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Bibliometrics Methods in Detecting Citations to Questionable Journals

Barbara S. Lancho Barrantes^{a,*}, Sally Dalton^b, Deirdre Andre^b

^a University of Brighton, School of Architecture, Technology and Engineering, United Kingdom

^b University of Leeds Libraries, United Kingdom

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ABSTRACT

In recent times, there has been a proliferation of questionable practices in research publishing, for example, via predatory journals, hijacked journals, plagiarism, tortured phrases and paper mills. This paper intends to analyse whether journals that had been removed from the Directory of Open Access Journals (DOAJ) in 2018 due to suspected misconduct were cited within journals indexed in the Scopus database. Our analysis showed that Scopus contained over 15 thousand references to the removed journals identified. The majority of the publications citing these journals came from the area of Engineering. It is important to note that although we cannot assume that all the journals removed followed unethical practices, it is still essential that researchers are aware of the issues around citing journals that have been suspected of misconduct. We suggest that research libraries play a crucial role in training, advising and providing information to researchers about these ethical issues of publication malpractice and misconduct.

Introduction

The growth of digital publishing and open-access models have brought enormous benefits for researchers, including increased research visibility and improved transparency and reproducibility (Jisc, 2019). While these innovations have widened the access and discoverability of high-quality academic research, they have also led to an increase in journals that do not always adhere to ethical publication practices. In some cases, profit-making is the motivation behind the nature of such journals. Through inadequate quality editorial practices, questionable publishers proliferate science and threaten the credibility of academic research (Beall, 2016; Forero et al., 2018; Klyce & Feller, 2017). A waste of economic resources and a loss of disciplinary knowledge occurs, as findings of publicly funded research are often inappropriately presented and submitted in untrustworthy and fraudulent journals (Moher et al., 2017). Furthermore, Cobey et al. (2019) found that publishing in questionable journals could result in missed helpful peer review opportunities, reputational damage, and fewer citations.

This article will use the term 'questionable publishing' rather than 'predatory publishing'. Although predatory publishing seems to be the most accepted and common term to use when referring to this issue we felt that it is more appropriate to use the word questionable. Teixeira da Silva and Kimotho (2022) highlighted the fact that although some journals may have some problematic practices, it does not automatically

make these journals 'predatory'. They suggest that labelling journals as predatory can lead to discrimination against legitimate emerging or start-up scholarly journals and that these are primarily based in Low and Middle-Income Countries (LMICs). We acknowledge that not all journals that have been labelled or identified as predatory, have predatory practices, therefore we felt it was more appropriate to use the less discriminatory and accusatory term 'questionable'.

Questionable publishing has been an unintended consequence of the rise and success of open-access publishing based on an author-pays business model (Beall, 2013). Unscrupulous publishers can trick authors into submitting articles by mimicking legitimate Open Access journals or hijacking their websites or branding (Trapp, 2020). They can also lure less well-resourced authors by charging lower article processing fees than legitimate journals (Petrou, 2020). However, the problem of publishing unacceptable research is not just limited to Open Access journals. There have been instances where subscription-based journals have also published unethical or fraudulent research (Berger & Cirasella, 2015). In addition, some publishing companies have had to retract misleading papers due to non-existent peer reviewing (Basu, 2015).

According to the analysis of the reasons scholars have provided for publishing in questionable journals, there are four main reasons they do so: many researchers publish in 'predatory' journals because they provide the services they require, the urgency to publish, inadequate research skills, and the long time to publish (Kurt, 2018). Studies have

* Corresponding author at: University of Brighton, United Kingdom

E-mail addresses: b.lanchobarrantes@brighton.ac.uk (B.S. Lancho Barrantes), s.dalton@leeds.ac.uk (S. Dalton), d.andre@leeds.ac.uk (D. Andre).

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also shown that some authors are unaware of questionable journals and outreach and training may be an appropriate intervention (Cobey et al., 2019; Cohen et al., 2019; Kurt, 2018).

The publish or perish (POP) environment in academia and a super metricised research culture, focused on journal-level metrics such as Journal Impact Factor, have had unintended negative consequences on individual researchers' mental health and well-being (Schneider, 2019). Researchers have been forced to adapt to the speed and quantity culture, particularly concerning hiring, promotion, and tenure. As a result, they can feel pressured to publish more frequently or rapidly than in legitimate publications. Some researchers choose to circumvent legitimate publishing routes as they are deterred by lengthy peer review processes and perceived biases against early career researchers (Shaghaei et al., 2018).

Initiatives for preventing questionable publishing

To combat questionable publishing, the following lists of journals have been compiled:

- Beall's list (<https://beallist.net/>) of potential predatory journals.
- Cabell's Predatory Reports (<https://www2.cabells.com/>).

Research conducted by Strinzel, Severin, Milzow, and Egger (2019) found that while these lists gave researchers a good idea of which journals and publishers might be questionable or legitimate, they did not provide much useful information. Lists tend to emphasise criteria that are easy to verify, such as ethics, professional standards, and policies, while other criteria, such as peer review, are harder to validate. Beall's list has also been accused of discrimination and unfairness, especially towards scholars from LMICs (Kimotho, 2019; Teixeira da Silva & Kimotho, 2022).

There are alternative methods that display publishers and journals that are considered reliable, including

- Directory of Open Access Journals (DOAJ) (<https://doaj.org/>).
- Scholarly Open Access Publishers Association (OASPA) (OASPA, n. d.).
- Committee on Publication Ethics (COPE) (<https://publicationethics.org/>).
- World Association of Medical Editors (WAME) (<https://www.wame.org/>)

The Directory of Open Access Journals (DOAJ), the Committee on Publication Ethics (COPE), the Open Access Scholarly Publishers Association (OASPA), and the World Association of Medical Editors (WAME) have "seen an increase in the number, and a broad range of quality, in membership applications". (Redhead, 2018). As a result, these organisations have collaborated to identify principles of transparency and best practice for scholarly publications and clarify that these principles form the basis of the criteria for membership (Redhead, 2018). The COPE principles of transparency and best practice in scholarly publishing advise editors and publishers on all aspects of publication ethics, particularly how to handle research and publication misconduct (COPE, DOAJ, OASPA, & WAME, 2022).

DOAJ emphasises good research practice and has established a few general criteria that must be fulfilled by a journal to be accepted and included. These criteria include the need of transparent information on the journal's processes, policies, and management. Signs that a journal may not be reliable can include inadequate production processes, brief titles, deceptive or fabricated metrics, unknown publication location and ownership, and ambiguous information regarding article processing fees.

