










REVIEW ARTICLE

A narrative review of the phenomenon of predatory journals to create awareness among researchers in veterinary medicine

Charbel Fadel¹  | Aneliya Milanova²  | Jelena Suran³ | Andrejs Sitovs^{4,5}  |
Tae Won Kim⁶  | Abubakar Bello⁷  | Solomon Mequanente Abay⁸ | Stefanie Horst⁹ |
Rositsa Mileva²  | Michela Amadori¹⁰ | Ena Oster¹¹  | Giovanni Re¹⁰ |
Arifah Abdul Kadir¹²  | Graziana Gambino¹⁰ | Cristina Vercelli¹⁰ 

¹Department of Veterinary Sciences, University of Pisa, Pisa, Italy

²Faculty of Veterinary Medicine, Trakia University, Stara Zagora, Bulgaria

³Apiotix Technologies, Split, Croatia

⁴Department of Pharmacology, Rīga Stradiņš University, Riga, Latvia

⁵Laboratory of Finished Dosage Forms, Rīga Stradiņš University, Riga, Latvia

⁶College of Veterinary Medicine, Chungnam National University, Daejeon, South Korea

⁷Department of Pharmacology and Toxicology, Faculty of Veterinary Medicine, Wrocław University of Environmental and Life Sciences, Wrocław, Poland

⁸Department of Pharmacology and Clinical Pharmacy, Addis Ababa University, Addis Ababa, Ethiopia

⁹Department of Population Health Sciences, Institute of Risk Assessment Sciences (IRAS), One Health Pharmacology, Utrecht University, Utrecht, The Netherlands

¹⁰Department of Veterinary Sciences, University of Torino, Torino, Italy

¹¹University of Zagreb, Faculty of Veterinary Medicine, Zagreb, Croatia

¹²Department of Veterinary Preclinical Sciences, Faculty of Veterinary Medicine, Universiti Putra Malaysia, Serdang, Selangor, Malaysia

Correspondence

Cristina Vercelli, Department of Veterinary Sciences, University of Torino, Torino, Italy.

Email: cristina.vercelli@unito.it

Abstract

In recent years, especially since the COVID-19 pandemic, the number of *predatory* journals has increased significantly. Predatory journals exploit the “open-access model” by engaging in deceptive practices such as charging high publication fees without providing the expected quality and performing insufficient or no peer review. Such behaviors undermine the integrity of scientific research and can result in researchers having trouble identifying reputable publication opportunities, particularly early-career researchers who struggle to understand and establish the correct criteria for publication in reputable journals. Publishing in journals that do not fully cover the criteria for scientific publication is also an ethical issue. This review aimed to describe the characteristics of predatory journals, differentiate between reliable and predatory journals, investigate the reasons that lead researchers to publish in predatory journals, evaluate the negative impact of predatory publications on the scientific community, and explore future perspectives. The authors also provide some considerations for researchers (particularly early-career researchers) when selecting journals for publication, explaining the role of metrics, databases, and artificial intelligence in manuscript preparation, with a specific focus on and relevance to publication in veterinary medicine.

KEYWORDS

legitimate journals, predatory journals, research, scientific integrity, veterinary medicine

1 | INTRODUCTION

According to Merriam-Webster's dictionary, "predatory" is defined as "one who injures or exploits others for personal gain or profit." When this word is used to define a journal, the meaning is immediately clear and does not refer to any positive outcome. The term "predatory journal" (PJ) is related to harmful outcomes, especially for early-career scientists and for the public, who may rely on misinformation reported in articles of uncertain quality published in journals that pretend to be reputable and reliable (Figure 1).

Predatory journals were first described by Dr. Jeffrey Beall, an associate professor and librarian at the University of Colorado, who observed the evolution of editors publishing counterfeit journals to take advantage of the open-access model, "exploit(ing) the author-pay model, damage scholarly publishing, and promote unethical behavior by scientists" (Beall, 2012, p. 179). Many researchers have argued that Beall's terminology "predatory journals" alone is not sufficient to describe this type of publication. Instead, they have suggested other terms such as "questionable journals," "bad faith journals," "dark journals," "illegitimate journals," "deceptive journals," and "pseudo-journals" (Hebrang Grgić & Guskić, 2019). Beall was also the first to create a list of PJs and publishers to guide authors in choosing a legitimate journal. This was helpful in drawing researchers' attention for the first time to the problem of PJs, but it has several flaws that compromise its utility: Such a list may be incomplete and subject to dispute, and the content may quickly become outdated or even obsolete due to the constantly evolving nature of predatory publishing (Al-Moghrabi et al., 2023; Koerber et al., 2023; Yan et al., 2018). Also, Beall's list was often criticized for the lack of transparent criteria. A recent independent analysis of the journal titles included in Beall's list of PJs showed that only a limited number of them can be found in different recognized databases (Richtig et al., 2023).

All methods that have been created to identify PJs agree that such publications exist purely for economic gain (Balon, 2023; Martinino et al., 2023). A comprehensive study by Shen and Björk (2015) found that the publication volume of PJs has increased significantly

between 2010 and 2014, from 53,000 to an estimated 420,000 articles, published by nearly 8000 active journals, with an estimated market size of approximately \$74 million (Shen & Björk, 2015). More recently, Linacre (2022) estimated the PJ market to be worth at least \$75–\$100 million per year.

