



Beyond the paywall: the role of preprints in overcoming publication bias

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Preprints have become a transformative tool in scientific communication, addressing critical challenges of traditional publishing, including long peer-review timelines, high costs, and systemic publication bias. Publication bias, which disproportionately favors studies with positive or statistically significant results, undermines the comprehensiveness and accuracy of the scientific record. By offering an open platform for sharing all research findings, preprints ensure that studies with null or negative results are also represented, mitigating the selective publication that skews research fields and meta-analyses. The COVID-19 pandemic highlighted the importance of preprints, as they facilitated the rapid dissemination of urgent findings while maintaining accessibility. Unlike traditional journals, preprints bypass lengthy review processes, enabling immediate access to data and fostering timely feedback, collaboration, and application. This inclusivity and transparency enhance trust in the research process while democratizing access to scientific knowledge. Despite their advantages, preprints face challenges, such as inconsistent quality standards, discrepancies between preprints and final publications, and risks associated with unverified findings. These challenges can complicate their use in systematic reviews and evidence-based medicine, requiring careful consideration and handling. This paper explores the interplay between preprints and publication bias, detailing how preprints can reduce bias while identifying limitations that must be addressed.

Keywords: Evidence-based medicine; Open access publishing; Peer review; Preprints; Publication bias

Introduction

The advancement of science relies on the transparent dissemination of knowledge through rigorous research and peer review. Academic journals have long served as gatekeepers, ensuring the credibility of published findings. However, the current scholarly publishing model faces notable challenges, including prolonged peer-review processes, financial barriers, and systemic biases that influence what research gets published.

Among these issues, publication bias is particularly problematic. It refers to the selective publication of studies based on the nature of their results, where positive or statistically significant findings are more likely to be published, while

null or negative results remain unpublished. This bias distorts the scientific literature, undermining the reliability of meta-analyses and evidence-based decision-making [1].

Preprints—publicly available research manuscripts posted on online platforms before formal peer review—offer a promising solution to some of these challenges. By enabling immediate access to research, preprints facilitate intellectual exchange, establish priority of discovery, and democratize access to scientific findings [2]. However, they also present challenges related to quality assurance, research integrity, and the potential for misinterpretation.

This paper explores the role of preprints in mitigating publication bias, assesses their advantages and limitations, and proposes strategies for integrating them effectively within the

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scientific publishing ecosystem.

Publication Bias

Publication bias is a type of reporting bias, where certain study results are selectively revealed or suppressed [3]. It encompasses multiple forms, including, time-lag bias (delayed publication of non-significant findings), duplicate publication bias (repeated publication of significant results), location bias (selective dissemination in high-impact journals), citation bias (preferential citation of positive results), language bias (non-English studies being underrepresented) and outcome reporting bias (selective reporting of significant endpoints). Among these, publication bias—the preferential publication of studies with statistically significant results—has the most profound impact on the scientific record [1]. This phenomenon arises from selective publication based on the nature and direction of study findings. It systematically skews the truth in meta-analyses, as positive or novel results are disproportionately represented, while studies with null or negative outcomes are underreported.

Several factors contribute to publication bias [1,4]. Academic journals often prioritize studies that are groundbreaking, transformative, or media-friendly, as these are likely to attract readership and enhance journal impact factors. Researchers, anticipating these preferences, may self-censor by submitting only studies with significant results, while withholding null or negative findings. Additionally, the peer review process itself may undervalue or reject studies without statistically significant outcomes. In some cases, researchers resort to "p-hacking," manipulating methods or analyses to produce significant results, further distorting the evidence base [5].

The implications of publication bias are far-reaching. Overrepresentation of positive findings misguides subsequent research and policy decisions, undermines reproducibility by excluding null results, and leads to inefficient resource allocation [4,6]. Addressing publication bias requires systemic changes to ensure all research findings are accessible. Platforms such as indexed mega-journals (*Scientific Reports*, *PLoS ONE*) and preprint servers provide avenues to share underrepresented studies, fostering a more transparent and inclusive scientific ecosystem.

Preprints: An Accessible and Efficient Mode of Sharing Research

Preprints are publicly available research manuscripts shared on online platforms before undergoing formal peer review

[2]. They allow researchers to disseminate findings quickly, establish intellectual precedence, and engage with a global audience. Popular platforms like arXiv, bioRxiv, and medRxiv cater to various disciplines, promoting open communication and early feedback.