The Think, Check Submit Checklist (<https://thinkchecksubmit.org/>) is one resource that authors have been encouraged to use to identify genuine journals, and there are many other checklists available that can

help identify publishers of questionable nature.

These initiatives have encouraged researchers to combat questionable publishing through the use of transparent research processes such as open peer review and depositing papers in preprint servers (Kalra, Seetharaman, Maddulety, & Bakhshi, 2022). The scholarly communication community has also tried to combat this issue by increasing awareness among academics and publishers of best practice frameworks and standards around publishing practices. Tackling questionable publishing needs a multi-stakeholder approach, involving academic institutions, publishers, learned societies, funders, and the open research community (IAP, 2022).

Until recently, there was no universal understanding of what constituted a questionable journal. An international network of researchers, journal editors, funders, policymakers, representatives of academic institutions, and professional partners developed a definition of predatory journals and publishers through a consensus process (Cukier et al., 2020; Grudniewicz et al., 2019). It was acknowledged by the group that it was a complex task to distinguish predatory journals and publishers. Consequently, when attempting to define predatory journals and publishers, the group identified four key features that could be used to distinguish them: "Predatory journals and publishers are entities that prioritise self-interest at the expense of scholarship and are characterised by false or misleading information, deviation from best editorial/publication practices, lack of transparency, and/or use of aggressive and indiscriminate solicitation practices." (Cukier et al., 2020; Grudniewicz et al., 2019).

New developments in automatic detection are supporting researchers in identifying questionable journals. For instance, in addition to initiatives such as checklists, journal lists, and best practice standards, there is an emerging area of research around using automated systems and machine learning to detect questionable journals and citation contamination. Automated language analyses techniques have been proven valuable in identifying the differences in the writing style of questionable and unquestionable journals (Taskin, Krawczyk, & Kulczycki, 2022; Markowitz, Powell, & Hancock, 2014). Machine learning applications have also been shown to be effective in distinguishing between questionable and legitimate journal websites (Chen, Wong, Liao, & Yuan, 2020). Finally, Hinchcliffe and Clarke (2019) have mooted the idea of developing an Application Programming Interface (API) that could automatically analyse a submitted journal article's citations, to identify any of the journals within the citation list from questionable journals. Although the development of these tools could support researchers in identifying questionable journals, it is essential to note that they are not a panacea; the knowledge and expertise of the researcher will always play a vital role in identifying questionable journals.

Many academic libraries worldwide are already responding to the issue of questionable publishing by developing services and support tools for researchers. For example, a survey carried out in 2020 found that almost half of the academic libraries in the US and Canada offer workshops on questionable publishing (Buitrago-Ciro & Bowker, 2020). In addition, most provide information on library websites on how to avoid questionable publishers and identify reputable places to publish. There is also some evidence that researchers expect libraries to provide support services to ensure that they publish in reputable journals. For example, a questionnaire of researchers' issues and support needs around publishing at Taipei Medical University found that 60 % of respondents expected the library to provide journal lists of reputable and questionable publishers and individual consultations to researchers and awareness events (Huang, Hsiao, Siao, Yu, & Chiu, 2021).

Questionable journals in databases and citation contamination

Although the initiatives discussed in the previous section benefit researchers, identifying whether a journal is questionable can still be very complex. It requires a detailed evaluation based on several considerations. It is even more challenging because some questionable

journals are indexed in mainstream bibliographic databases, even though the databases have strict inclusion criteria (Duc et al., 2020; Manca et al., 2017; Manca, Moher, Cugusi, Dvir, & Deriu, 2018). For example, in 2017 Scopus re-evaluated journals on Beall's list and discontinued specific journals as a part of its ongoing journal re-evaluation program. However, existing content from these journals remained in the database, allowing Scopus to keep consistency in the bibliometric indicators based on citations (McCullough, 2021).

There can also be issues with the journal selection criteria used by databases; Manca et al. (2018) found that PubMed's policy for journal selection was more limited than Medline, and as a result, content from questionable journals did appear in the database. Consequently, researchers can no longer automatically assume that a particular journal is not questionable because it shows up in a traditional database.

Another issue emerging from questionable publishing is citation contamination. Citation contamination, a term coined by Anderson (2019), happens when researchers cite articles published in questionable journals. Citation contamination is a threat to research integrity as it can lead to disseminating potentially flawed, fraudulent, or plagiarised research. Several studies have shown that questionable journals continue to be cited, albeit in small numbers (Akça & Akbulut, 2021; Oermann et al., 2019; Oermann et al., 2020; Ross-White, Godfrey, Sears, & Wilson, 2019) and some recent studies have shown citation contamination to be more widespread (Kulczycki, Hołowiecki, Taşkın, & Krawczyk, 2021; Moussa, 2021). Moussa (2021) found that questionable journals in marketing were being cited extensively and, as a result, have started to contaminate the scholarly literature. Kulczycki et al. (2021) found that articles from questionable journals were being cited within Web of Science, and 37 % of the citations were from impact-factor journals. The results of these studies show that researchers are citing articles in questionable journals and, as a result, are potentially contributing to the problem of questionable publishing.

Within this paper, we will build upon previous research by investigating the issue of questionable journals being indexed in databases, and analyse the prevalence of citation contamination. We will then offer recommendations on how library and bibliometric services can help researchers navigate the problem of questionable publishing. We will aim to address the following research questions:

- How many publications included in a citation database are citing questionable journals?
- What scientific discipline do they belong to?
- Which countries have the highest concentration of citations to these journals?
- Do these publications have a high impact?
- Do they involve international collaboration?

Data and methods

The Directory of Open Access Journals (DOAJ) provides tools and practical resources to educate researchers by promoting research integrity and building trust in credible research and publications.

In the spirit of transparency and best practice, DOAJ regularly updates its list of journals removed from its directory. The reasons for removal are 'Suspected misconduct from the publisher', 'Ceased publication', 'Journal not adhering to Best Practice' and 'malicious website' (DOAJ, 2022). The date of removal is also noted on the list. When DOAJ removes a journal for "Suspected editorial misconduct by publisher", this generally refers to questionable practices. However, these can take many forms and be of varying seriousness. It is worth clarifying here that when it removes a journal for "Journal not adhering to best practice", this usually means that the journal no longer meets DOAJ's essential criteria for inclusion, but there is no suggestion of misconduct.

The directory pays special consideration to the editorial board's issues. A thorough review of new applications guarantees that no questionable journals are added to the database. If journals that have been

included in DOAJ appear to show suspicious conduct, they will be reviewed and removed if necessary (DOAJ, 2022).