Moreover, submitting and publishing articles in PJs waste both human and financial resources. Time, money, and resources that could have gone into legitimate research projects are instead directed toward publications with questionable sources. Despite the large market size of PJs, Linacre (2022) highlighted that publishing in such journals results in a loss of funding resources and author engagement with almost no return on investment as these articles are not being cited further. Why could this happen? Because it is a fraud, but one that is well disguised and takes advantage of the growing need of researchers to publish many articles each year to advance their careers (i.e., "publish or perish" culture) or to obtain funding (Linacre, 2022). The affected scholars are mostly researchers who possess limited resources and frequently lack sufficient expertise in understanding publication ethics (Koerber et al., 2023). They usually operate within institutional environments that prioritize quantity over quality (Koerber et al., 2023). The credibility of science is seriously threatened by predatory publications, and the negative influence of these practices is also borderless, with PJ publishers, and also one-third of authors who publish with them, being geographically dispersed across Asia, Africa, North America, and Europe (Linacre, 2022).

The majority of PJs publish articles on medical topics, mainly in the field of human medicine (Hulsey et al., 2023; Kachooei et al., 2023). Several papers in the literature warn scholars about the risk of PJs in orthopedics (Kachooei et al., 2023; Yan et al., 2018), ophthalmology (Gurnani & Kaur, 2021), dentistry (Al-Moghrabi et al., 2023), and neurosurgery (Deora et al., 2021). However, these concerns have not been widely recognized as a major issue in veterinary medicine journals, nor have they attracted substantial attention within the veterinary scientific community. Indeed, despite the high prevalence of predatory journals in veterinary medicine, only one editorial letter has been published, reporting a case with



FIGURE 1 Predatory journal's essence. Adapted from Grudniewicz et al. (2019).

PJs which misled an author in publishing work related to honey bees (Fortier, 2023). In the authors' opinion, this relative lack of attention may be because researchers in veterinary sciences, including veterinary pharmacology, form smaller communities compared to those in the human medical sciences. Consequently, these researchers may have a less pronounced impact on the broader scientific world. Another possible reason for this lack of reporting in veterinary medicine may be due to a general lack of awareness about PJs among veterinarians and professionals related to veterinary medicine: A survey of 145 writing workshop participants (73.1% were from veterinary schools) found that only 23% were aware of the term "predatory journals" and only 4.8% were familiar with Beall's list (Christopher & Young, 2015). Most respondents did not understand the true nature of PJs, often confusing poor practices with predatory ones. Christopher and Young (2015) strongly advocate for mentors to guide and educate novice veterinary authors so that they can recognize PJs and make well-informed decisions when choosing the right platform for their work. However, it is important to first develop clear guidelines that include essential elements to help researchers characterize legitimate journals and identify the features of predatory publishers and their journals, books, or congresses (Cortegiani et al., 2020; Gastel, 2021).

This review therefore aimed to:

- Describe the characteristics of PJs.
- Differentiate between reliable journals and PJs using specified criteria for evaluating journal quality.
- Investigate the attractions for predatory publishing and the harmful influence it has on scientific research.
- Evaluate the negative impact on the scientific community.
- Explore future perspectives.

with specific insight into veterinary medicine and veterinary pharmacology, with specific reference to the countries and regions in which the authors of this manuscript work.

2 | CHARACTERISTICS OF PREDATORY JOURNALS

The primary objective of open-access (OA) publishing is to accelerate the dissemination of scientific findings by providing readers with free online access to high-quality research information (Hebrang Grgić & Guskić, 2019). However, some journal publishers took advantage of this unique concept for their economic gain and started exploiting the article processing charge (APC) cost model for OA publication without subjecting the submitted manuscript to a robust peer-review process (Christopher & Young, 2015; Elmore & Weston, 2020; Tindall et al., 2021). These counterfeit publishers are dishonest, lack candor, and constantly try to deceive researchers, particularly those who are new to scholarly communication (Beall, 2012). More recently, predatory publications have moved from the margins of scientific discussions to a more mainstream audience.

Moreover, PJs post on social media, thus mimicking another thing that reliable journals usually do (Grudniewicz et al., 2019).

Predatory publishing has caused professional concern among academics and their institutions, and the identification, characterization, and demarcation of predatory from non-predatory publications are controversial. It is difficult to evaluate journals due to the great variability in the types, combinations, and degree of illegitimacy: PJs frequently resemble professional publications in their appearance, making it difficult for researchers to distinguish them from respectable and genuine publications (Grudniewicz et al., 2019; Rupp et al., 2019; Zakout, 2020). To identify potential PJs, in the past authors could have used Beall's list. While Beale's list has been shut down, its spirit and the concepts on which it was founded have been welcomed, passed down, and improved by other lists, such as Cabell's Predatory Reports (Beall, 2012; Elmore & Weston, 2020). Moreover, knowledge about the issue has been explained in books such as *The Predatory Paradox* (Koerber et al., 2023). Authors can also consult with mentors and their professional experts or carefully check the journal's website to see whether it has characteristics of a PJ or not. When checking a journal's website, there are several characteristics which may suggest a PJ. The most obvious characteristics include an unspecified or rapid publication process, without a thorough peer review or any transparent evaluation process (Koerber et al., 2023). Moreover, the APC fees are usually very expensive; however, a discount (sometimes very tangible) is easily attainable by simply requesting it without having to provide detailed explanations (Kachooei et al., 2023; Yan et al., 2018). Well-recognized journals that are familiar with OA publishing and are included in all relevant databases usually have similar APCs. This uniformity arises from the fact that these reputable journals, having extensive experience with the principles of OA publishing and enjoying broad indexing, tend to set their APCs at a level that is comparable across the scholarly landscape. Furthermore, information about the editorial board is incomplete or false for PJs, including the inclusion of the names of well-known scholars without their consent or involvement (Cook et al., 2023; Yan et al., 2018). Finally, PJs can be characterized by the lack of a clearly described policy for retraction of manuscripts, lack of information on the copyright procedure, or what procedures are in place in case of misconduct, including plagiarism (Koerber et al., 2023).

