in journal publication. I could gain new technologies and ideas through two science editor organizations: the Korean Council of Science Editors (KCSE) and the Council of Asian Science Editors (CASE). Involvement in these organizations gave me tremendous momentum for the journal quality advancement of the *AB*. In addition, attending international meetings such as the Council of Science Editors (CSE) in the United States and the European Association of Science Editors (EASE) became a valuable experience, which helped me to prepare plans for the future of the journal.

Indexing by global databases

Registering to major international databases was another crucial step to enhance journal exposure for global readership and citation frequency. We observed that the IF of *AJAS* was notably enhanced a few years after the beginning of journal coverage by some databases such as PubMed Central. Currently, *AB* is indexed by most global databases, including Web of Science, Scopus, PubMed Central, Directory of Open Access Journals (DOAJ), ScienceCentral, EBSCO, and Chemical Abstracts. In addition, adopting an open-access policy in 2014 was a meaningful change, as we joined many other international journals in the global movement of free-access research output. We are fortunate to collect over 1,000 yearly submissions in a few years despite several competing international journals in animal science that have recently emerged in Asia. We consider the coverage by these databases positively influenced the reputation of the journal and, hence, manuscript submission.

Journal title change

The title of our official journal has been changed from "*Asian-Australasian Journal of Animal Sciences*" to "*Animal Bioscience*," effective from January 2021. The title was a bit too long earlier and led the authors to avoid citing *AJAS* because of the complexity of its name. After a few years of discussion, we finally decided to adopt the name "*Animal Bioscience*." Although it took almost an entire year to complete the title change process, the change will help us enhance the brand identity of the journal, secure international leadership, and perhaps cover the diverse interests of the animal industry and academia in the long run.

On the other hand, we had to undergo a few tough times for many prearrangements due to the title change. There required many preparations such as modification in journal style and format and online system and arrangement with all existing databases for continued coverage. Although we expected manuscript submission and journal IF might go down to some extent, the title change resulted in a much more severe impact than anticipated on both parameters. Especially, manuscript submission went down by almost 50% with slightly less influence on citation frequency. We hope these are temporary and will see more positive effects of journal title change within a few years.

Science editors' organizations

One of my most valuable experiences as EIC thus far has been my involvement in creating KCSE, which was founded on September 21, 2011, with a vision to improve the qualities and international status of scientific journals published in Korea. Since its founding, this vision has been pursued through the concerted efforts of academic journal editors. I have been thrilled to see KCSE grow, thanks to full support from many scientific journals in Korea, with nearly 350 member journals as of September 2022. This rapid progress was possible primarily because of the dedication of the executive board members. Professor Jung Il Jin, the first president, was instrumental in securing a solid ground for the organization with continued dedicated service by Professors Jong Kyu Ha (the second president), Hyung Soon Kim (the third president), and Sun Huh (the fourth and current president). Of course, without the strong support from member societies and individuals, the success of KCSE would not have been possible. My association with KCSE provided an excellent opportunity to learn about new publishing technologies and trends through personal communication with fellow editors and meetings and training sessions, where I was acquainted with many experts from local journals and international organizations such as CSE, EASE, and CASE.

One of the major flagships of a collaborative effort by the KCSE has been the creation of CASE in 2014. For several years, the KCSE prioritized scholarly exchange among editors in Asia. On October 1, 2013, a group of 18 editorial representatives from several Asian countries gathered at the Korean Federation of Science and Technology Societies (KOFST) and agreed that an organization dedicated to the advancement of scientific research publication across Asia is needed. Thus, CASE was conceived. After a year of preparation, the council was established officially during the Asian Science Editors' Conference and Workshop 2014 at KOFST on July 2, 2014. CASE aims to improve the quality of scientific journals published in Asia through consulting and sharing information on editing and publishing and become a counterpart to existing international science editors' associations. Thus far, CASE organized seven Asian Science Editors' Conferences and Workshop, which served as a platform for Asian editors to exchange views and knowledge on journal publication and editing. In addition, it is one major outcome of joint efforts between CASE and KCSE to formulate the formation of national editors' organizations in Vietnam, Indonesia, and Malaysia. We certainly look forward to seeing the continued role of CASE in fostering more countries in Asia as a member.

Short-term and long-term plan

The recent outstanding journal quality improvement was, to an extent, due to the recently completed 7-year development program, i.e., the "*AJAS* 2020 program" from 2014 to 2020. We adopted many innovative editorial and journal management measures during the program period. The systems and programs applied to *AJAS* during this period include DOI, ORCID, CrossMark, CrossCheck, Cited-by, and information on Institutional Animal Care and Use Committee (IACUC) or Institutional Review Board (IRB). All these measures contributed to the enhancement of journal visibility and citation frequency substantially. Total citations increased 4.7 times reflecting a similar level of increase in IF, which boosted the ranking from 37% to 78%, which is high enough to qualify as a Q1 journal [3]. One additional thing I like to mention is that EIC should not hesitate to seek advice from internal and external experts. Checking the publication system in parts or its entirety through consultation gave us a good opportunity to review our system and make a proper development program.

Teamwork

For successful journal publication, continued and dedicated efforts by many stakeholders are required. In particular, small society journals such as *AB* cannot expect enough financial and manpower support from the society, which requires dedication from many volunteers. It was fortunate that at *AB* we were able to recruit many individuals who were willing to be involved in journal publication, a strong asset for *AB*. In addition to a formal editorial committee, we have a group of associate editors, formerly members of technical committee, responsible for handling manuscripts of their expertise. These are the key members who keep track of the manuscript flow, making sure manuscripts under review fall within the technical and ethical standards of the journal. On the other hand, in meetings of EIC, Co-EIC, and Deputy EIC, we discuss most of the short- and long-term plans and pending issues coincident with the preparation of the guidelines needed at *AB*.

Concluding Remark

Looking back on my career as the EIC of *AJAS* and *AB*, these 20-some years were challenging, but at the same time rewarding period for me. I am happy to see the development of *AJAS* and *AB* where I was able to contribute to the development of this journal. However, I would think that I and all members of *AB* should not satisfy with a small success and we should bring continued innovation to maintain as a leading journal in the ever-changing global publication environment. I believe that *AB* should be able to provide the best content to become a highly prestigious and respected journal. Continued efforts are required to invite high-quality articles. Furthermore, *AB* should be able to provide a global standard system to stakeholders such as authors, reviewers, and the general public for efficient and easy access to *AB*.

From my own experience, I suggest that editors try to obtain as much new information as possible from various resources. EASE, CASE, and other national and international publication organizations are excellent sources for this information. Additionally, editors must fully grasp the performance metrics of their journals. Any major change in metrics should be recognized and proper measures taken at an early stage. It is always worthwhile to invest in the development of an efficient and user-friendly system for authors, reviewers, readers, and other potential users. Equally important is establishing a good relationship with experts in your field and others, directly and indirectly, related to the journal such as academic society, industry, and national and international organizations. Finally, I recommend that editors make both short- and long-term developmental plans with achievable and predictable targets. Periodic checks, equally important as the plan itself, will show you where you are and where you are heading.

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Essay

Performance of Indonesian Scopus journals in the area of agricultural and biological sciences

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Introduction

Background

In Indonesia, 1,264 publishers operate 7,410 scholarly journals accredited by the government, reflecting an increase of 23.71% from the previous data of 5,990 accredited scholarly journals [1]. Those journals are distributed as follows: 305 nationally reputable journals (4.12%) with an S6 accreditation, 2,099 journals (28.33%) with an S5 accreditation, 2,541 (34.29%) with an S4 accreditation, 1,369 (18.48%) with an S3 accreditation, 976 (13.17%) with an S2 accreditation, and 120 (1.62%) with an S1 accreditation (S1 indicates the highest level of accreditation for accredited journals in Indonesia).