DOAJ is highly regarded as one of the most reliable databases of open-access journals. For this reason, we used the data from the directory for our study. We chose the journals excluded from DOAJ in the course of the year 2018 for 'Suspected misconduct from the publisher'. In 2018, DOAJ removed a total of 57 journals, the exact time and specific reason for academic misconduct was not declared. We examined all 57 journals to select only the journals with unique titles and ISSN to make sure none had homonymy problems. Out of the 57, only 21 had exclusive titles.

We employed the Scopus citation database to examine the number of documents that are still referencing the journals that were eliminated from DOAJ. It is widely accepted that Scopus is a dependable, curated, and comprehensive database for abstracts and citations, containing an extensive global and regional selection of scientific journals, conference proceedings, reviews, books, etc. Maintaining the integrity of Scopus and looking after its high-quality and curated content is paramount to the database. Therefore, Scopus is vigilant in identifying and discontinuing journals that have become questionable. Scopus has a position statement that explains how they identify and re-evaluate potentially questionable journals, to help exclude poor-quality and questionable publications from the Scopus database (Elsevier, 2022).

After identifying the journal's subject of study, we liaised with Elsevier's International Center for the Study of Research (ICSR) lab. The ICSR's mission is to "further the study of research and thus to contribute to the evidence base supporting the practice of research strategy, evaluation, and policy" (International Center for the Study of Research, n.d.). ICSR provided a file with a total of 15,268 research outputs (articles, reviews, conference proceedings) published from 2018 to 2021 in journals indexed in Scopus. These outputs referenced our sample of journals removed from DOAJ by suspected editorial misconduct by the publisher. The data was downloaded in September 2021.

It is worth mentioning that the time it takes to publish a paper can range from one to three years on average, depending on multiple factors like the author's experience, the topic, the type of institution, and if the journal is open access, etc. It is possible that these articles were written before the year DOAJ eliminated the journals. However, to remain consistent with bibliometric methods, we employ the conventional publication and citation windows commonly utilised for the composition of bibliometric indicators. To guarantee the data offered the most comprehensive amount of information, we chose to employ citation data from 2018 to 2021. It might be possible that researchers citing these questionable journals were not aware of DOAJ's withdrawal, the results showed the ability of bibliometric approaches to trace the paths of citation contamination which is the central aim of the study.

To analyse the citations in more detail, we used the analytical tool SciVal (<https://www.scival.com/>). SciVal offers access to the performance of 20,000 research institutions and 230 nations worldwide (Elsevier, 2022). For visualising the publications, we used VOSviewer (<https://www.vosviewer.com/>), a software tool for constructing and visualising bibliometric networks. These networks may include journals, researchers, or individual publications, and they can be constructed based on citation, bibliographic coupling, co-citation, or co-authorship relations. We applied the following bibliometric indicators to the 15,268 research outputs:

- Scholarly outputs: The total number of publications which cited our sample of journals. It can be used to indicate scholarly productivity. This indicator illustrates the proportion of references to the 21 journals in total, 15,268.
- Collaboration: percentage of our sample that have research collaborations. This indicator helps us to determine whether the publications were carried out with international, national, or institutional authors, or simply by a single author. This indicates the extent of the

involvement of countries or institutions in the publications which reference questionable journals.

- **Field-Weighted Citation Impact (FWCI):** it is the proportion of total citations received by a given output relative to the average of the citations expected in the subject field. This indicator was essential in our study to evaluate the influence of papers citing questionable journals. If the FWCI surpasses 1.0, it indicates that these publications have gained more citations than the mean in the related disciplines or subject areas, which provides us with a sign of the propagation of knowledge and the significance of these issues. If other publications are citing the publications which referred to the questionable journals, all are contributing to the proliferation of the publication issues.
- **% Outputs in Top Citation Percentiles:** This indicator helps us to group the publications among the most cited publications worldwide. We aimed to determine if any of the publications were the most cited within the subject, which would have a significant impact on any further research.
- **Publications in Top Journal Percentiles:** This illustrates the proportion of our sample that can be found in the most highly cited journals from the Scopus database. We aimed to investigate whether the 15,268 had been published in highly cited academic journals within their fields, which would demonstrate a fragile editorial quality control of their content.

Apart from the SciVal indicators we constructed a new indicator, denominated: Citing questionable per publication indicator. It quantifies the number of references to questionable journals made by a country or institution when compared to the total amount of publications it has produced. Establishing if there is a correlation between productivity and the number of references to questionable journals.

CiteScore measures the average amount of citations received per document over 4 years. CiteScore Quartiles are based upon CiteScore Percentiles and are divided into Quartile 1 (between 99-75th percentiles), Quartile 2 (between 74-50th percentiles), Quartile 3 (between 49-25th percentiles), and Quartile 4 (between 24-0th percentiles). (Elsevier, 2019).

Considering we are using data from DOAJ, which is a unique and extensive index of diverse open-access journals from around the world, we decided to analyse the extent of open access in the citing journals. The following Open Access Filters have also been applied to our sample of documents (McCullough, 2021):

- **Gold (pay-to-publish OA articles):** Documents that are in journals which only publish open access. It allows immediate access to the published article in a subscription journal or an Open Access journal.
- **Hybrid Gold:** Documents are in journals that provide authors with the choice of publishing open access.
- **Bronze:** Published version of a manuscript accepted for publication; the publisher has chosen to provide temporary or permanent free access.
- **Green:** Published version of a manuscript accepted for publication, available at a repository. Documents may also be available in gold or other free-to-read on the publisher platform. (Elsevier, 2022)

Results

This section analyses in detail the 15,268 outputs citing the sample of journals excluded by DOAJ in 2018. We can observe some bibliometric indicators applied to these publications included in Scopus in Table 1. In addition, we have analysed the publications by year to see the behaviour through the data range.

The table below provides an overview of the indicators across the years. The overall score can be split into the respective years, as demonstrated in the particular columns. The overall international collaboration is an average of the entire period, that is a mean of the

Table 1
Bibliometric indicators applied to the set of publications citing the questionable journals.

	Overall	2018	2019	2020	2021
Scholarly outputs citing the journals that we analysed	15,268	3309	4383	5075	2501
International collaboration (%)	19.4	14.5	17.6	20.2	27.5
Field-Weighted Citation Impact (FWCI)	1.02	0.75	0.84	1.01	1.74
% Outputs in top citation percentiles	10.3	7.1	7.8	11.4	16.6
% Outputs in top journal percentiles	9.1	5.8	6.8	10.4	13.8

percentages of international collaboration of all documents 15,268 (instead of the mean of the international collaboration values per column/year). The overall FWCI can also be observed, it is the average of the FWCI of all publications, which also allows us to observe the relative value of the individual years. As an example for clarity, the average Field-Weighted Citation Impact (FWCI) of the total publications is 1.02 which mean the average of the FWCI of each 15,268 publications from the years 2018 to 2021 (it would differ from the average of 2018–2021 FWCI which is 1.08). On the other hand, the mean FWCI calculated for all outputs published in 2018 was 0.75, which is the average FWCI of all publications produced in 2018. We can observe the percentage of the total outputs which are among the Top Citation Percentiles in total and broken down by years. The Outputs in Top Journal Percentiles have an average that can be partitioned by looking at the yearly breakdown.