Often, the names of PJs are very similar to the original reputable journals with websites that are similarly organized but lack the crucial information outlined above. Frequently, the websites of PJs look unprofessional with grammatical errors, low-quality graphics, or spelling mistakes. Nevertheless, it is worth noting that several newly established journals, particularly in geographic areas with limited resources, may lack a visually polished website, although they produce high-quality research.

Aside from the journal name, website characteristics, and information outlined above, authors may receive unsolicited emails from PJs asking for manuscript submissions. Typically, these emails mention a previously published paper of the authors and often contain generic or irrelevant content (Cook et al., 2023). Oermann

et al. (2018) analyzed 206 email invitations sent to nursing school faculty and students over a 10-week period. Some of these emails contained flattering wording, odd expressions, and many grammatical errors. A significant portion (57.8%) of the emails showed no clear signs that the journal or publisher were predatory, but they definitely were, and the quantity of unsolicited emails can be substantial: In the field of orthodontics, an observational study reported that over a period of 1 year the number of invitations sent by email by presumed PJs significantly exceeded emails from reputable journals (Livas & Delli, 2023).

The key characteristics of PJs are presented in Table 1.

In order to help researchers to determine whether a journal should be considered predatory, Dadkhah and Bianciardi (2016) created the predatory rate (PR), which indicates the risk of whether or not a journal could be considered predatory. A PR of 0 means that the journal is not predatory. A PR between 0 and 0.22 indicates predatory practices, and anything above 0.22 defines a PJ (Dadkhah & Bianciardi, 2016). Sharma et al. (2019) further used the just mentioned method to calculate the PR for pharmacology journals from

Beall's list and confirmed that all selected journals were predatory as they had a PR above 0.22.

3 | DISTINGUISHING LEGITIMATE JOURNALS

3.1 | Criteria for evaluating journal quality

The process of publishing scientific works requires careful selection of a suitable journal. The successful "life" of an article depends on many factors, and an important one is finding the journal which brings the message to a target group of specialists who work in the field related to the topic of the article. Therefore, finding well-recognized journals in the scientific community is the ultimate responsible step for every researcher. Objective criteria describing reputable publication practices can be helpful in finding the right journal. The most important features of reputable publication practices are listed in Table 2.

3.2 | Accreditation and indexing

Accreditation (process of officially recognizing), cross-referencing (linking citations across publishers), and indexing (the presence of the journal in a compiled list) are the important indicators of a journal's legitimacy and quality. The journal's article significance and scientific contribution can be quantitatively assessed based on the number of citations in other articles. Both journals and individual researchers can be evaluated using the Hirsch index (H-index), a balanced parameter introduced by Masic and Begic (2016). It quantifies both the productivity (number of publications) and citation impact (number of citations) of the scholar's or journal's work. An H-index of, for example, 10 means that 10 papers have each been cited at least 10 times, reflecting a balance between quantity and impact of research output.

The following databases mentioned are considered valuable resources to evaluate whether a journal is legitimate or not. Some recognized accreditation bodies and indexing services include:

- Directory of Open Access Journals (DOAJ): It indexes high-quality, peer-reviewed open-access journals that adhere to strict publishing standards. DOAJ facilitates the discovery of trustworthy open-access journals, supporting the accessibility and visibility of scholarly research, freely accessible and easy to read.
- Medline: It is the United States' National Library of Medicine's (NLM) premier bibliographic database, containing papers about life sciences. The enrollment criteria are very strict. It is the main component of PubMed: Its role is to provide comprehensive coverage of the biomedical and life sciences literature. It includes references to articles from a wide range of biomedical journals, covering topics such as medicine, nursing, dentistry, veterinary medicine, and more.

TABLE 1 Identifiable features of suspected predatory journals.

Item	Features
Time	Lack of a fixed time frame for article publishing yet a rapid publication is promised following payment of article processing charges
Style	The website language and design target young authors who are inexperienced in scholarly communication The journal solicits manuscripts aggressively through spam or individual emails The journal has a history of publishing low-quality or deceptive research Manuscripts are suggested to be sent through mail instead of using an online submission system
Policy	The journal does not have a defined policy about its scope, peer review, and editing process Editorial boards are either exaggerated or non-existent making it difficult to determine their identities or contacts
Article processing charge (APC)	The journal demands a hefty fee to publish articles
Database	The journal does not appear in reputable databases such as Scopus or PubMed
Impact factor (IF)	The journal has a low or no IF. The journal has a name that is identical to a well-established reputable journal with a high IF

TABLE 2 Summary of strengths of reliable journals.

Items	Strengths
Transparency and disclosure	Journals provide clear and comprehensive information about their peer-review process, publication fees, copyright policies, and ethical guidelines. Legitimate journals usually show this information, which is very close to the criteria outlined in Committee on Publication Ethics (COPE, https://publicationethics.org/)
Traceability	Journals that have a link to the publisher, ISSN, or ISBN are announced
Open-access (OA) policies	Transparent OA policies, such as Creative Commons licenses, ensure that research articles are freely accessible to readers without financial or legal barriers
Archiving and preservation	Reputable journals prioritize archiving and preservation of published content to ensure long-term accessibility and prevent loss of valuable research
Editorial policies	Journals establish clear editorial policies, including guidelines for authorship, conflicts of interest, retractions, and corrections, promoting ethical publishing practices
Medical publishing policies	In this specific field, standards set out in the Principles of Transparency and Best Practice in Scholarly Publishing issued by the Directory of Open Access Journals (DOAJ), the Open Access Scholarly Publishing Association, the Committee on Publication Ethics (COPE), and the World Association of Medical Editors are followed