The journals indexed in the Scopus database are generally in the S1 category. Although there are many scholarly journals in Indonesia, the number of international journals is still not enough relative to the total number. It is usually said that Scopus, Science Citation Index Expanded, Social Sciences Citation Index, and Arts and Humanities Citation Index journals are international journals. There may be enough room for science journals in Indonesia to be promoted to international journals. The Indonesian government has supported journal publication through the journal accreditation system [1], and there is a need for academic societies and institutes to upgrade their journals. To promote journals, the topic of articles is a major concern. Articles on recently emerging topics or those frequently dealt with are beneficial to journals to be read and cited by other researchers. Therefore, it is essential to find the major topics and other bibliographic trends in a specific research area. A bibliometric analysis is a good tool to answer these questions. In this essay, journals in the agricultural and biological sciences were analyzed because the number of journals in this area was the highest among all research areas of Indonesian journals listed in Scopus.

Objectives

This essay aimed to reveal the bibliometric analysis of Scopus journals in the area of agricultural

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and biological sciences in Indonesia until the end of June 2022. The analysis included highly cited articles, co-authorship networks, keyword co-occurrence networks, and citation networks. The results can provide insights into the research trends and network of Indonesian researchers and co-researchers in the agricultural and biological sciences so that more intensive international collaboration can be pursued.

Methods

Ethics statement

This was not a human-subject study; therefore, neither Institutional Review Board approval nor informed consent was needed.

Study design and setting

This study conducted a bibliometric analysis of data from Scopus [2]. First, Scopus journals published in Indonesia were classified according to the subject area. Second, data were retrieved from the Scopus database from July 5 to 10, 2022. All data at the time of the search were collected. The search terms were 20 journals in the "journal" field (Suppl. 1). The retrieved data from Scopus included metadata of 20 journals in the subject area of agricultural and biologicals ciences (Dataset 1). Third, a bibliometric analysis of 20 target journals w as done to visualize the highly cited articles, the co-authorship network, keyword co-occurrence network, and citation network with VoSViewer ver. 1.6.16 (Centre for Science and Technology Studies, Leiden University; https://www.vosviewer.com).

Statistical methods

Descriptive statistics were presented.

Distribution of Indonesian Journals Indexed in the Scopus Database According to the Subject Area

In July 2022, there were 117 Indonesian journals indexed in Scopus. These journals are grouped into eight fields of science, with one group of "new entry" (Table 1).

Table 1 shows that the Scopus journals published in Indonesia were mostly included in Q3 (35.89%), and journals with the subject area of arts and humanities had the highest number included in Q1. This presentation indicates that the field of arts and humanities has gained interest and popularity, as well as refe rences from authors. However, when analyzing the distribution of journals published in Indonesia by subject area, the fields of agricultural and biological sciences, engineering, decision sciences, and computer science contributed the most publications, reaching 20 journals for agricultural and biological sciences, and 19 journals for engineering, decision sciences, and computer science.

Table 1. Distribution of Scopus journals from Indonesia according to subject area and SJR quartile (Q) ranking

Subject area	No. of journals	Q1	Q2	Q3	Q4
Agricultural and biological sciences	20	0	1	10	9
Arts and humanities	16	10	4	1	1
Economics	3	0	0	2	1
Social sciences	16	1	5	9	1
Fundamental science	10	1	1	4	4
Health	14	0	1	6	7
Environmental science	6	0	1	1	4
Engineering, decision sciences, & computer science	19	1	8	9	1
New entry	13	0	0	0	0
Total	117	13	21	42	28

SJR, Scientific Journal Rankings.

The journals included in the Scopus database did not experience a significant increase for a long time after the launch of Scopus. It was only from 2015 to 2022 that international journals published in Indonesia started to be indexed by Scopus. Even in 2020, there were only 19 Indonesian journals included in the Scopus database.

Bibliometric Analysis of the 20 Scopus Journals Published in Indonesia in the Subject Area of Agricultural and Biological Sciences

Highly cited articles

In this subject area, there are 20 journals occupying Q3 and Q4. *Kukila*, which is currently published by the Indonesian Ornithologists Union, became the first journal included in the Scopus database in 1996. However, *Biodiversitas*, published by the Society for Indonesian Biodiversity and co-publisher by the Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret Surakarta, was acknowledged to be the most productive journal, as it published 3,069 articles since 2014 and obtained 8,292 citations or 2.7 average cites per article. The average number of cites per article is obtained from the total citations divided by the total papers. The 10 top-ranking highly cited articles from these 20 journals are listed in Table 2.

Co-authorship network

Fig. 1 depicts the 121 countries from which authors have contributed to 20 Scopus journals in Indonesia. When a minimum number of 14 documents from a country was applied, 31 countries were identified. Japan (189 documents, with a

Table 2. Ten top-ranking highly cited articles from Scopus journals published in Indonesia in the subject area of agricultural and biological sciences

Ranking	Article title	Source of publication
1	Microencapsulation improved probiotics survival during gastric transit	*HAYATI J Biosci* 2017;24:1–5
2	Sumatra bird report	*Kukila* 1996;8:9–56
3	Diversity and abundance of polyisoprenoid composition in coastal plant species from North Sumatra, Indonesia	*Biodiversitas* 2018;19:1–11
4	Amino acid profile of earthworm and earthworm meal (Lumbricus rubellus) for animal feedstuff	*J Indones Trop Anim Agric* 2009;34:253–7
5	Implication of land-use and land-cover change into carbon dioxide emissions in Karang Gading and Langkat Timur wildlife Reserve, North Sumatra, Indonesia	*Jurnal Manajemen Hutan Tropika* 2015;21:25–35
6	Rapid and simultaneous determination of feed nutritive values by means of near infrared spectroscopy	*Trop Anim Sci J* 2018;41:121–7
7	Lettuce canopy area measurement using static supervised neural networks based on numerical image textural feature analysis of Haralick and Gray level co-occurrence Matrixs	*Agrivita* 2020;42:472–86
8	Diversity and distribution of plasmodial myxomycetes (Slime molds) from La Mesa Ecopark, Quezon City, Philippines	*Biotropia* 2010;17:51–61
9	The relationship between the normalized difference vegetation index, rainfall, and potential evapotranspiration in a banana plantation of Venezuela	*Sains Tanah* 2021;18:58–64
10	Anti-apoptotic activity of anthocyanins has potential to inhibit caspase-3 signaling	*J Trop Life Sci* 2020;10:15–25

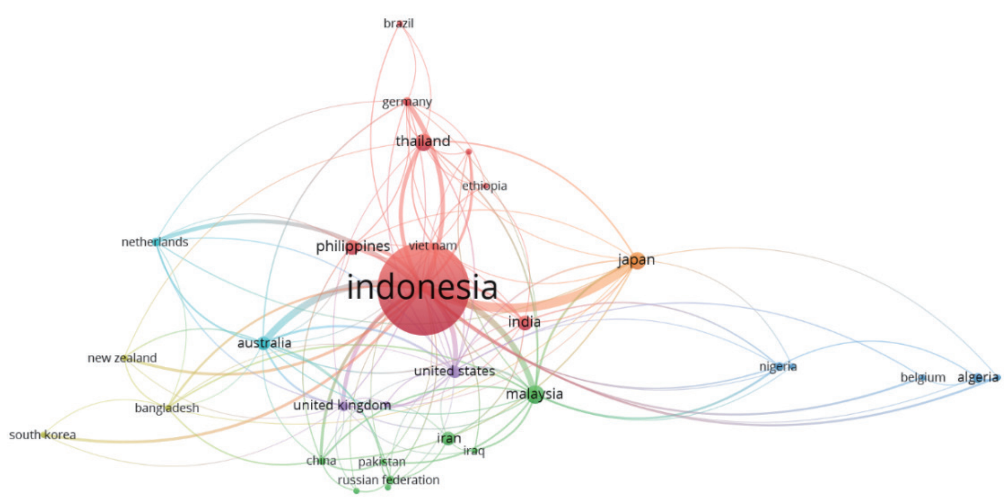

Fig. 1. Network of Indonesian authors with authors from other countries in the field of agricultural and biological sciences from Scopus journals published in Indonesia.