As we can observe in the table, the average of international collaboration is 19.4 %, in other words almost 20 % of these publications were produced in collaboration with authors from different countries. 10.3 % of them are included in the highest citation percentiles worldwide and 9.1 % of these outputs were published in the 10 % top journal percentiles. When we look at the data over the years, the publications produced in 2020 are the ones that cited these journals the most, with a number of 5075 publications. These results show that the outputs citing the DOAJ removed journals did not have an exceptionally high citation impact according to the citation indicators. Nevertheless, there were still over 15,000 outputs citing them in the specified period.

In Fig. 1 we applied Open Access Filters to find out more about whether the journals were open access and if so, what type of open access.

7291 of 15,268 documents (47 %) were identified as Open Access publications, meaning that 53 % were non-open access journals. This demonstrates that the issue of citing questionable journals happens in both open access and non open access journals. Most of the outputs were classified as Gold and Green open access with 38 % and 31 % of 15,268, respectively. The following figure analysed the type of publications classified in the different CiteScore quartiles.

Regarding the CiteScore quartiles, most publications were published in second and third-quartile impact journals meaning the venue of these publications could be considered to be high-impact (Fig. 2).

Fig. 3 indicates the author’ affiliation countries that referenced the sample of journals eliminated from DOAJ in 2018. The graph represents the Citing questionable per publication indicator; It is a ratio between the total number of publications citing these journals per country compared with the total publications of these countries produced in the same period of time. For example, Algeria produced 32,011 between 2018 and 2021, of which 433 (1.35 %) cited the journals excluded from DOAJ. India, Indonesia and China are the countries with more references in total to questionable journals. It should be mentioned that the greater the production of a country, the greater the probability they include references to questionable journals, that is why we decided to

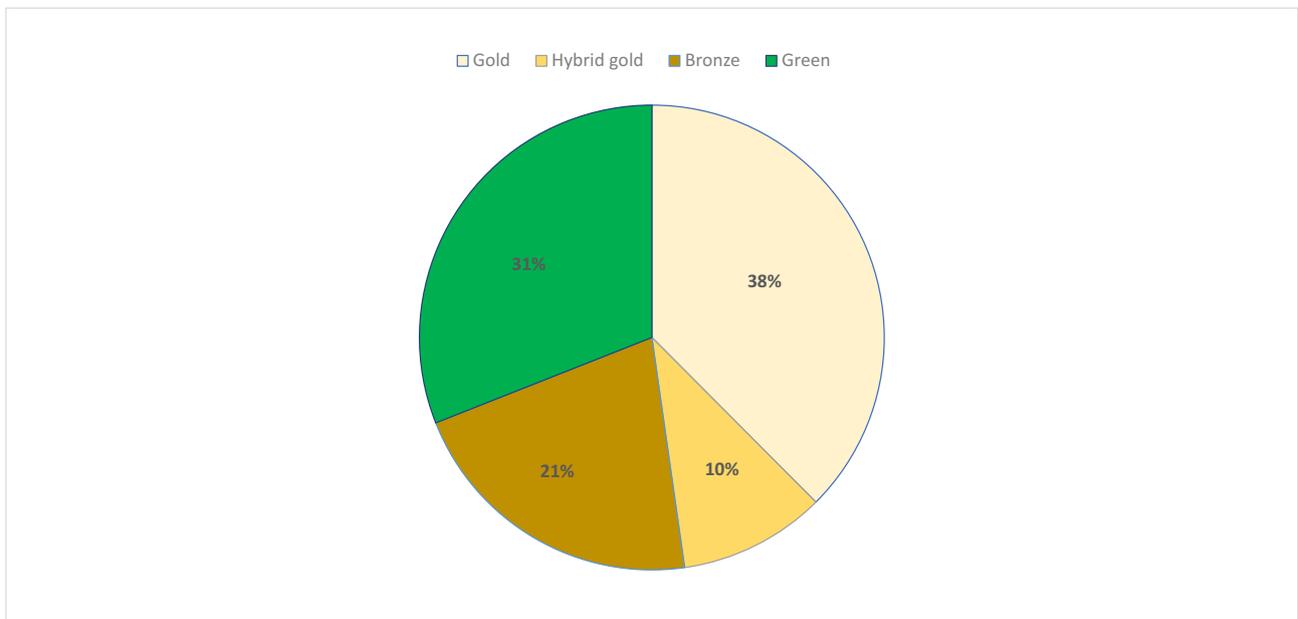


Fig. 1. Typology of open access journals where these outputs are published.

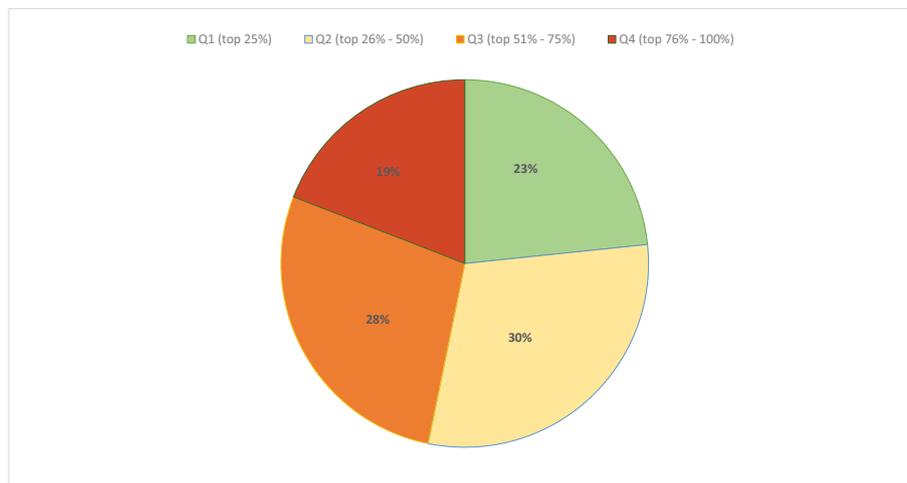


Fig. 2. Journals classified by CiteScore quartiles.

use a proportion. Iraq, Morocco, and Algeria are the countries that cite these journals the most (according to the Citing questionable per publication indicator).