- PubMed: It comprises citations from Medline, life science journals, and books. Citations may be linked to PubMed Central (PMC), a substantial library with less stringent inclusion criteria than the National Library of Medicine (NLM). This means that if an author's study is funded by the National Institutes of Health (NIH) or a similar agency and is published in a PJ, it could still be visible on PMC (Deora et al., 2021).
- Web of Science (WOS): It plays a pivotal role in academic research by offering a multidisciplinary citation database and research platform. Through citation indexing, it enables researchers to trace and assess the impact of scholarly works. It also provides comprehensive bibliographic information, calculates journal *impact* factor (IF), and supports research evaluation and assessment. Journals that are indexed in WOS are generally considered reputable and have met specific criteria for inclusion. Journals that meet the quality criteria of the WOS are included in the Emerging Sources Citation Index (ESCI), which plays a pivotal role in providing visibility to scholarly journals, serving as a platform that highlights and indexes promising scholarly journals in the early stages of evaluation for potential inclusion in more established citation indexes. Those that additionally meet impact criteria are included in Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), or Arts and Humanities Citation Index (AHCI), depending on the journal subject. These three established citation indexes play a crucial role in the scholarly landscape, providing comprehensive coverage and rigorous evaluation of academic literature.

Inclusion in these indexes enhances a journal's visibility, credibility, and impact within specific disciplinary domains, facilitating broader recognition and accessibility for researchers, academics, and institutions on a global scale. Journals are periodically re-evaluated (dynamic evaluation) to ensure they are in the appropriate collection and can be moved from ESCI to SCIE, SSCI, or AHCI or back when they gain or lose impact, respectively. Web of Science quantifies journal citations by journal impact factor (JIF), which is based on the last 2 years' citations in different document types. Yearly journal impact factors are published in the Journal Citation Report (JCR) and in Scimago Journal and Country Rank (SJR), which are useful to compare journal quality in different research areas.

- Scopus: Elsevier Scopus database indexes a wide range of reputable journals and provides comprehensive coverage of scholarly literature. Scopus metrics are CiteScore, Source-Normalized Impact per Paper (SNIP), Scimago Journal Rank (SJR), and H-index. Journals indexed in Scopus are ranked according to the SJR, which is a useful tool to compare journals within one discipline. Journal SJR is calculated by dividing the average weighted number of citations by the number of published papers in the journal in the last 3 years. This metric is based on the idea that not all references are equal, evaluating the weight of the citation by its prestige, that is, the quality of the journal from which the reference is taken. SJR divides the journals into four quartiles (Q1, Q2, Q3, and Q4), where Q1 journals are cited more frequently and in higher-ranking

journals, compared to the other quartiles. Source-Normalized Impact per Paper measures journal contextual citation rates in particular research areas in Scopus-indexed publications, by dividing journal's raw impact per publication (RIP), an average number of citations in the journal, by relative database research potential (RDCP), which is a metric for comparing the research capabilities of databases in a specific field. With SNIP values higher than 1, the journal is cited more frequently than other journals in its research area. Source-Normalized Impact per Paper metric is less impacted by journal manipulative activities than other metrics. CiteScore is a representative of the citation impact of a journal. This metric is based on the number of citations received by a journal in 1 year for papers published in the three previous years, divided by the number of papers indexed in Scopus published in the same 3 years.

- Elton B. Stephens Company (EBSCO) information services provide access to full text of high-quality articles licensed from reputable publishers. Even if it is a private collection, it is freely accessible and transparent in its policy and is recognized by library professionals.
- Open Access Scholarly Publishing Association (OASPA) is a non-profit association that represents the interests of OA publishers in scientific, technical, and academic disciplines.

It is always useful to bear in mind that it is better to consult at least two databases (i.e., "cross reference") to ensure that a journal is reliable, as a single database alone might not guarantee the status of legitimate journals (Al-Moghrabi et al., 2023; Deora et al., 2021; Gurnani & Kaur, 2021). Indeed, there has been a rapid increase in PJs circumventing policies of these databases, resulting in their indexing in PubMed, Scopus, and WOS (Duc et al., 2020; Manca et al., 2018).

Aside from the more formal indexing sites outlined above, recently an open list of predatory publishers and journals was published by the [Predatory Reports team](#), whose members are anonymous and independent (<https://predatoryreports.org/the-list>). They claim on their website that they do not receive monetary donations and they decided not to display advertising on their website in order to preserve their integrity. They promote education and awareness about PJ and leave it to the discretion of those who consult the list to independently reach an opinion. Another "blacklist" is the Predatory Reports from Cabell's Scholarly Analytics (Frandsen, 2022), which is, unfortunately, not freely available and accessible behind the paywall. Cabell's website mentions that they examine each journal "against 60+ behavioural indicators, screening for everything from misleading metrics to irregular publication practices."

Veterinary researchers should not forget the role of university libraries, which can be of significant help in distinguishing between legitimate and PJs. The role of university libraries is underestimated with the electronic access to articles with OA, but the librarians with their specialized knowledge can contribute to the education of young scientists (Martinino et al., 2023).

3.3 | Impact factor

The impact factor, bibliometric parameter developed by Clarivate Analytics, gauges the average citations of articles from a journal over a two-year period. Based on the IF, journals belonging to a certain subject category are categorized into quartiles according to JCR and SJR.

The impact factor is a central measure in many countries of research impact. Some national systems for university accreditation, including in Italy, Croatia, and Bulgaria, are based on publication in journals from Q1 to Q4. In Lebanon, journals and quartiles are utilized to accredit professors, but not as the primary metric for accrediting universities. In Malaysia, yearly research output performance for academic staff is gauged on the publications in JCR-indexed Q1–Q4 and Scopus-indexed journals. Owing to the importance of credibility and accreditation (personal and/or institutional), researchers must exercise caution and thoroughly investigate journals to ensure the credibility and impact of their research before sending the manuscript for publication.