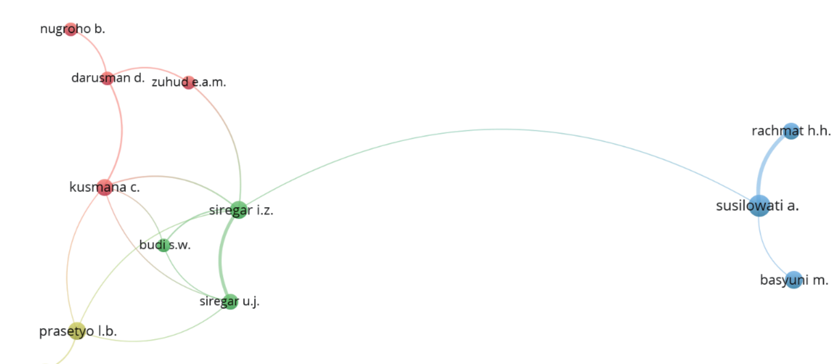

Fig. 2. Network of authors in the field of agricultural and biological sciences from Scopus journals published in Indonesia.

total of 583 citations and a total link strength of 197), Malaysia (214 documents, with 594 total citations and a total link strength of 124), and Australia (122 documents, with a total citation of 326 and a total link strength of 137) had the strongest collaborative relations with Indonesia compared to other countries. This presentation is signified by the established links between Indonesia and Japan, Indonesia and Malaysia, and Indonesia and Australia.

When analyzing authors' contributions, 14,361 authors have published in Indonesian Scopus journals focusing on agricultural and biological sciences. Fig. 2 shows the network of authors who contributed to this area, which formed four clusters. Fifty-eight authors had at least 15 papers. Partasasmita R (Universitas Padjadjaran, Bandung, Indonesia) had the most publications, with 57 publications, a total of 215 citations, and a total link strength of 67. Followed by Iskandar J (Universitas Padjadjaran) with 53 publications, 284 citations, and a total link strength of 75; and Susilowati A (Universitas Sumatera Utara, Medan, Indonesia) with 40 publications, 170 total citations, and a total link strength of 20.

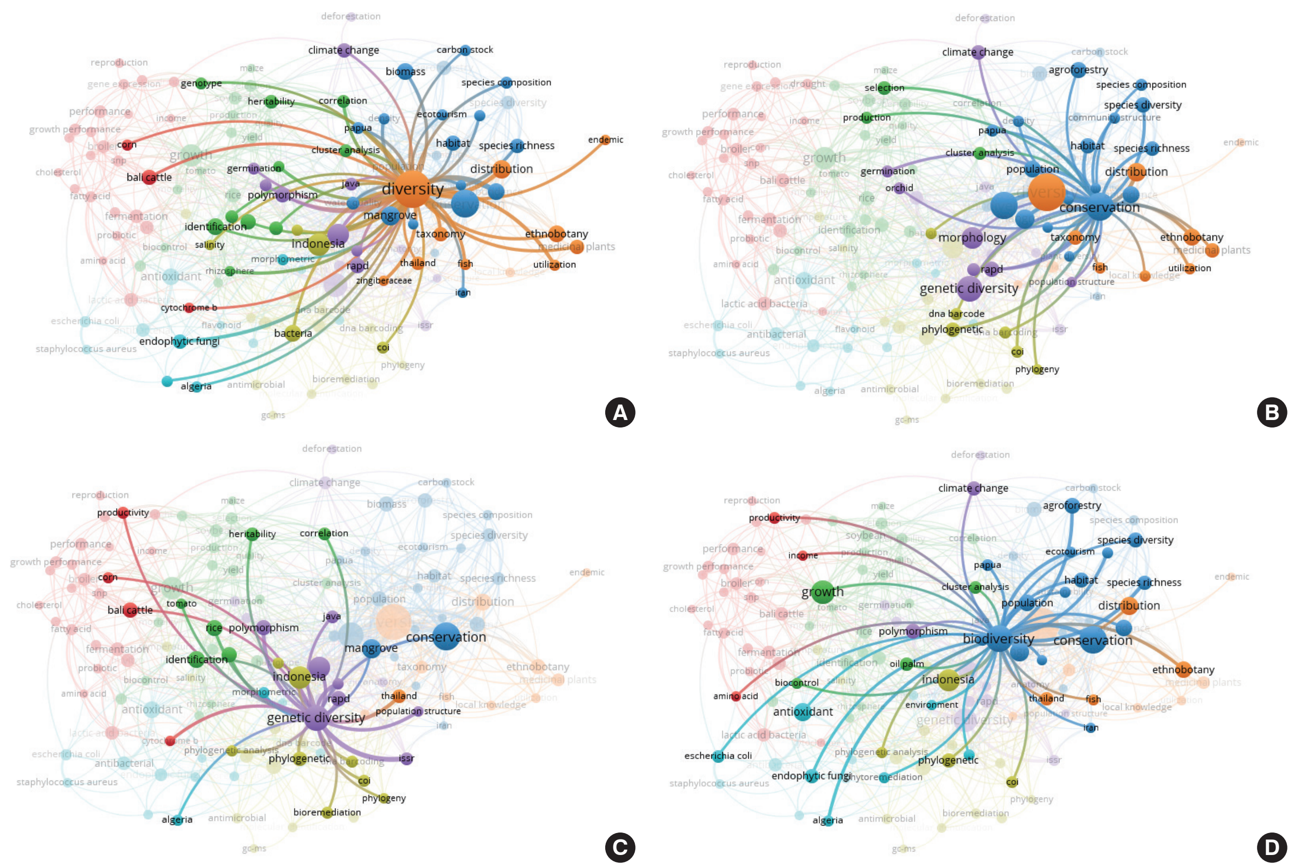

Fig. 3. The four most widely published research topics in the area of agricultural and biological sciences from 20 Scopus journals published in Indonesia. (A) Diversity topics. (B) Conservation research topic. (C) Genetic diversity research topics. (D) Biodiversity research topics.

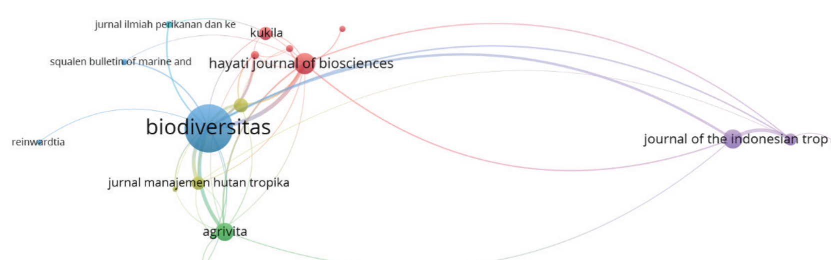

Fig. 4. Visualization of the citation network in the field of agricultural and biological sciences from Scopus journals published in Indonesia.

Keyword co-occurrence network

Four topics were dealt with most frequently (Fig. 3): diversity, conservation, genetic diversity, and biodiversity. These four aforementioned topics indicate that Indonesia's richness and biodiversity provide sources of research for publication.

Citation network

The journal with the most references from other journals was *Biodiversitas*, published by the Department of Biology, Sebelas Maret University Surakarta (Fig. 4). The visualization results are in line with the data in Suppl. 1, emphasizing that *Biodiversit* as the journal that published the most articles and was cited the most.

Conclusion

Partasasmita R was the author with the most publications. Authors in Japan, Malaysia, and Australia contributed the most to the network of Indonesian authors. In addition, diversity, conservation, genetic diversity, and biodiversity were identified as the most widely investigated research topics in the agricultural and biological sciences. Those findings can serve as a model of bibliometric analysis for journals in other research areas.