To gain a better understanding of why these countries are citing the given set of journals the most, it is important to delve into their motivation. It is possible that the questionable journals are primarily based in those countries, which could be a factor. However, our analysis only reveals the countries from which the citations originated, not the underlying reasons. There could be a variety of explanations for why researchers from certain countries are referencing these questionable journals.

Fig. 4 shows the type of collaborations in the outputs citing the sample set of questionable journals. Each output is assigned to one of

four mutually exclusive collaboration types based on affiliation information: international, national, institutional, or single authorship.

It is interesting to observe that most of the outputs in Fig. 4 were the result of institutional collaboration (6724), followed by national (4596) and international collaboration (2966). There were also some outputs that were the sole work of a single author (981). However, we can notice that the international collaboration publications obtained the highest field-weighted citation impact (FWCI) (1.75). These publications received a higher-than-average impact compared to the same type of publications, discipline, and period.

The co-authorship map in Fig. 5 shows all the different countries that participated in the publications citing our sample. We have used fractional counting instead of the full counting. The idea of fractional

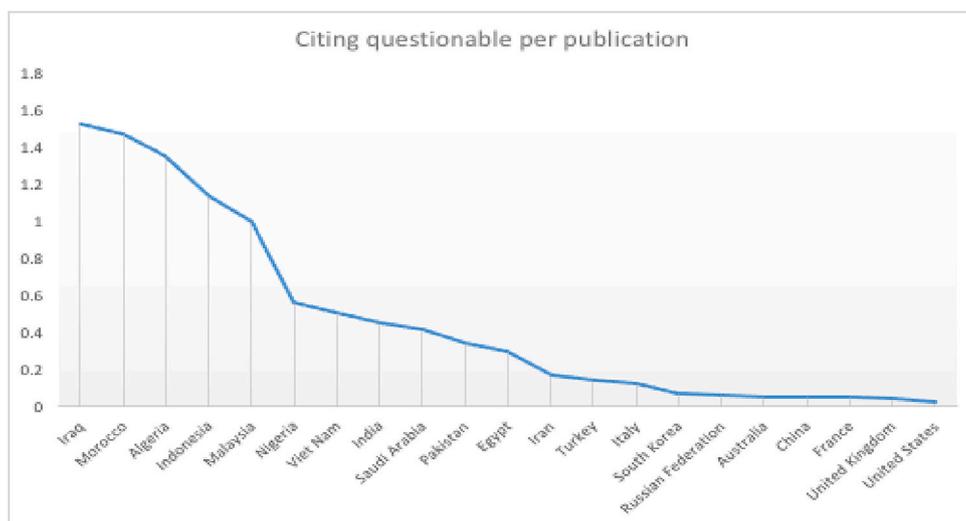


Fig. 3. Countries citing the sample set of questionable journals.

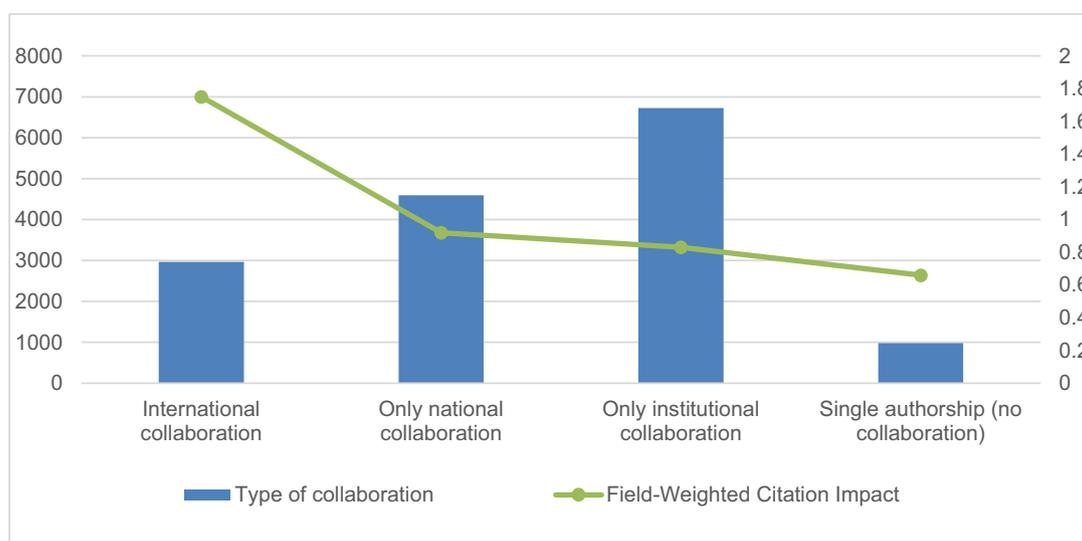


Fig. 4. Type of research collaboration of the publications citing the sample set of journals removed from DOAJ.

counting reduces the influence of authors with multiple affiliations. When it comes to multi-affiliate authorship, there could be various reasons why a work is published like that. It is important to subject these papers to a fractional count to ensure fairness. “When fractional counting is used, the strength of a co-authorship link between two authors is determined not only by the number of documents co-authored by the authors but also by the total number of authors of each co-authored document.” (Leiden University, 2022).

364 countries meet the thresholds, and the total strength of the co-authorship links with other countries is calculated. Malaysia, India, Indonesia, the United States, and China are the countries with the highest total link strength. These countries frequently collaborate with other countries in the publications citing journals removed from DOAJ. Each link has a strength, represented by a positive numerical value—the higher this value, the stronger the link. The total link strength shows the number of publications in which two countries occur together.

In Fig. 6 we can observe the subject area of the outputs that are citing the sample removed from DOAJ. Scopus indexed its journals into different subject areas depends on the scope and thematic of the journal. The database uses four broad subject areas to classify its content: Physical sciences, Health sciences, Social Sciences, and Life Sciences.

There are a number of 27 subject areas in Scopus divided into 300 approximately sub-subject specific categories. It is important to keep in mind that some journals may fall under multiple subject areas, so there may be some appear simultaneously in different subject areas.

Engineering, Computer Science, and Mathematics are the subject areas where the majority of publications cited questionable journals. Medicine is not among the main ones, even though Medicine is one of the subject areas that brings together the most significant scientific production worldwide.

Fig. 7 shows a co-occurrence map among all the keywords used in the publications citing these journals. The full counting method has been used to calculate the relationships among keywords (Van Eck & Waltman, 2017).