Preprints address many challenges of traditional publishing [2,7]. They bypass lengthy review processes, enabling researchers to share findings immediately, whereas traditional journals often take 9–18 months to publish [8]. Even with expedited processes for COVID-19-related studies recently, peer review still requires time for thorough evaluation by qualified reviewers. By sharing preprints publicly, researchers can establish intellectual priority for their findings, demonstrating ownership and preventing duplication of effort. This is particularly valuable in competitive fields, where securing recognition for ideas and results is critical. This immediacy accelerates scientific progress by facilitating timely discussions and applications of new knowledge. Preprints also democratize access to scientific information, providing free and unrestricted availability to researchers, practitioners, and the public. Additionally, these platforms encourage community feedback, allowing authors to receive constructive criticism and suggestions from peers. This feedback enhances the quality and impact of the research before formal publication.

Moreover, studies have shown that articles shared as preprints gain increased visibility and citations. For instance, research indicates that papers on platforms like bioRxiv and arXiv consistently receive more citations and higher altmetric scores, reflecting their broader reach and engagement. Research by Fu and Hughey showed that papers with a bioRxiv preprint had 1.36 times more citations and 1.49 times higher Altmetric Attention Scores compared to those without preprints [9]. Similarly, studies on arXiv have demonstrated that papers posted on the platform consistently achieve greater citation advantages across databases like Web of Science, Scopus, and Google Scholar [10].

By promoting inclusivity, preprints support a more equitable publishing landscape [11]. Unlike traditional journals that may exhibit selective biases, preprints welcome all findings, irrespective of perceived significance without gatekeeping, contributing to a transparent and collaborative research environment.

Challenges of Preprints

Despite their advantages, preprints come with challenges. A significant number of preprints may never progress to formal publication, or substantial delays may occur between pre-

print posting and journal publication. Gilanos et al. reported that only 8.6% of COVID-19-related preprints were published in indexed journals by mid-2020 [12]. Similarly, Baumann and Wohlrabe found that approximately 25% of economics working papers on major preprint servers remain unpublished [13]. Bai et al. demonstrated a significant average time lag of 65.4 days (ranging from 0 to 271 days) between preprint posting and journal publication for COVID-19-related randomized controlled trial (RCT) preprints in 2021 [14].

Differences between preprints and their peer-reviewed versions, including changes in sample size, endpoints, or interpretations, can create inconsistencies. Although many studies show a high degree of agreement between preprints and final publications, discrepancies in quality and reporting standards raise concerns about preprint reliability.

Davidson's meta-epidemiological study found no significant differences in treatment effect estimates between preprints and peer-reviewed studies [15]. Janda et al. observed that medRxiv preprints aligned closely with journal articles in sample sizes (86.4%), primary endpoints (97.6%), and interpretations (96.2%) [16]. However, these findings also highlight that a small percentage of discrepancies still exist, such as differences in sample size (14.6%) or interpretation (3.8%).

Quality assurance is another issue. Without peer review, preprints may lack the rigor typically associated with published articles. For instance, preprints are often less likely to disclose conflicts of interest, funding sources, or methodological details [17]. Preprints with smaller sample sizes or higher bias were less likely to be published [14]. Further, only 57.9%, 49.5%, and 98.9% of COVID-19-related academic articles were registered at Clinicaltrials.gov, Chinese Clinical Trial Registry, and EU Clinical Trials Register, which also may decrease the quality of evidence [12].

However, some researchers argue that preprints can still represent high-quality work due to the "Self-Selection Bias Postulate" or "Quality Postulate" [18,19]. This concept suggests that authors may choose to post their best-quality research as preprints, which tend to receive more citations and online engagement. Additionally, prominent researchers with expertise in their fields may be more likely to share preprints, potentially enhancing their overall quality. Although some argue that the self-selection of high-quality work for preprints offsets these concerns for quality, ensuring their credibility remains essential.

Intellectual property concerns can also deter researchers from sharing their work as preprints. Fear of plagiarism or jeopardizing future formal publication opportunities often discourages early sharing of research findings.