Conflict of Interest

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Data Availability

Dataset file is available from the Harvard Dataverse at https://doi.org/10.7910/DVN/4BPXO9.

Dataset 1. Raw data retrieved from the Scopus database with a search for 20 Indonesian journals in the area of agricultural and biological sciences.

Supplementary Material

Supplementary file is available from the Harvard Dataverse at https://doi.org/10.7910/DVN/4BPXO9.

Suppl. 1. List of internationally reputable journals published in Indonesia in the field of a gricultural and biological sciences.

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Essay

Before you click "submit," be your own first reviewer

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Abstract

For various reasons, despite previous linguistic, formatting, and other checks, beginner-authored or multi-authored manuscripts may be rushed to submission while lacking consistency. This article provides a clear outline of the final round of checks for section consistency, subsection consistency, and overall coherence that a scientific manuscript should undergo before submission. Checks for consistency should target the following: consistency between full and short titles; the exact answer in conclusion to research objectives (questions) and matching between methods and results in the abstract; consistency from a comprehensive view of the research field to the announcement of a single specific objective in the introduction section; coherence between methods and results sections and between results and illustrations in the rest of the text; and, recalls of the objective, the results, and the conclusions in the discussion section. Finally, consistency should be ensured between the various sections of the abstract and those of the manuscript, with the ideal abstract being a true miniature of the manuscript. An original figure provides a handy visual checklist authors might use to implement and achieve manuscript drafting. This round of checks increases readability, comprehensibility, confidence in the results, and the credibility of the authors. Subsequently, confidence and credibility will increase the probability of publication and the visibility of a whole team's work.

Keywords

Comprehension; Linguistics; Probability; Publishing; Peer review

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Introduction

Writing a scientific article is not easy [1,2]. Writing a pleasant scientific article is much more difficult. That said, one might object that a scientific article is not intended to be pleasant; it is not a novel [3]. This feeling is right, but a scientific article should nevertheless be as smooth as possible (providing the specialty and subject allow smoothness) or, at the least, easy to follow.

In the everyday experience of scientific authors, finishing an article is as tedious as the number of authors is high [4]. Indeed, despite modern digital tools, the final revisions by all authors might be the longest and the most "politically tricky" step of the writing process because introducing even minor corrections by one author might not please the others. Furthermore, additions or minor corrections scattered throughout various locations of the text may challenge its coherence. Consequently, to end a complicated, time-consuming presubmission ping-pong process, a decision is taken to submit the article as it is, with the hope that the reviewers will come up with a pacifying decision or authoritative comments [5].

Thus, many scientific articles might be submitted without undergoing an array of important checks whose results are beneficial because they make any scientific article much more readable and easier to follow. These checks aim to ensure the overall consistency (i.e., logical coherence) of an article and even that of its sections and subsections (Fig. 1). In this article, I would like to present the checks that authors should carry out before submitting a manuscript to a journal.

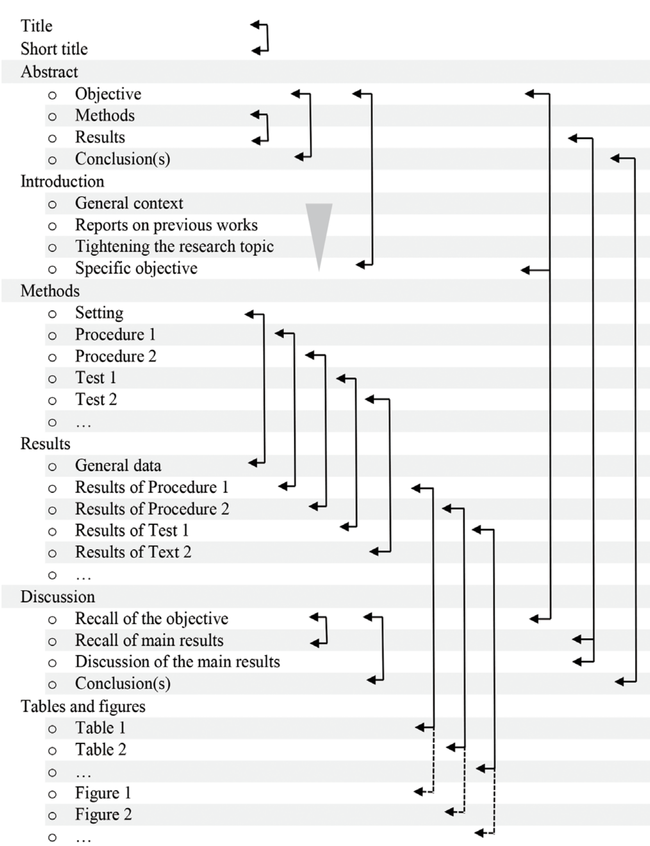

Fig. 1. Subsection consistencies to check within a scientific manuscript. The dotted arrows denote alternatives.

Checks for Consistency

Consistency of the titles

First, consistency should exist between the main title and the running (or short) title. This is obvious but not always carefully checked because the running title might be hastily—and thus, poorly—formulated just at the time the submission system solicits it. Supplying a running title that gives the same meaning, content, perspective, and promise as the title is not always straightforward [6]. Sometimes, searching for such a short title leads to changing the long title; this results in a more accurate and evocative main title [7].

Consistency of the abstract

The abstract should be consistent in two aspects. First, consistency should exist between the study's objective (or purpose) and its conclusion. When the two correspond and are accurate and true, the abstract inspires confidence in the whole study. Otherwise, the reviewer may feel somewhat misled. Second, consistency, or a kind of parallelism, should exist between the abstract's methods and results [8]. In other words, each sentence of the results should tell the outcome of each procedure mentioned in the methods. This echoing also inspires confidence. Otherwise, the core of the abstract will appear disorganized and uneasy to follow or trust.

Consistency of the introduction

Consistency should also be found within the introduction. It should be checked, first, that this section "tells a story" on how and why the authors came to the object of their research. Furthermore, its subsections proceed as a kind of funnel from a wide view of the field or topic to the narrow and exact objective of the study [9]. There are a few other structural possibilities, but the funnel form is probably the most assuring. It should be checked, then, that there is a single objective, clearly and concisely expressed. Announcing more than one objective will lead the reviewers to check that all have been dealt with fully and/or equally, which is not always done. Often, when several objectives are announced, some end by being either totally forgotten or incompletely treated and discussed. Finally, it should be checked that the objective stated in the introduction corresponds to the objective stated in the abstract.

Consistency between the methods and the results

Two advisable features of a good methods section are gradation and structure [10]. Gradation leads the reader from the general setting of the study to the most sophisticated statistical test or model and from the most common to the most complex physical, chemical, or medical procedure. This puts the reader in a comfortable environment before taking him or her to a novel test or procedure that requires more concentration to understand. The structure should split the methods section into subsections that relate to the same context, including medical processes, imaging, laboratory, or statistics, or group together each procedure and its related quantitative analysis. This structure makes it easy to follow what was carried out, when, and why, and prompts the reader to expect the results within given frames.

Next, logically, a good results section reproduces the same structure as the methods and displays the outcomes of the procedures and tests in the same gradation [11–13].

Consistency of the discussion with the other sections

A series of final checks should be carried out in the discussion section. First, the restatement of the objective should be consistent with the restatement of the main results. Second, the former restatement should be consistent with the abstract's objective, the objective set in the introduction, and the overall conclusion. Third, the results discussed must be mentioned in the abstract's results and dealt with in the results section. Fourth, the overall conclusion must match the abstract's conclusion. Generally, these critical checks are not always done simply because tired authors rush to finish or because minor but numerous amendments are made to the discussion by several authors soon before submission. However, some reviewers and, afterward, readers might start reading the discussion before the other article's sections [14–16]. Therefore, unresolved inconsistencies may shed doubts on the rigor and reliability of the work.