Although it is used as a measure of quality and prestige for journals and researchers, it has notable limitations. The IF is not representative of individual articles, correlates poorly with actual citations, and only covers a limited time window (Lievers, 2013; Roy et al., 2002; Vanclay, 2012). Additionally, IF can be inflated through the manipulation of citations, such as self-citations or excessive citations within the same journal (Falagas & Alexiou, 2008; Yu et al., 2018). This can artificially inflate the number of citations and subsequently increase the IF. Additionally, the IF may favor journals that publish review articles or articles in rapidly developing fields, as these tend to receive more citations (Ketcham & Crawford, 2007; Obremsky et al., 2005). Hence, it is unsuitable as the sole source for comparing publications, and its use in funding and tenure decisions is contentious (Lievers, 2013; Roy et al., 2002).

Predatory journals may falsely claim to have high IFs, use invented metrics, or claim databases without any importance, misleading authors about their standing. Thus, given widespread reliance on the IF for accrediting journals, potential authors must exercise caution. Authors should diligently verify a journal's standing by consulting the reliable databases mentioned above before submission. In order to provide a huge panorama, it is important to cite that alternative metrics exist, such as the Altmetric Attention Score (AAS): It can provide information about impact assessment (Fassoulaki et al., 2021). Nevertheless, to adhere to the aim of the present review, this topic will be not further developed.

3.4 | Peer-review process

As previously mentioned, one of the most important features of legitimate journals is the provision of a reputable peer-review process. Experienced researchers have an important obligation to pass their knowledge on to the next generation. One way to fulfill this task is by writing and teaching, specifically through reviewing manuscripts

objectively, based on facts, and free from the influence of emotions or other subjective factors. Predatory journals do not engage in peer review and so do not offer these advantages to the research community (Al-Moghrabi et al., 2023; Hulsey et al., 2023; Yan et al., 2018). Some authors, particularly in countries where international publication is imperative but quality is not a priority, may deliberately choose PJs to circumvent the lengthy and rigorous peer-review process (Yeo-Teh & Tang, 2021).

Key aspects of a reputable peer-review process include:

- Expert reviewers: Reputable journals elicit the help of experienced professionals as reviewers, who assess the scientific value, methodology, and validity of submitted publications.
- Double-blind review: In a double-blind review, the identities of both the authors and the reviewers are concealed, limiting bias and ensuring objective judgment.
- Timeliness: A respected journal aims to complete the peer-review process in a reasonable time frame, balancing thorough evaluation with timely publication.
- Author criticism: Authors receive constructive criticism and suggestions to improve their submissions, which helps to improve the overall quality of published articles.

Although the peer-review process has a long tradition and strong consistency in legitimate journals, there are cases where editors have problems finding qualified reviewers (Kachooei et al., 2023). Very often, advanced researchers do not have time to review manuscripts. This voluntary work is related to an ethical obligation to contribute to the advancement of knowledge in a particular field by improving the quality of published articles through the reviewing process. Sometimes, in order to motivate reviewers, journals have offered the possibility of concessions or discounts for future publications. This situation, accompanied by other factors, may result in journals that were previously considered reputable being reclassified as predatory. Due to ongoing changes in the sector such as these, it is important for authors to undergo systematic and regular revision of each journal's reputation.

3.5 | Motivations that may lead (or mislead) authors in publishing

In scientific practice, a fundamental principle is the rigorous evaluation and thorough examination of all research activities. This principle is particularly important in the field of veterinary medicine, where it serves to ensure animal health and prevent any form of exploitation.

Authors themselves contribute to the maintenance of PJs, either intentionally or unintentionally. Some individuals may not assign high importance to the quality and integrity of journals. Instead, their main objective might revolve around generating an adequate volume of papers to secure professional advancements or their position. Consequently, these authors engage with PJs by purposefully

bypassing the peer-review process, seeking to rapidly enhance their reputation (Cobey et al., 2019; Kurt, 2018). Conversely, some researchers may be under the misconception that a swift peer-review process equates to quality, trusting a PJ's purported quality control measures, when this is not the case. Regrettably, research published under such circumstances in PJs with an attempt to publish as quickly as possible becomes what is referred to as "lost science," as it frequently cannot be found through formal academic searches (Clark & Smith, 2015). It is important to note that while peer review is becoming increasingly time-sensitive, the speed of the process alone does not necessarily indicate that a journal is predatory.

Predatory journals frequently prey on academics from low-income countries, who have few publishing opportunities and are typically unaware of the predatory methods. In various countries, obtaining a doctoral degree, or sometimes even a master's degree, increasingly depends on the completion of a publication. A case in point is Iran, where students are required to publish their work to qualify for graduation (Ebadi & Zamani, 2018); the same practice occurs in Croatia. In Bulgaria, according to the regulations which outline the rules for acquiring a PhD degree, a PhD student has to perform the experiments and publish three papers within 3 years. In Italy, a PhD student must publish at least one paper as the first author during the PhD period. By contrast, in Malaysia, a PhD student must publish at least two manuscripts as the first author during the period of study before graduation. It is the responsibility of the supervisor to ensure their post-graduate students are vigilant in identifying and avoiding PJs to protect the integrity of their PhD work through publication in legitimate journals. Even after completion of higher degrees, significant emphasis on publication remains. Turkish universities are willing to provide financial incentives to their faculty members for publishing (Demir, 2018), whereas Ghanaian universities have integrated publications as prerequisites for career advancement (Atiso et al., 2019). These examples underscore the considerable pressure researchers face in the early stages of their careers. However, this occurrence is not exclusively a reaction from regions with geopolitical challenges or a response to the practices of academia in more privileged areas (Collyer, 2018). Shaghaei et al. (2018) illustrated that, even in Denmark, early-career researchers experienced comparable pressures to publish. When choosing publication channels, young researchers often consider factors such as speed of publication, open access, and the audience reached, rather than relying solely on their familiarity with a journal or awareness of its reputation. Publishing research undeniably constitutes an integral aspect of academia, underscoring the primary responsibility of supervisors and senior researchers to assist students and early-career researchers in identifying and navigating suitable publication avenues.