Based on the figure above, we can see the most frequently used keywords in the publications, which can help us identify the main thematic areas they cover. The co-occurrences map is a powerful tool that enables us to reveal the connections between terms by identifying clusters of related publications. With its intuitive interface and powerful analytical capabilities, the co-occurrences map is an indispensable tool for any researcher looking to unlock the full potential of their data. After analyzing the data, we found that there are 5342 keywords that meet the

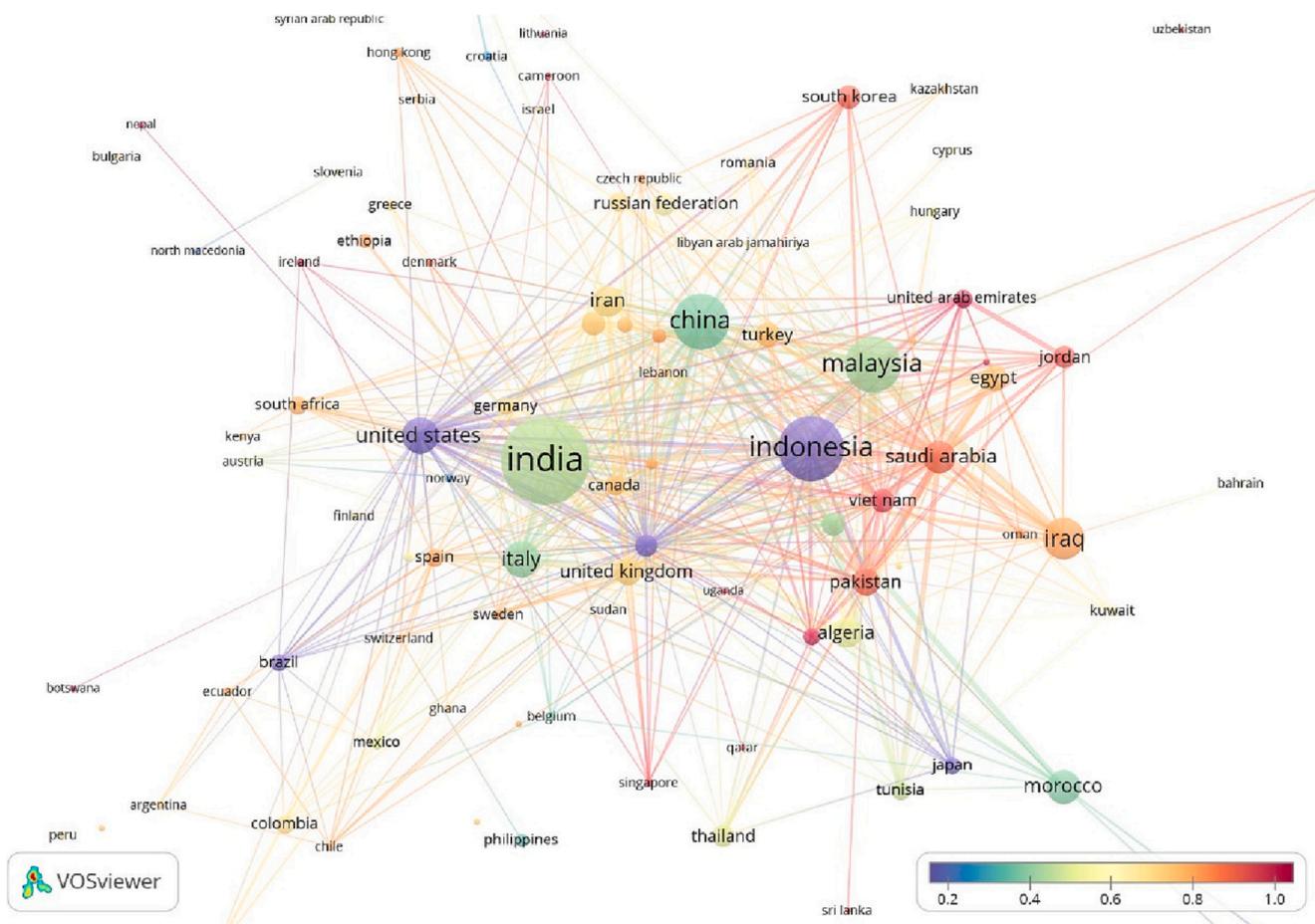


Fig. 5. Collaboration network map of countries citing the sample of questionable journals.

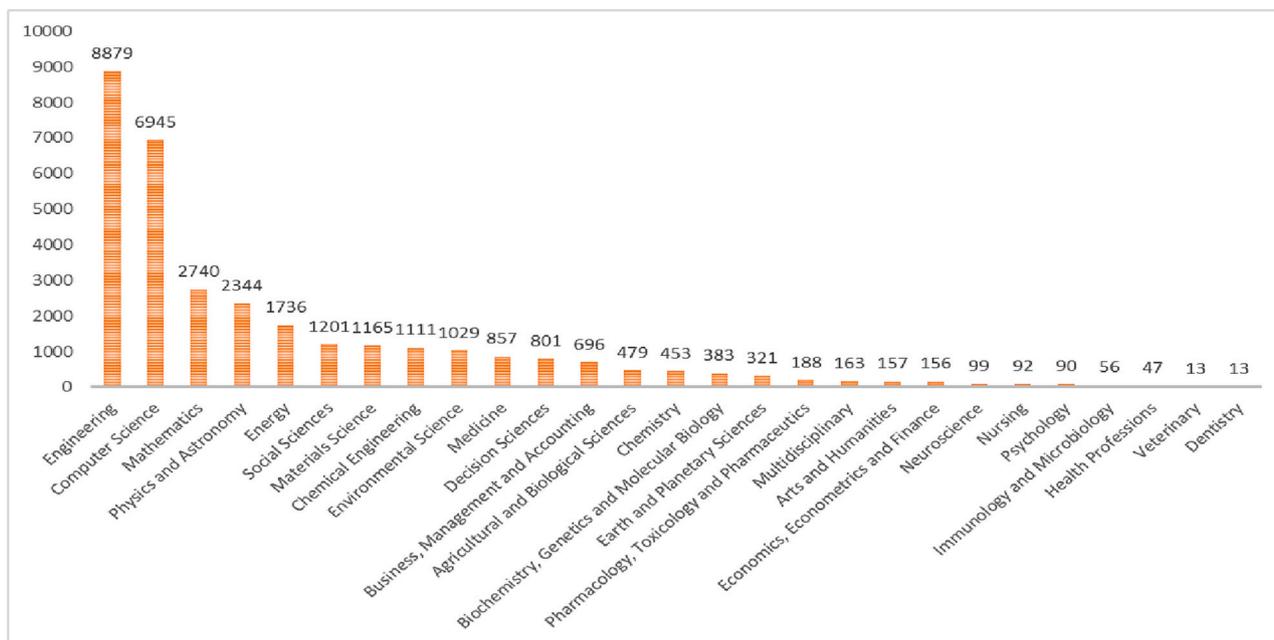


Fig. 6. Subject areas of the outputs that cite the questionable journals.

minimum threshold of five occurrences. We then calculated the total strength of the co-occurrence links for all of these keywords. From this analysis, we discovered that the top 1000 keywords with the greatest

total link strength can be classified into four clusters, with machine learning, internet of things, energy efficiency, and optimization being the most frequently repeated and connected with the other keywords.