Consistency with the illustrations

Finally, an easy connection should exist between the result of a given procedure or test and a table or a figure, as the most convenient and visually pleasing way to present information (Fig. 1).

Conclusion

Broadly, in written communication, consistency ("the orderly treatment of a set of linked elements in a document") is "a necessary characteristic of polished, highly readable prose" [17]. Ensuring it is essential to increase the persuasiveness and credibility of all actors involved in science production and diffusion. More narrowly, acting as one's own first reviewer might not be fast or straightforward, but is certainly inoffensive and always rewarding.

Finally, checking for inconsistencies in a manuscript before submitting it is like sensing for asperities on a carving before varnishing it: a final aesthetic touch to technical achievement.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Meeting Report

Meeting report on the Ninth International Congress on Peer Review and Scientific Publication

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Meeting: Ninth International Congress on Peer Review and Scientific Publication
Date: September 8–10, 2022
Venue: Chicago, IL, USA and online
Organizer: JAMA Network, BMJ, and Meta-Research Innovation Center at Stanford (METRICS)

The Ninth International Congress on Peer Review and Scientific Publication was held in Chicago, IL, USA from September 8 to 10, 2022. This year's meeting was hybrid, and all plenary sessions were livestreamed for online participants. The congress has been held every 4 years since the first meeting in 1989; however, due to the COVID-19 pandemic, this year's congress was delayed for a year. JAMA Network, BMJ, and the Meta-Research Innovation Center at Stanford (METRICS) co-hosted the conference. A total of 511 participants from 37 countries, including five invited speakers, 50 plenary lecturers, and 125 poster presenters attended. The participants were editors, publishers, researchers, funders, bibliometric and informatics experts, information innovators, librarians, journalists, policymakers, and ethicists. I attended onsite and enjoyed 3 days of the congress in Chicago (Fig. 1). The congress provided a forum for the presentation and discussion of new research on the quality and credibility of peer review and scientific publication, to establish an evidence base on which scientists can improve the conduct, reporting, and dissemination of scientific research. Onsite and online participants actively participated in every session, and the time allotted for questions and answers was very interesting.

In accordance with the aim of the congress, which was to encourage research on the quality and credibility of peer review and scientific publication, the congress provided extensive advanced information and new knowledge that could improve the conduct, reporting, and dissemination of scientific research. The program embraced a wide range of disciplines, not limited to biomedicine. As usual, the program was determined by the abstracts submitted by researchers, representing the interests and work of their scientific communities. This year's congress had numerous excellent and worthwhile topics. Several topics of perennial interest, such as bias, editorial decision-making, research and publication ethics, reporting guidelines, peer

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Fig. 1. The Ninth International Congress on Peer Review and Scientific Publication.

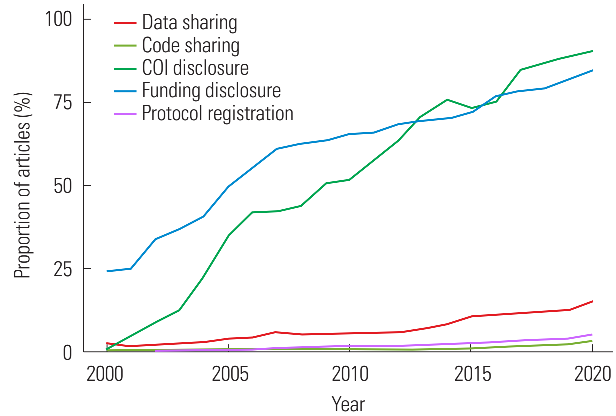

Fig. 2. Indicators of transparency across the open biomedical literature on PubMed Central. COI, conflict of interest. Adapted from Serghiou et al. [1], available under the Creative Commons License.

review models, and the dissemination of scientific and scholarly information were presented. Additional topics for this year's congress included social media and citations, as well as pandemic science. As a committee director of the Korean Association of Medical Journal Editors (KAMJE), I was particularly interested in the transparency of publication processing and peer review training.

On September 8, an invited speaker, Isabelle Boutron from France, gave the Drummond Rennie Inaugural Lecture titled "Bias, Spin, and Problems With Transparency of Research." She is a director of Cochrane France and co-convener of the Bias Methods Group of the Cochrane Collaboration and a member of the SPIRIT-CONSORT Executive Committee. Her research focused on meta-research, methodological issues of assessing interventions, transparency, reporting guideline development, and research synthesis. She emphasized the role of the peer review process, research environment, and research ecosystem for improving transparency in scientific publications. She stated that although the percentages of articles with disclosures of conflicts of interest and funding have sharply increased compared to other indicators of transparency in the open biomedical literature (Fig. 2) [1], peer review is often biased and insufficient, and we must try to our best to reduce spin during the research and peer review processes.

The second invited lecture on the 1st day of the congress was presented by Paul Glasziou from Australia, whose topic was "Barriers to Using Research: Reducing Flawed, Inappropriate, and Poorly Reported Research." In this lecture, he covered the broad scope of the problems of reporting guidelines, with examples including the Template for Intervention Description and Replication (TIDieR) and the use of computer-aided research. He stated that journals' requirements to use reporting guidelines constituted an initial and important step, but the processes involved are insufficient, and a mix of additional strategies would be needed in different stages of the research process. He also mentioned that in order to improve the quality of research and reporting, the use of such tools early in research projects is very necessary.

In addition to these two impressive invited lectures, 18 plenary lectures about "Authorship, Contributorship, and Misconduct," "Diversity, Equity, and Inclusion," "Editorial and Peer Review Models," and "Pandemic Science" were presented on the 1st day of the congress. Because this congress was held during the COVID-19 pandemic, many presented topics were related to COVID-19. Among them, an assessment of updates in new evidence during the rapidly evolving COVID-19 pandemic using living systematic reviews (LSRs) was presented. LSRs about COVID-19 were updated faster than those on other subjects. Thus, the rapidly evolving COVID-19 pandemic and available research could be more rapidly updated by LSRs. Other research dealt with the reliability of COVID-19–related preprints. Due to a surge in the dissemination of preprints resulting from a demand for faster and wider access to scientific knowledge about COVID-19, their preprints raised the issue of validating their results. Fortunately, the numerical results were generally similar between COVID-19 preprints and related peer-reviewed publications in the majority of randomized controlled trials.

On the 2nd day of the congress, an invited lecture entitled "Improving the Research Culture to Increase Credibility of Research Findings" was given by Brian Nosek from the United States. In this lecture, he talked about improving openness, rigor, and reproducibility in research. He said that these were less a technical challenge and more a social challenge, and that accuracy and transparency had to be sustained to improve research credibility. He addressed the importance of registered reports because they could reduce publication bias and increase rigor. He concluded that researchers and stakeholders could be doing more collaboratively to align incentives and rewards with core scholarly values to accelerate discovery and advancement of knowledge, solutions, and treatments.

The next invited speaker was Holly Falk-Krzesinski from the United States. She dealt with gender, race, and ethnicity data in editorial management systems. She emphasized the importance of sharing ethnic and gender information about researchers, editors, and reviewers to improve research integrity and reduce bias.

The other plenary abstracts—"Author and Peer Reviewer Guidance and Training," "Peer Review," "Dissemination of Clinical Trial Findings," and "Grant Review and Funded Research"—followed. Ariel Lyons-Warren from the United States raised a question: "Does mentoring improve the overall quality of peer review?" She showed that peer review quality significantly improved after the completion of a formal mentored peer review program in terms of improving the critique of research methodology and suggested a more structured review process to enhance overall review quality. I thought that a structured mentoring program would be a valuable approach to expand the pool of qualified peer reviewers and could ultimately improve research integrity. A program of this type should be introduced in Korea.