A survey by Cobey et al. (2019) found that scientists usually turn to PJs when facing challenges in publishing. The interviewees justified this decision by writing that they felt the desire to disseminate their research more easily or that they had recklessly given in to submitting their documents due to the unrelenting invitations to publish from the PJs. Research indicates that, in Italy, at least 5% of 46,000 researchers publish in such journals (Bagues et al., 2019). To

contextualize this topic in veterinary medicine, it was found that only 23% of 145 veterinarians and medical writers in Canada were aware of what PJs are and the risks associated with them (Christopher & Young, 2015). Unfortunately, no more recent reports are available in the literature related to neither veterinary medicine nor veterinary pharmacology. Such research is essential to fully comprehend the extent and severity of the issue in this specific area.

3.6 | Negative impact on research in veterinary medicine and pharmacology

Are PJs contaminating science and medicine? Yes, indeed, they are. The negative impact of very low-quality publications is higher for health sciences around the globe, due to the possible direct impact on health care and research (Forero et al., 2018). If PJs allow mediocre research to be published without proper review, there is a risk that unproven information will be shared in the scientific community or, even worse, among the general public. Moreover, if poor quality information is conveyed by unreliable scientific papers, unsafe experimental treatments may be used in further research, putting subsequent subjects at risk. Additionally, researchers may refer to, and discuss, incorrect findings from PJs in their submissions to reputable journals, further extending the spread of such misinformation (Kokol et al., 2017) and potentially inadvertently lending false credibility to flawed research. Conversely, if a paper published in a reliable journal is further cited in a PJ, it contaminates the research presented in the earlier paper, raising questions about its legitimacy (Linacre, 2022).

The rise of PJs in veterinary medicine poses several challenges. Firstly, publishing in these journals can harm the reputation of the authors and the credibility of their research (Shamseer et al., 2017). The absence of thorough peer review in PJs may result in suboptimal scientific quality in published articles, potentially misleading readers and impeding the progress of veterinary knowledge. Alternatively, even if the scientific content is very sound, the journal's questionable reputation can adversely affect the dissemination and recognition of the work and its authors.

It is important to acknowledge that some articles published in PJs are not of poor quality. Indeed, some are well-executed and contribute valuable insights to their respective fields. However, the integrity and reliability of such articles can be overshadowed by the prevalence of substandard or unreliable content also included in these journals. As a result, even robust, high-quality studies may face skepticism or doubt from clinicians and researchers due to their association with predatory publishing practices.

In veterinary medicine, inaccurate data retrieved from unreliable sources can lead to incorrect diagnoses and treatment/surgical decisions, potentially resulting in ineffective or harmful therapies for animals. Furthermore, as PJs are frequently accessible online for free, their impact on the public is undeniably negative and potentially harmful (Hansoti et al., 2016; Teixeira da Silva, 2019), as owners can easily access such information when searching the Internet for information about their pets' diseases. In clinical pharmacology

specifically, inaccurate pharmacokinetic data can endanger animal health by resulting in inappropriate administration of medications and treatment protocols. Veterinary pharmacologists and practitioners strive to base their treatment approaches on accurate and dependable pharmacokinetic and pharmacodynamic data. However, suboptimal dosages or incorrect administration routes may lead to treatment failure, toxicity, or adverse effects in animals. Thus, the potential risks to animal health and welfare arise when treatment recommendations, evidence-based protocols, and safety profiles stem from unreliable research.

In summary, PJs lead to significant risk of spreading inaccurate data, and this risk overshadows actual scientific advances in veterinary medicine. Affiliation with PJs can tarnish the reputation of veterinary pharmacologists and the field as a whole. It is important to note, however, that flawed research can be (and is) published in journals not classified as predatory, highlighting the need for authors to practice diligence when selecting journals, regardless of whether they are suspected to be predatory or legitimate ones.

4 | FUTURE DIRECTIONS

PJs are continually adapting to the changing academic publishing landscape, and the potential damage to research integrity and public safety is a significant concern. Continued vigilance and collaborative efforts by all stakeholders are essential to gradually reduce the impact of PJs and ensure academic integrity. While the detrimental impact of PJs is evident across various research fields, specialized fields such as veterinary pharmacology may encounter even more significant challenges, considering the limited capacity and scale of papers published (Richtig et al., 2018).

Researchers can reduce the risk of harm from PJs by adopting a combination of strategies to evaluate journals, identify potential predatory journals, and avoid them (Chen et al., 2023; Teixeira da Silva & Kendall, 2023). Researchers can also share their submission experiences with colleagues or consult with their institution's library and plan the submission according to the time, cost, and reputation of the targeted journal (Eaton, 2018). Institutions and professional societies can organize workshops and training sessions dedicated to researchers, early-career scholars, and graduate students about the benefits of publishing in well-recognized journals and how to identify PJs (Deora et al., 2021). There is also a growing consensus on the need for a systematic and practical response to tackle PJs (Cukier et al., 2020). Academic institutions and research organizations should educate scientists using the evaluation tools previously described or new tools such as "Think, Check, Submit" (<https://thinkchecksubmit.org/journals/>) (Hulsey et al., 2023). Furthermore, governments should provide global and regional guidelines for preventing questionable academic activities in order to mitigate the influence of PJs on researchers (Kim et al., 2020). Some further suggestions to improve the current situation are provided in Table 3.