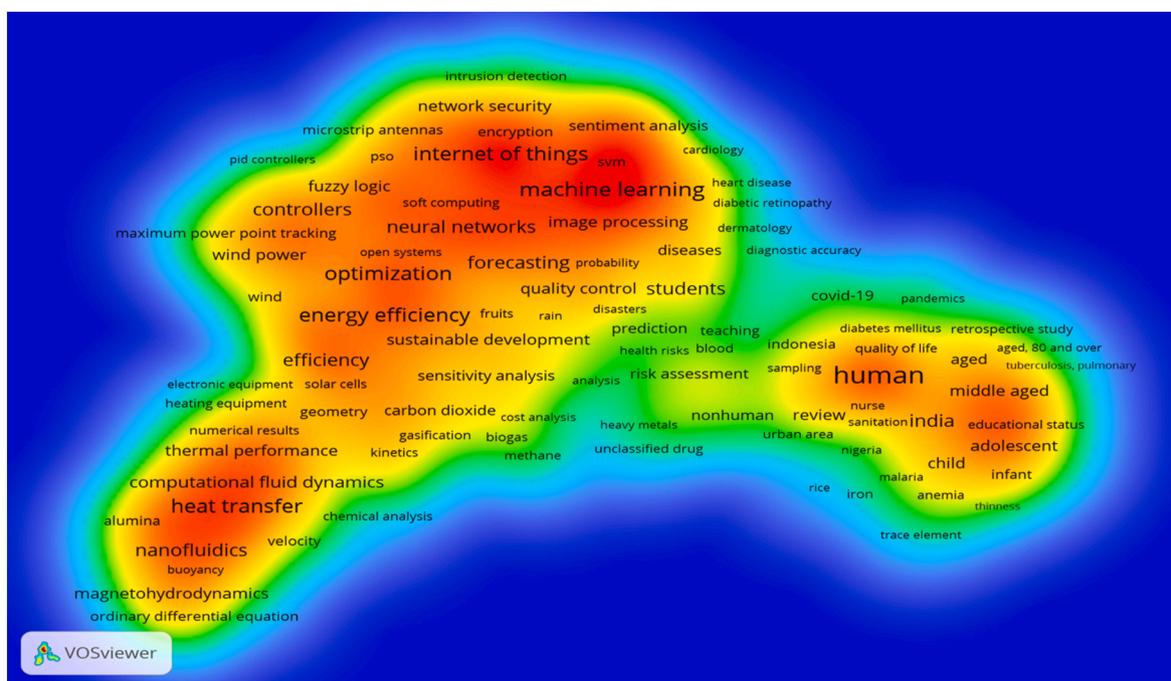


Fig. 7. Co-occurrence map of all keywords used in the outputs citing the questionable journals.

This information provides valuable insights into the underlying relationships between different concepts and can help us to explore new avenues for research.

Discussion and conclusions

In this work, we have analysed 21 journals removed from DOAJ in 2018 by suspected of editorial misconduct by the publisher. DOAJ constantly updates its list of removed journals to promote transparency.

We used the bibliometric database Scopus because of its strong commitment to the quality of its content and curation processes. We calculated the number of publications in the database that still cite these journals even though they are removed from the directory. We found that 15,268 outputs published between 2018 and 2021 have cited some of these 21 journals. Almost 20 % of these publications were produced in collaboration with international countries. 10.3 % of them are included in the highest citation percentiles worldwide and 9.1 % of these outputs were published in the 10 % top journal percentiles. 53 % were non-open access journals, demonstrating that it is not just an issue with OA journals.

As researchers, we must be aware of any potential citations to questionable journals. Peer reviewers and journal editors play a crucial role in the publishing process by acting as the primary checkpoint in the detection of such issues. However, it is important to note that simply cite a publication in a questionable journal does not automatically mean that the citing work is unethical. We cannot confirm whether papers published in these journals have followed the best research standards either. While this paper does not intend to directly infer a correlation between citing questionable journals and questionable research practices, it intends to bring visibility to the issue of citing papers of questionable journals. We must use our own judgment to decide what is of high quality, such as reading the methodology of the paper or checking if it is reproducible and conducted transparently.

An acknowledgement from a senior researcher in the form of a supporting citation can be seen as a sign of approval, but we need to be cautious if the work is published in a questionable journal, as other early career research could follow that pattern. If we continue to reference these journals, it may lead to an increased spread and distribution in an

unfavourable way. It is crucial that we address this issue and identify potential solutions through further research.

The debate surrounding the questionable nature of academic journals remains ongoing, as it relies on numerous variables that are constantly evolving. According to [Teixeira da Silva, Dunleavy, Moradzadeh, and Eykens \(2021\)](#), a journal's credibility cannot be solely determined by its open access status. Instead, its acceptance or rejection on reputable academic indexes, as well as whitelists or blacklists, should also be considered. [Garfield \(1996\)](#) found that the phrase "Publish or Perish" became popularised through Marshall McLuhan's statement that it was the "beanery motto" (with "beanery" being a derogatory term for the modern university). This strongly implies that research, and its dissemination, are no longer an endeavour of intellectual advancement, the acquisition of knowledge, making meaning of the world, or even an artistic mission. Academic publishing has become a business in its own right ([De Leeuw, 2020](#)).

Research has shown that countries with less structured publication governance systems, fewer publishing opportunities, and potential language limitations are particularly susceptible to unethical publishing practices ([Moher et al., 2017](#)). The unequal access to scientific information by developing countries deserves a mention. Some countries have been discriminated against and denied access to the global publishing ecosystem due to the high cost of scientific journals and specialised databases. In several publications, it has been revealed that open-access publishing fees deter researchers in the global south. Brazilian researchers are among those who claim resources for publishing fees are hard to come by. Researchers had previously suspected but failed to demonstrate that journal fees associated with open access articles are a barrier to authors in low- and middle-income countries. Peter Suber affirms "High APCs distort research, they exclude authors, and we should all be trying to find ways to overcome those barriers." ([Kwon, 2022](#)).