On September 10, the last day of the congress, the lecture by the invited speaker Tony Ross-Hellauer from Austria was highly anticipated. He talked about "Peer Review in the Age of Open Science." He introduced the open peer review model, which has become a central concern within the scholarly communication process. He said that the benefits of open peer review could increase accountability and transparency, avoid conflicts of interest, increase review quality, combat predatory journals, and inspect review processes. Despite concerns regarding possible higher reviewer refusal rates, increased time taken for reviews, and undesirable exposure of criticism to authors, the frequency and efficacy of open peer review have steadily increased. We need to be receptive to this challenge for shared research and enhanced transparency.

After that, other plenary abstracts were presented, such as "Data Sharing and Access," "Preprints," "Open Science," "Reproducibility and Postpublication Peer Review," and "Social Media and Citations." I was particularly interested in the plenary abstract on preprints because this issue has recently received increasing attention in Korea. Five lectures were presented on the topic of preprints. According to the metrics of preprint submissions and posts from 2019 to 2021, preprints grew rapidly particularly for COVID-19–related research. For example, there were 913 submissions to medRxiv in 2019, 14,070 in 2020, and 12,691 in 2021, and most of the submissions were related to COVID-19. Preprint servers have grown rapidly, particularly for COVID-19–related research and active repositories for clinical and health science research. One of the lecturers who compared preprints to corresponding publications found that although a few preprints changed their main findings, most clinical studies posted as preprints and subsequently published in peer-reviewed journals had highly similar study characteristics, results, and interpretations. Further research would be needed to determine who requested those changes and why, whether these changes were associated with the quality of the study or the expertise of those requesting them, and whether changes led to increases in validity, transparency, or readability. In addition, preprints received attractive attention from media and social networking services.

The Ninth Peer Review Congress featured 3 days of presentations on new research into peer review and all aspects of scientific publication, bias, quality of reporting, and information access and dissemination. It was not limited to delivering knowledge about publication, but also addressed the expansion of ways of achieving scientific integrity in research. Overall, 125 onsite and virtual posters of original research were displayed during the congress. Participants looked around the poster hall and discussed the posters with presenters in detail. I stopped by a poster titled "Concordance between peer reviewer's recommendations and editorial decision-making at *The Journal of Pediatrics*." It was particularly interesting because it assessed the review process using the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines and showed how to improve the quality of reviews.

The congress had highly diverse topics and was very valuable for me as an editor and a researcher. During the congress, lunch was served every day as a three-course meal, not a buffet. This enabled the participants to join and interact with each other. I was able to extensively share information about the integrity of peer review in scientific publications. I would like to extend special thanks to the KAMJE for giving me the opportunity to participate in this beautiful congress.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Announcement

Events in 2023

The Korean Council of Science Editors announces the schedule of events in 2023. Precise schedule and registration of the following workshops are or will be available at https://www.kcse.org.

Table 1. Schedule of events in 2023 by the Korean Council of Science Editors

	January	February	March	April	May	June
Science Editing (twice a year)		Vol. 10 No. 1 (20)				
Newsletter (four times a year)			No. 45 (31)			No. 46 (30)
Editor's Workshop	2023 Preconference Workshop (13)				Editor's Workshop (24)	
Manuscript Editor's Training & Workshop			Basic Manuscript Editing (9, 16, 23, 30)	Basic Manuscript Editing (6, 13, 20, 27)		
Publication Ethics Workshop				Publication Ethics Workshop (7)		Publication Ethics Workshop (23)
	July	**August**	**September**	**October**	**November**	**December**
Science Editing (twice a year)		Vol. 10 No. 2 (20)				
Newsletter (four times a year)			No. 47 (30)			No. 48 (31)
Editor's Workshop			Editor's Workshop (20)	Scopus Workshop (26–27)		Editor's Workshop (13)
Manuscript Editor's Training & Workshop	Examination for Korea Manuscript Editors Certification (14)				Manuscript Editor's Workshop (3)	
Publication Ethics Workshop				Publication Ethics Workshop (13)		

Instructions to Authors

Enacted January 1, 2014

1. GENERAL INFORMATION

Science Editing (Sci Ed) is the official journal of the Korean Council of Science Editors (KCSE). Anyone who would like to submit a manuscript is advised to carefully read the aims and scope section of this journal. Manuscripts should be prepared for submission to *Science Editing* according to the following instructions. For issues not addressed in these instructions, the author is referred to the International Committee of Medical Journal Editors (ICMJE) "Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals" (http://www.icmje.org).

2. COPYRIGHTS AND CREATIVE COMMONS ATTRIBUTION LICENSE

A submitted manuscript, when published, will become the property of the journal. Copyrights of all published materials are owned by KCSE. The Creative Commons Attribution Non-Commercial License available from: http://creativecommons.org/licenses/by-nc/4.0/ is also in effect.

3. RESEARCH AND PUBLICATION ETHICS

The journal adheres to the ethical guidelines for research and publication described in Guidelines on Good Publication (http://publicationethics.org/resources/guidelines) and the ICMJE Guidelines (http://www.icmje.org).

1. Authorship

Authorship credit should be based on 1) substantial contributions to conception and design, acquisition of data, and/or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; 3) final approval of the version to be published; and 4) agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Every author should meet all of these four conditions. After the initial submission of a manuscript, any changes whatsoever in authorship (adding author(s), deleting author(s), or re-arranging the order of authors) must be explained by a letter to the editor from the authors concerned. This letter must be signed by all authors of the paper. Copyright assignment must also be completed by every author.

- Corresponding author and first author: *Science Editing* does not allow multiple corresponding authors for one article. Only one author should correspond with the editorial office and readers for one article. *Science Editing* does accept notice of equal contribution for the first author when the study was clearly performed by co-first authors.
- Correction of authorship after publication: *Science Editing* does not correct authorship after publication unless a mistake has been made by the editorial staff. Authorship may be changed before publication but after submission when an authorship correction is requested by all of the authors involved with the manuscript.

2. Originality and Duplicate Publication

Submitted manuscripts must not have been previously published or be under consideration for publication elsewhere. No part of the accepted manuscript should be duplicated in any other scientific journal without the permission of the Editorial Board. If duplicate publication related to the papers of this journal is detected, the manuscripts may be rejected, the authors will be announced in the journal, and their institutions will be informed. There will also be penalties for the authors.

A letter of permission is required for any and all material that has been published previously. It is the responsibility of the author to request permission from the publisher for any material that is being reproduced. This requirement applies to text, figures, and tables.

3. Secondary Publication

It is possible to republish manuscripts if the manuscripts satisfy the conditions of secondary publication of the ICMJE Recommendations (http://www.icmje.org/urm_main.html).

4. Conflict of Interest Statement

The corresponding author must inform the editor of any potential conflicts of interest that could influence the authors' interpretation of the data. Examples of potential conflicts of interest are financial support from or connections to companies, political pressure from interest groups, and academically related issues. In particular, all sources of funding applicable to the study should be explicitly stated.

5. Statement of Informed Consent and Institutional Review Board Approval

Copies of written informed consent documents should be kept for studies on human subjects. For clinical studies of human subjects, a certificate, agreement, or approval by the Institutional Review Board (IRB) of the author's institution is required. If necessary, the editor or reviewers may request copies of these documents to resolve questions about IRB approval and study conduct.

6. Process for Managing Research and Publication Misconduct

When the journal faces suspected cases of research and publication misconduct such as redundant (duplicate) publication, plagiarism, fraudulent or fabricated data, changes in authorship, an undisclosed conflict of interest, ethical problems with a submitted manuscript, a reviewer who has appropriated an author's idea or data, complaints against editors, and so on, the resolution process will follow the flowchart provided by the Committee on Publication Ethics (http://publicationethics.org/resources/flowcharts). The discussion and decision on the suspected cases are carried out by the Editorial Board.