In parallel, universities, research institutions, and funding agencies should promote a shift from a quantitative approach

TABLE 3 Suggestions for researchers, academics, and institutions to improve the current situation about predatory journals.

Researchers should familiarize themselves with the characteristics of predatory journals and be vigilant in avoiding them
 Conduct thorough research and evaluation when selecting journals for publication
 Seek guidance from reputable organizations, societies, and academic institutions
 Engage in educational programs and utilize available resources to enhance their understanding of predatory publishing practices
 Prioritize research integrity, including rigorous peer review, transparency, and adherence to ethical guidelines
 Consider the balance between accessibility and quality in publishing choices, making informed decisions based on the reputation and impact of the journals. Authors should strive to publish their work in journals with a strong reputation and impact within their respective fields. This ensures that their research reaches a wide audience and contributes to the advancement of knowledge

to a qualitative approach for assessing academic output. The San Francisco Declaration on Research Assessments (DORA; Raff, 2013) is working with other organizations to coordinate an action plan to change the way researchers are evaluated (Aubert Bonn & Bouter, 2023; DORA, 2021). This change in evaluation criteria will help shift the focus from production of quantitative results (i.e., focused on rapid publication) to publishing quality work that requires care. This transition is crucial to encourage researchers to prioritize qualitative improvements in their research outcomes.

International solidarity is crucial in combating PJs across national borders, such as DOAJ, OASPA, and Committee on Publication Ethics (COPE; Koerber et al., 2020). Differences in how countries define certain journals can lead to inconsistent evaluation of researchers, resulting in inequalities for certain researchers. Sharing the international evaluation criteria for PJs and categorizing them are essential. This not only guarantees the credibility of research at a national level, but also ensures its recognition on the international stage. Such uniformity in approach may be easier to achieve in more specialized research areas such as veterinary pharmacology, where global solidarity can be established more efficiently than in broader research areas. We suggest that this process begins with this review article and is followed by the exchange of knowledge and understanding of PJs within small research groups and the sharing of this knowledge with other subgroups to reach a common consensus on action plans for PJs.

National authorities must support the efforts of researchers by evaluating the quality of scientific works to be able to objectively evaluate who is worthy of receiving funding in universities and research institutes. The Ministry of Education, academic institutions, and funders provide financial support to universities according to the published papers. For instance, the evaluation of the impact and quality of the articles according to the regulations in Bulgaria is based on the quartiles. The highest score is given to articles published in Q1 of Web of Science and Scopus. The number of papers published in such journals determines the budget for scientific work at the universities. In Italy, Croatia, and Malaysia, the situation is

similar as national funding or career advancement is based on the number of papers published and the quartile of the journals. The practice shows that the time necessary from receiving the paper to its publication takes a year sometimes, which can cause problems with following the terms of PhD programs.

It is vital to also consider the impact of artificial intelligence (AI) and its use in writing and reviewing scientific papers. It is a current and controversial topic for conducting and publishing scientific research that warrants significant further exploration, but in the present review, the focus will lie on the potential for use and abuse of PJs. The increasing adoption of AI and advanced large language models (LLMs) (OpenAI's ChatGPT 4.0 currently being the most notable), along with image and other media generation software, introduces both breakthroughs and challenges within scientific realms, including veterinary pharmacology. These technologies, while streamlining data analysis and enhancing the efficiency of scientific writing, also pose a risk of being co-opted by PJ (Liverpool, 2023). These dubious outlets, known for bypassing thorough peer review in favor of collecting publication fees, might exploit AI capabilities (Liverpool, 2023). Researchers must be aware that while the recent AI tools can be used to write convincing manuscripts, the generated content may be incorrect, compromising the integrity of the entire scientific field (Dadkhah et al., 2023). Most of these software programs are freely accessible and therefore attractive to young researchers. The ability to create a manuscript is based on the capacity to "cut" some sentences from the papers available in the literature and mimic scholarly work, but which in reality are merely the result of a clever prompt (Liverpool, 2023), and able to elude the plagiarism detection software, also based on an AI algorithm (Gao et al., 2023).

Another condition that researchers and authors need to be aware of is the "paper mills." These terms are used to identify companies that sell authorships of papers after writing them and receiving acceptance for them (COPE, 2022). These companies reach this goal through manipulation of peer review, plagiarism, or even fabrication of content, falsification of results, leading to the creation of fake manuscripts (COPE, 2022). AI-based generative tools for text and various image-creation software, such as ChatGPT, DALL-E 2, Perplexity, and ClickUp, offer novel methods for crafting content typical of paper mills, potentially making it challenging to identify such fabrications (Liverpool, 2023). These companies are ambiguous, frequently targeting medical sciences and healthcare professionals, and should not be confused with companies that provide laboratory and research services (Dadkhah et al., 2023). Usually, it is easy for paper mills to publish in PJs, but some of them can also be found in reputable journals, and a few automated software programs can detect them. According to this, human inspection and reference checking are still the best methods to avoid publishing fake information (Dadkhah et al., 2017, 2023). Despite the intrinsic risks related to the use of these tools, it is impossible not to know or use them because we live in a world where AI is everywhere. In fact, despite the risks of false information provided, AI can be very useful and time-saving when used correctly in research: It can be employed for technical, non-scientific motives such as reformulation, language