Lastly, preprints carry a risk of misuse. Since they are not

peer-reviewed, unverified findings might be misinterpreted or misapplied, especially in critical areas such as policy-making or public health. Without appropriate caution, this could lead to flawed decisions based on incomplete or preliminary data.

Addressing these challenges is essential to maximize the benefits of preprints while minimizing their risks. By ensuring transparency, fostering rigorous evaluation, and promoting responsible use, preprints can continue to play a valuable role in the scientific ecosystem.

Interaction Between Preprints and Publication Bias

Preprints play a crucial role in addressing publication bias by providing an open and inclusive platform where research findings can be shared regardless of their perceived importance or outcomes. This inclusivity ensures that scientific contributions, whether positive, negative, or neutral, are represented fairly, promoting a more balanced understanding of research and mitigating the effects of selective publication. By incorporating unpublished data such as conference abstracts or personal communications, preprints contribute to a more comprehensive and accurate evidence base [20].

The COVID-19 pandemic exemplified the value of preprints in urgent scenarios [21]. As the demand for rapid data sharing increased, preprint platforms gained prominence, enabling quick dissemination of COVID-19-related research while maintaining accessibility. This demonstrated how preprints could complement traditional journals in addressing time-sensitive challenges. In contrast to traditional journals, preprints eliminate the lengthy peer-review process, allowing researchers to share their findings almost immediately [2]. This accessibility also benefits researchers conducting systematic reviews or meta-analyses, enabling them to include preprint articles that have not yet undergone formal publication, thereby enriching their data sources.

Transparency is another key advantage of preprints. By making research publicly available at an early stage, preprints allow the scientific community to observe the development of studies. This openness builds trust, enhances accountability, and encourages collaboration to improve research quality, therefore reducing publication bias.

However, relying on preprints for evidence-based medicine comes with challenges. Systematic review and meta-analysis that include unpublished data may have different results than those that do not. For instance, excluding unpublished data, such as preprints, can sometimes lead to overestimation of results in systematic reviews, though this issue is rela-

tively rare [22]. A study analyzing 1,910 meta-analyses across various disciplines, encompassing 33,355 data points, compared effect sizes from peer-reviewed journal studies with those from other formats, including preprints, conference papers, and unpublished drafts. The findings showed that gray literature, including preprints, generally reported smaller effect sizes than peer-reviewed journals [23]. This suggests that preprints and similar formats may be less influenced by publication bias or the pressure to engage in practices like p-hacking. In such cases, a deeper analysis of the causes and reasons is required.

Preprint repositories often lack the standardized search strategies used in major databases, making data retrieval less consistent and harder to reproduce. Additionally, preprints may present evolving results that require frequent updates to meta-analyses, and discrepancies between preprints and their final published versions—such as changes in authorship, endpoints, or additional analyses—can create further inconsistencies. Preprints also lack the rigorous quality assurance provided by peer review, which raises concerns about their reliability and scientific rigor.

To maximize the potential of preprints while addressing these challenges, thoughtful integration into research practices is essential.

Strategies to Address Challenges Related to Preprints and Publication Bias

To maximize the potential of preprints while addressing their challenges, specific strategies are essential. Preprint platforms should implement basic quality checks to ensure methodological soundness. Integrating preprints into formal publishing workflows can align early dissemination with traditional processes, reducing conflicts.

Transparency can be further improved by requiring authors to share raw data, code, and detailed methodologies. Educating researchers, editors, and reviewers about publication bias will promote equitable evaluation of research outcomes. Recognizing and citing preprints formally within academic contexts will encourage their broader acceptance, fostering a culture of openness and inclusivity.

Conclusion

Preprints are transforming scientific communication by addressing key challenges such as publication bias and delays in knowledge dissemination. By offering a platform for rapid, inclusive, and transparent sharing, preprints complement traditional publishing systems and enrich the scientific

record. However, their successful integration requires thoughtful strategies to ensure credibility, minimize misuse, and uphold rigorous standards. Through collaboration and innovation, preprints can enhance the accessibility, reproducibility, and fairness of research, contributing to sustained progress and the creation of a robust knowledge base.

Conflict of Interest

Hyun Kang has been an editor-in-chief of the Journal of Evidence-based Practice since 2025. However, he was not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflicts of interest relevant to this article were reported.

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Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

Ethics Approval and Consent to Participate

Not applicable.

Author Contributions

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