7. Editorial Responsibilities

The Editorial Board will continuously work to monitor and safeguard publication ethics: guidelines for retracting articles; maintenance of the integrity of the academic record; preclusion of business needs from compromising intellectual and ethical standards; publishing corrections, clarifications, retractions, and apologies when needed; and excluding plagiarism and fraudulent data. The editors maintain the following responsibilities: responsibility and authority to reject and accept articles; avoiding any conflict of interest with respect to articles they reject or accept; promoting publication of corrections or retractions when errors are found; and preservation of the anonymity of reviewers.

4. AUTHOR QUALIFICATIONS AND LANGUAGE REQUIREMENT

1. Author Qualifications

Any researcher throughout the world can submit a manuscript if the scope of the manuscript is appropriate.

2. Language

Manuscripts should be submitted in good scientific English.

5. SUBMISSION AND PEER REVIEW PROCESS

1. Submission

All manuscripts should be submitted to kcse@kcse.org by the corresponding author.

2. Peer Review Process

Science Editing reviews all manuscripts received. A manuscript is first reviewed for its format and adherence to the aims and scope of the journal. If the manuscript meets these two criteria, it is dispatched to three investigators in the field with relevant knowledge. Assuming the manuscript is sent to reviewers, *Science Editing* waits to receive opinions from at least two reviewers. In addition, if deemed necessary, a review of statistics may be requested. The authors' names and affiliations are removed during peer review. The acceptance criteria for all papers are based on the quality and originality of the research and its scientific significance. Acceptance of the manuscript is decided based on the critiques and recommended decision of the reviewers. An initial decision will normally be made within 4 weeks of receipt of a manuscript, and the reviewers' comments are sent to the corresponding author by e-mail. The corresponding author must indicate the alterations that have been made in response to the reviewers' comments item by item. Failure to resubmit the revised manuscript within 4 weeks of the editorial decision is regarded as a withdrawal. A final decision on acceptance/rejection for publication is forwarded to the corresponding author from the editor.

6. MANUSCRIPT PREPARATION

1. General Requirements

- The main document with manuscript text and tables should be prepared in an MS Word (docx) or RTF file format.
- The manuscript should be double spaced on 21.6×27.9 cm (letter size) or 21.0×29.7 cm (A4) paper with 3.0 cm margins at the top, bottom, right, and left margin.
- All manuscript pages are to be numbered at the bottom consecutively, beginning with the abstract as page 1. Neither the author's names nor their affiliations should appear on the manuscript pages.
- The authors should express all measurements according to International System (SI) units with some exceptions such as seconds, mmHg, or °C.
- Only standard abbreviations should be used. Abbrevia-

tions should be avoided in the title of the manuscript. Abbreviations should be spelled out when first used in the text—for example, extensible markup language (XML)—and the use of abbreviations should be kept to a minimum.
- The names and locations (city, state, and country only) of manufacturers should be given.
- When quoting from other sources, a reference number should be cited after the author's name or at the end of the quotation.

Manuscript preparation is different according to the publication type, including original articles, reviews, case studies, essays, editorials, book reviews, and correspondence. Other types are also negotiable with the Editorial Board.

2. Original Articles

Original articles are reports of basic investigations. Although there is no limitation on the length of the manuscripts, the Editorial Board may abridge excessive illustrations and large tables. The manuscript for an original article should be organized in the following sequence: title page, abstract and keywords, main text (introduction, methods, results, and discussion), acknowledgments, references, tables, figure legends, and figures. The figures should be received as separate files. Maximum length: 2,500 words of text (not including the abstract, tables, figures, and references) with no more than a total of 10 tables and/or figures.

- **Title page:** The following items should be included on the title page: 1) the title of the manuscript, 2) author list, 3) each author's affiliation, 4) the name and e-mail address of the corresponding author, 5) when applicable, the source of any research funding and a list of where and when the study has been presented in part elsewhere, and 6) a running title of fewer than 50 characters.
- **Abstract and Keywords:** The abstract should be one concise paragraph of less than 250 words in an unstructured format. Abbreviations or references are not allowed in the abstract. Up to 5 keywords should be listed at the bottom of the abstract to be used as index terms.
- **Introduction:** The purpose of the investigation, including relevant background information, should be described briefly. Conclusions should not be included in the Introduction.
- **Methods:** The research plan, materials (or subjects), and methods used should be described in that order. The names and locations (city, state, and country only) of manufacturers of equipment and software should be given. Methods of statistical analysis and criteria for statistical significance should be described.
- **Results:** The results should be presented in logical sequence in the text, tables, and figures. If resulting parameters have statistical significance, P-values should be provided, and repetitive presentation of the same data in different forms should be avoided. The results should not include material appropriate for the discussion.
- **Discussion:** Observations pertaining to the results of the research and other related work should be interpreted for readers. New and important observations should be emphasized rather than merely repeating the contents of the results. The implications of the proposed opinion should be explained along with its limits, and within the limits of the research results, and the conclusion should be connected to the purpose of the research. In a concluding paragraph, the results and their meaning should be summarized.
- **Conflict of interest:** Any potential conflict of interest that could influence the authors' interpretation of the data, such as financial support from or connections to companies, political pressure from interest groups, or academically related issues, must be stated.
- **Acknowledgments:** All persons who have made substantial contributions, but who have not met the criteria for authorship, are to be acknowledged here. All sources of funding applicable to the study should be stated here explicitly.
- **References:** In the text, references should be cited with Arabic numerals in brackets, numbered in the order cited. In the references section, the references should be numbered and listed in order of appearance in the text. The number of references is limited to 20 for original articles. All authors of a cited work should be listed if there are six or fewer authors. The first three authors should be listed followed by "et al." if there are more than six authors. If a reference has a digital object identifier (DOI), it should be supplied. Other types of references not described below should follow *The NLM Style Guide for Authors, Editors, and Publishers* (http://www.nlm.nih.gov/citingmedicine).

Journal articles:

1. Kim JA, Huh S, Chu MS. Correlation analysis of the citation indices of Korean scientific journals listed in international databases. Sci Ed 2014;1:27-36. http://dx.doi.org/10.6087/kcse.2014.1.27
2. Brobo E, Cambon-Thomsen A, De Castro D, et al. Citation of bioresources in journal articles:moving towards standards. Eur Sci Ed 2013;39:36-8.

Books and book chapters:

3. Morris S, Barnas E, LaFrenier D, Reich M. The handbook of journal publishing. New York: Cambridge University Press; 2013.

4. Cho HM, editor. KOFST journals 2011. Seoul: The Korean Federation of Science and Technology Societies; 2012. http://dx.doi.org/10.5082/Kofst_J_2011
5. Booth BA. Peer review. In: Coghill AM, Garson LR, editors. The ACS style guide. 3rd ed. New York: Oxford University Press; 2006. p. 71-6.

Online sources:
6. Committee on Publication Ethics. Guidelines for retracting articles [Internet]. Committee on Publication Ethics; 2009 [cited 2013 Sep 20]. Available from: http://publicationethics.org/files/retraction%20guidelines.pdf
7. Testa J. The Thomson Reuters journal selection process [Internet]. Philadelphia: Thomson Reuters; 2012 [cited 2013 Sep 30]. Available from: http://wokinfo.com/essays/journal-selection-process/

Conference papers:
8. Shell ER. Sex and the scientific publisher: how journals and journalists collude (despite their best intentions) to mislead the public. Paper presented at: 2011 CrossRef Annual Member Meeting; 2011 Nov 14-15; Cambridge, MA, USA.
9. Kim HW. Challenges and future directions on journal "perspectives in nursing science" in Korea. Poster session presented at: Asia Pacific Association of Medical Journal Editors Convention 2013; 2013 Aug 2-4; Tokyo, Japan.

Scientific and technical reports:
10. Kim SN, Park JR, Bae HS, et al. A study on the meta evaluation of Korean university evaluation. Seoul: Korean Educational Development Institute; 2004. Report No.: CR 2004-45.