There are publications discussing the barriers African researchers face in accessing open access publishing resources. African researchers are still viewed as consumers of a global information-sharing society rather than contributors ([Nwagwu, 2013](#)). According to the original definition of OA for peer-reviewed literature, there must be no "financial, legal, or technical barriers" ([Budapest Open Access Initiative](#)

(BOAD, 2002). Nevertheless, these are some of the most common publishing obstacles found in Africa. Nwagwu (2013) and Butler (2013) expressed concerns about “predatory” journals or journals connected to “controversial scholarly open-access publishers” (Beall, 2014) which are often regarded to be scams intending to obtain money from unsuspected researchers. Despite the questionable nature of some of the journals on Beall's (2014) list, they may remain the only method of publication available for African researchers (Nwagwu, 2013).

Researchers from developing countries are more prone to being targeted by exploitative companies if their collaboration is limited to within their own country or with countries nearby since they can be easily identified as susceptible targets for the acceptance of publishing materials. Working together in a collaborative effort between researchers from the northern and southern hemispheres can not only improve the quality and reach of research but also promote inclusivity and establish a globally connected research network. Both sides can benefit from the positive outcomes of working together in collaboration. The researcher in the developing country is obtaining access to the resources, while the researcher in the developed nation can reap the rewards of the diverse input.

Moreover, some analyses have indicated that global research collaboration can be very valuable in detecting questionable publishing (Moher & Moher, 2016). Nowadays, the average original research paper boasts five authors. This is interesting to note as it highlights the collaborative nature of modern research, but it also raises questions about how credit is apportioned and shared among authors. The author sequence in research publications may differ in scientific fields, i.e. high-energy particle physics teams list authors alphabetically. So, it cannot be automatically determined which author provided the most substantial contribution to a study. Generally, the first author is credited for the most significant contribution to the project, from formulating the ideas and structure of the research paper to writing and revising the paper and supervising the article submission (Defining the role of authors and contributors (ICMJE, 2023)). Librarians have made a remarkable contribution to the medical field through their systematic reviews and this must be acknowledged in the publications. (Hubbard & Laddusaw, 2020) It should be noted that junior authors may be replaced in the line of authorship by one of greater seniority, even though this is not an ethical practice, it may take place. Another possible circumstance could be that an author from a developing nation may have done the majority of the work and not be given all the credit it deserves, yet this person does not complain to be included in well-respected international collaboration networks. Consequently, being a co-author of a scientific paper is not limited to simply being credited, but is a form of publicity, reputation, and recognition, and can have a positive impact on a researcher's future career. When researchers are fairly recognised, they will have an increased reputation as research leaders and can attain more access to funding and resources that remove the necessity of submitting to questionable journals. We understand that this is not enough to solve the large-scale problem, but it could help slow and lessen it, with certain countries being the easiest to target. The Contributor Roles Taxonomy (CRediT) (<https://credit.niso.org/>) could be employed to uncover which countries had the greatest input to these outputs, enabling them to receive the recognition they are due and to reduce the culture of publishing or perish.

Even though our time range includes the Covid-19 pandemic, medicine was not among the most cited subject areas, which is quite surprising. It cannot be observed that this topic has maximally inflated citations as has been observed in other publications (Fassin, 2021). Does this have to do with the publication profiles of the countries and their preferences when citing? For example, in what discipline do the countries that cite these journals publish the most? Is there a relation between the countries' preferences (measured by the concentration of publications in specific subject areas) and the number of citations to questionable journals per discipline? This could be a future line of research. It would be a stimulating area of research to investigate the association

between ChatGPT and “machine learning” articles. As Machine Learning was one of the most co-occurrence terms in our study. Do these terms affect the volume of content being published in these journals and do they appear frequently in these publications? Might ChatGPT have had a role in those articles?

Our analysis showed that researchers from across the world were citing the journals removed from DOAJ in 2018 and it is clear that researchers need to improve their awareness and knowledge of identifying questionable journals. The ability to critically evaluate publishing options is key to enabling researchers to distinguish between reputable and questionable journals. Zhao (2014) argues that academic libraries are well-positioned to support researchers in developing scholarly literacy skills as they employ staff who have expertise in areas such as open-access publishing, copyright, and licensing, as well as bibliometrics.

Research is already in progress on how Artificial Intelligence (AI) and automated learning could be used to identify questionable journals (Chen et al., 2020; Hinchcliffe & Clarke, 2019; Markowitz et al., 2014). Bibliometric practitioners could collaborate with AI experts to further develop this work. The combination of AI and bibliometric expertise could move the research forward and help to develop more techniques and tools to help researchers identify questionable journals.

Bibliometric practitioners need to do more to contribute and strengthen the research on identifying questionable journals. Research support staff (including bibliometric practitioners) in academic and research libraries should consider developing more support to enable researchers to make informed publishing choices. This support could include:

- delivery of clear information on library websites about where to publish
- provision of training on where to publish and tools available to check the reliability of sources
- promotion of best practice guidelines around publishing
- facility of journal checking services and one-to-one consultations with bibliometric practitioners and other library staff with expertise in this area
- training on the use of tools to help identify questionable journals

However, it is not just the responsibility of bibliometrics practitioners to support researchers in this area. Publishers and funders also have a responsibility in encouraging researchers to check whether they have unknowingly cited questionable journals. For example, publishers could require authors to confirm that they have checked their citations as part of the article submission process. This would raise awareness of the problem of questionable publishing while reducing the risk of citation contamination. This paper has built upon the work that has already been done by exploring the problem of questionable journals being indexed in databases and measuring the extent of citation contamination. Guidance has been given on how library and bibliometric services can help researchers in addressing the difficulty of questionable publishing. Academic librarians need to be more actively engaged in spreading awareness of questionable practices in publications, journals, and publishers.

We acknowledge that checking individual citations when writing up research is not a quick or easy process and is yet another thing for researchers to do. However, we feel it is vital for researchers to engage with this issue, and bibliometric practitioners, publishers, and funders all have a key role in highlighting and reducing the problem of citing questionable journals.

CRediT authorship contribution statement

Barbara S. Lancho Barrantes: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Visualization, Writing - original draft, Writing - review & editing. **Sally Dalton:** Conceptualization, Methodology, Writing - review & editing. **Deirdre Andre:**

Conceptualization, Methodology, Writing - review & editing.

Declaration of competing interest

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

Data availability

The authors do not have permission to share data.

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