translation, communication, and automation of routine tasks and administrative tasks, allowing researchers to focus on the more important aspects of their work. In fact, AI tools represent a resource for non-native English speakers to write well-formulated and comprehensible sentences (Gödde et al., 2023; Hwang & Chang, 2021; Hwang & Chen, 2023). It is therefore necessary to improve knowledge about these tools and explain when they are used, especially when it comes to medical topics (Tang et al., 2023). Ethical concerns may arise if considering the possibility of using a third party or plagiarizing sentences or ideas, thus violating the intellectual property (Lund et al., 2023; Tang et al., 2023), and flooding the scientific world with realistic-looking articles that are misleading, misrepresentative, or nonsensical (Liverpool, 2023). There is a growing demand by academics to state the use of AI in the manuscript writing process. The aim is to protect the integrity and credibility of academic research papers (Hwang & Chang, 2021; Hwang & Chen, 2023; Tang et al., 2023). Another possible application of AI is in the revision of a manuscript, particularly in terms of speed and time-saving compared to human evaluation, but its efficacy has many limitations. Although AI may demonstrate the ability to identify methodological errors efficiently, it remains insufficient on its own due to its current lack of awareness regarding many scientific nuances and mistakes. On the other hand, manuscripts must be divided into several parts because a long manuscript will not fit in AI tools. Moreover, figures and tables are not revised (Biswas et al., 2023). This represents another concern as it has been reported that several papers published in recent years presented intentionally manipulated figures and were retracted after careful review (Behl, 2021; Bik et al., 2016). According to a study conducted in 2016, scrutiny of about 20,000 biomedical papers revealed that roughly 3.8% of them had figures with problems, and at least half of those appeared to show signs of intentional tampering (Bik et al., 2016). In February 2021, the Journal of Cellular Biochemistry (JCB) disclosed that after an editorial inquiry, it retracted 23 out of 137 papers released between 2017 and 2020 due to allegations of image manipulation. These retractions account for 3.7% of the papers the journal published in that period (Behl, 2021). While many of these fraudulent papers were likely created with limited use of the advanced tools available today, this only serves to highlight the clear opportunities for parties generating these materials and the importance of remaining vigilant of their potential abuse.

Fortunately, the relevant bodies are well aware of this issue. Among numerous other challenges, the growth of AI and image generation tools and their misuse by paper mills was a topic addressed by COPE, a non-profit organization dedicated to ethical practices in scholarly publishing, along with the International Association of Scientific, Technical, and Medical Publishers (STM), at the UNITED2ACT Summit in May 2023 (Liverpool, 2023).

5 | CONCLUSION

Predatory journals, characterized by deceptive practices and a lack of rigorous peer review, pose a significant threat to scientific

research. They exploit the open-access publishing model and prey on researchers who are eager to publish their work. The motivations behind predatory publishing often revolve around financial gain rather than the advancement of scientific knowledge. Predatory journals have a negative impact on scientific research, leading to the dissemination of low-quality or misleading information, damaging the reputation of authors, and compromising the integrity of the academic community.

As a researcher, being able to identify legitimate journals is a crucial skill. Legitimate journals adhere to high-quality standards, undergo rigorous peer review, and provide transparent publishing practices. Reputable organizations and societies, journal rankings, the expertise of the editorial board and reviewers, and accreditation and indexing play a significant role in identifying legitimate journals. Veterinary researchers should be educated to consider only legitimate journals, and academic institutions and governments should shift the evaluation system of scientists to one that focuses on qualitative evaluation rather than quantitative evaluation (i.e., emphasizing the importance of the quality of the academic output rather than output quantity).

Moving forward, the veterinary pharmacology community must intensify efforts to raise awareness about the risks associated with PJs. Collaborative initiatives among researchers, students, institutions, and publishers can play a crucial role in raising the standards of the field and implementing more rigorous procedures during the paper submission process, as what we are doing with this review. In both human and veterinary medicine, the accurate transmission of information is especially crucial. Misleading treatment protocols embraced by veterinarians, or inaccurate information disseminated online and adopted by pet owners or farmers, can significantly jeopardize the lives and well-being of domestic and farm animals. Furthermore, misleading information can also pose dangerous risks to consumers and public health in general, particularly if tissue residue studies and withdrawal periods for milk and animal products are false. Only through collective efforts to disseminate accurate information and uphold ethical standards can we protect animal welfare and public health.

Finally, it is imperative to recognize the need for more research into publishing in PJs specifically in veterinary medicine, particularly in veterinary pharmacology. Within this, research initiatives that focus on identifying and quantifying predatory journals, as well as understanding the underlying pressures faced by veterinary researchers that lead to the decision to publish in PJs, would provide valuable data and outcomes. Such efforts should also explore the resulting consequences on veterinary medical practice. Through conducting thorough investigations and surveys, we can develop effective strategies to mitigate the risks associated with publishing in PJs and uphold the integrity of research in the veterinary field.

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Charbel Fadel: design conception, draft writing, draft revision. Aneliya Milanova, Jelena Suran, Andrejs Sitovs, Tae Won Kim, Abubakar Bello, Solomon Mequanante Abay, Stefanie Horst, Rositsa

Mileva, Michela Amadori, Ena Oster, Giovanni Re, Arifah Abdul Kadir, Graziana Gambino, Cristina Vercelli: coordinator, design conception, draft writing, draft revision.

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The authors declare that there are no conflicts of interest in publishing this work.

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The data sets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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None.

ORCID

Charbel Fadel  <https://orcid.org/0000-0001-9996-5942>

Aneliya Milanova  <https://orcid.org/0000-0002-6876-9436>

Andrejs Sitovs  <https://orcid.org/0000-0002-9529-8799>

Tae Won Kim  <https://orcid.org/0000-0002-5239-3833>

Abubakar Bello  <https://orcid.org/0000-0002-4224-2724>

Rositsa Mileva  <https://orcid.org/0000-0001-5173-343X>

Ena Oster  <https://orcid.org/0000-0001-5746-8497>

Arifah Abdul Kadir  <https://orcid.org/0000-0002-6132-2877>

Cristina Vercelli  <https://orcid.org/0000-0001-7766-4647>

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