News articles:
11. Kim R. SNU ranked 51st in university evaluation. Korean Times [Internet]. 2007 Nov 8 [cited 2013 Sep 25]. Available from: http://www.koreatimes.co.kr/www/news/nation/2007/11/117_13423.html

Dissertations:
12. Kim K. Quantum critical phenomena in superfluids and superconductors [dissertation]. Pasadena, CA: California Institute of Technology; 1991.

- **Tables:** Tables are to be numbered in the order in which they are cited in the text. A table title should concisely describe the content of the table so that a reader can understand the table without referring to the text. Each table must be simple and typed on a separate page with its heading above it. Explanatory matter is placed in footnotes below the tabular matter and not included in the heading. All non-standard abbreviations are explained in the footnotes. Footnotes should be indicated by [a)], [b)], [c)], ... Statistical measures such as SD or SE should be identified. Vertical rules and horizontal rules between entries should be omitted.
- **Figures and legends for illustrations:** Figures should be numbered, using Arabic numerals, in the order in which they are cited. Each figure should be uploaded as a single image file in either uncompressed EPS, TIFF, PSD, JPEG, and PPT format over 600 dots per inch (dpi) or 3 million pixels (less than 6 megabytes). Written permission should be obtained for the use of all previously published illustrations (and copies of permission letters should be included). In the case of multiple prints bearing the same number, English letters should be used after the numerals to indicate the correct order (e.g. Fig. 1A; Fig. 2B, C).

3. Reviews

Reviews are invited by the editor and should be comprehensive analyses of specific topics. They are to be organized as follows: title page, abstract and keywords, main text (introduction, text, and conclusion), acknowledgments, references, tables, figure legends, and figures. There should be an unstructured abstract of no more than 200 words. The length of the text excluding references, tables, and figures should not exceed 5,000 words. The number of references is limited to 100.

4. Case studies

Case studies are intended to report practical cases that can be encountered during editing and publishing. Examples include interesting cases of research misconduct and publication ethics violations; experience of new and creative initiatives in publishing; and the history of a specific journal development. They are to be organized as follows: title page, abstract and keywords, main text (introduction, text, and conclusion), acknowledgments, references, tables, figure legends, and figures. There should be an unstructured abstract of 200 words maximum. The length of the text excluding references, tables, and figures should not exceed 2,500 words. The number of references is limited to 20.

5. Essays

Essays are for the dissemination of the experience and ideas of editors for colleague editors. There is no limitation on the topics if they are related to editing or publishing. They are to be organized as follows: title page, abstract and keywords, main text (introduction, text, and conclusion), acknowledgments, references, tables, figure legends, and figures. There should be an unstructured abstract equal to or less than 200 words. The length of the text excluding references, tables, and figures should not exceed 2,500 words. The number of references is limited to 20.

6. Editorials

Editorials are invited by the editor and should be commentaries on articles published recently in the journal. Editorial topics could include active areas of research, fresh insights, and debates in all fields of journal publication. Editorials should not exceed 1,000 words, excluding references, tables, and figures. References should not exceed 10. A maximum of 3 figures including tables is allowed.

7. Book reviews

Book reviews are solicited by the editor. These will cover recently published books in the field of journal publication. The format is same as that of Editorials.

8. Correspondence

Correspondence (letters to the editor) may be in response to a published article, or a short, free-standing piece expressing an opinion. Correspondence should be no longer than 1,000 words of text and 10 references.

In reply: If the Correspondence is in response to a published article, the Editor-in-Chief may choose to invite the article's authors to write a Correspondence Reply. Replies by authors should not exceed 500 words of text and 5 references.

9. Video Clips

Video clips can be submitted for placement on the journal website. All videos are subject to peer review and must be sent directly to the editor by e-mail. A video file submitted for consideration for publication should be in complete and final format and at as high a resolution as possible. Any editing of the video will be the responsibility of the author. *Science Editing* accepts all kinds of video files not exceeding 30 MB and of less than 5 minutes duration, but Quicktime, AVI, MPEG, MP4, and RealMedia file formats are recommended. A legend to accompany the video should be double-spaced in a separate file. All copyrights for video files after acceptance of the main article are automatically transferred to *Science Editing*.

10. Commissioned or Unsolicited Manuscripts

Unsolicited manuscript with publication types of original articles, case studies, essays, and correspondence can be submitted. Other publication types are all commissioned or invited by the Editorial Board.

Table 1 shows the recommended maximums of manuscripts according to publication type; however, these requirements are negotiable with the editor.

Table 1. Recommended maximums for articles submitted to *Science Editing*

Type of article	Abstract (word)	Text (word)[a]	References	Tables & figures
Original article	250	2,500	20	10
Review	200	5,000	100	No limits
Case study	200	2,500	20	10
Essay	No	2,500	20	10
Editorial	No	1,000	10	3
Book review	No	1,000	10	3
Correspondence	No			
Letter to the editor	-	1,000	10	3
In reply	-	500	5	3
Video clip	No	30 MB, 5 min	-	-

[a]Maximum number of words is exclusive of the abstract, references, tables, and figure legends.

7. FINAL PREPARATION FOR PUBLICATION

1. Final Version

After the paper has been accepted for publication, the author(s) should submit the final version of the manuscript. The names and affiliations of the authors should be double-checked, and if the originally submitted image files were of poor resolution, higher resolution image files should be submitted at this time. Color images must be created as CMYK files. The electronic original should be sent with appropriate labeling and arrows. The EPS, TIFF, Adobe Photoshop (PSD), JPEG, and PPT formats are preferred for submission of digital files of photographic images. Symbols (e.g., circles, triangles, squares), letters (e.g., words, abbreviations), and numbers should be large enough to be legible on reduction to the journal's column widths. All of the symbols must be defined in the figure caption. If the symbols are too complex to appear in the caption, they should appear on the illustration itself, within the area of the graph or diagram, not to the side. If references, tables, or figures are moved, added, or deleted during the revision process, they should be renumbered to reflect such changes so that all tables, references, and figures are cited in numeric order.

2. Manuscript Corrections

Before publication, the manuscript editor may correct the manuscript such that it meets the standard publication format. The author(s) must respond within 2 days when the manuscript editor contacts the author for revisions. If the response is delayed, the manuscript's publication may be postponed to the next issue.

3. Galley Proof

The author(s) will receive the final version of the manuscript as a PDF file. Upon receipt, within 2 days, the editorial office (or printing office) must be notified of any errors found in the file. Any errors found after this time are the responsibility of the author(s) and will have to be corrected as an erratum.

8. PAGE CHARGES OR ARTICLE PROCESSING CHARGES

No page charge or article processing charge applies. There is also no submission fee.

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NOTICE: These instructions to authors will be applied beginning with the February 2014 issue.

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- ☐ Manuscript in MS Word (docx) or RTF format.
- ☐ Double-spaced typing with 11-point font.
- ☐ Sequence of title page, abstract and keywords, main text, acknowledgments, references, tables, figure legends, and figures. All pages numbered consecutively, starting with the abstract.
- ☐ Title page with article title, authors' full name(s) and affiliation(s), corresponding author's e-mail, running title (less than 50 characters), and acknowledgments, if any.
- ☐ Abstract up to 250 words for original articles and up to 200 words for reviews, essays, and features. Up to 5 keywords.
- ☐ All table and figure numbers are found in the text.
- ☐ Figures as separate files, in EPS, TIFF, Adobe Photoshop (PSD), JPEG, or PPT format.
- ☐ References listed in proper format. All references listed in the reference section are cited in the text and vice versa.
- ☐ The number of references is limited to 20 (for original articles, case studies, and essays), 100 (for reviews), or 10 (for editorials, book reviews, and letters to the editor).
- ☐ Covering letter signed by the corresponding author.

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