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Point-Counterpoint

Counterpoint: Preprints and the Future of Scientific Publishing—In Favor of Relevance

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Peer-reviewed journals provide an invaluable but inadequate vehicle for scientific communication. Preprints are now an essential complement to peer-reviewed publications. Eschewing preprints will slow scientific progress and reduce the public health impact of epidemiologic research. The coronavirus disease 2019 (COVID-19) pandemic highlighted long-standing limitations of the peer-review process. Preprint servers, such as bioRxiv and medRxiv, served as crucial venues to rapidly disseminate research and provide detailed backup to sound-bite science that is often communicated through the popular press or social media. The major criticisms of preprints arise from an unjustified optimism about peer review. Peer review provides highly imperfect sorting and curation of research and only modest improvements in research conduct or presentation for most individual papers. The advantages of peer review come at the expense of months to years of delay in sharing research methods or results. For time-sensitive evidence, these delays can lead to important missteps and ill-advised policies. Even with research that is not intrinsically urgent, preprints expedite debate, expand engagement, and accelerate progress. The risk that poor-quality papers will have undue influence because they are posted on a preprint server is low. If epidemiology aims to deliver evidence relevant for public health, we need to embrace strategic uses of preprint servers.

peer review; preprints; public health; scientific communication

Abbreviation: COVID-19, coronavirus disease 2019.

Editor's note: *A counterpoint to this article appears on page 1040.*

The traditional scientific publishing model is antiquated and inadequate. This reality has been long recognized in many fields and more recently in epidemiology. The coronavirus disease 2019 (COVID-19) pandemic galvanized epidemiology and made those inadequacies more salient. Preprint servers are now a crucial complement to traditional peer-reviewed journals, allowing rapid dissemination of information and a broader range of critiques—from both the scientific community and the public. BioRxiv, medRxiv, and their counterparts have effectively become platforms to provide detailed backup for sound-bite science delivered in the popular press or on social media. The major critiques of preprints are based on an inaccurate idealization of the peer-review process; an academic faith in credentialism and distrust of open, unregulated debate used to rationalize gatekeeping; and a logical leap assuming that restricting output will improve the quality of final publications. We first discuss why preprints are important, especially for public-health-oriented disciplines such as epidemiology, and then tackle the critiques.

THE CONTRIBUTION OF PREPRINTS

Preprint servers emerged in the early 1990s to facilitate communication among researchers. Early adoption began in mathematics and physics but rapidly spread across disciplines, with the Social Science Research Network (SSRN) launched as early as 1994. Timeliness is the key advantage of preprints. A recent systematic review of studies quantifying the time from submission to publication in the biomedical peer-reviewed literature found that the median time to release ranged from 70 to 558 days (1). Such delays are compounded by low acceptance rates, so papers often go

through multiple rejection and resubmission cycles before publication.

Delays are intrinsic to the editorially managed peer-review system. The peer-review system is intended to curate, sort, and rank. Such activities take time, and in the interest of maintaining quality, the system appoints a small cadre of editors to oversee the process. Editor-reviewer-editor handoffs inevitably create bottlenecks. Journals may add "fast-track" options or other initiatives to improve the speed and quality of reviews (2, 3), but the delay is built into the top-down review process, in which the editor seeks to match each paper with the most appropriate experts to evaluate its content and gauge its potential impact. Despite efforts to expedite the peer-review process, careful critical review takes time. The top-down process of inviting reviewers means that the person who agrees to review cannot necessarily drop all other obligations to complete the review. Shortening the peer-review process can threaten the quality of reviews and puts additional pressure on reviewers who volunteer their time.

As a result of the delay in the peer-review process, publications do not represent the forefront of current thinking, but instead often lag developments in a field by months or years. The peer-reviewed literature is thus inadequate to deliver time-sensitive scientific results needed to guide decision-making. During the pandemic, the need for timely epidemiologic evidence was obvious. Our team of COVID-19 researchers adopted a default policy of posting preprints after we realized that the routine journal review and embargo process would delay research by a minimum of months. This allowed us to report more timely findings on occupational inequalities in pandemic-era excess mortality (4), temporal shifts in racial-ethnic disparities in COVID-19 mortality (5), and pervasive educational inequalities in overall pandemic-period excess mortality. Many teams sought to circumvent publication-related delays by rapidly disseminating via preprints (6). For example, the Imperial College's initial COVID-19 modeling (7) and the RECOVERY trial's report on the effectiveness of dexamethasone treatment (8) were first disseminated via preprint. The Centers for Disease Control and Prevention called for academic groups and industry partners to contribute forecasts to derive a more accurate ensemble model for COVID-19 mortality (9, 10). Major peer-reviewed journals, even those focused on population health, could not meet the needs of the moment for rapid scientific dissemination. For example, the journal *Demography* published its first article evaluating consequences of the COVID-19 pandemic in February 2022 (available online November 2021) (11). To the journal's credit—and unlike many journals with similarly long peer-review processes—*Demography* considers publication of manuscripts previously posted on preprint servers (12, 13).

Even in normal, nonpandemic times, delaying scientific discussion is harmful. Scientific progress requires that researchers respond to the findings of others, seeking to falsify, replicate, or extend previous discoveries. If every exchange is delayed by a year or more, the detrimental impact compounds. Some evidence suggests that progress made by large scientific fields has slowed down since 1960—a possibility that should prompt novel policies on "how scientific work is produced, disseminated, consumed, and rewarded" (14).

Preprints circumvent this delay and accelerate debate, since manuscripts are typically posted within days of submission. The preprint server system also facilitates open collaboration and improves the chances that important, novel ideas will get past gatekeeping editors and reviewers. The peer-review system is fundamentally conservative, staffed by editors and reviewers who were trained and became successful by using existing or past theories, methods, and presentation approaches. Existing editors may favor their own or similar work and perpetuate gender and racial-ethnic disparities in scientific research publishing or funding (15, 16). True innovation may be better served by posting publicly prior to navigating the gauntlet of existing editors and reviewers.

SCIENTIFIC COMMUNICATION IS BEST SERVED WITH MULTIPLE PLATFORMS

Preprint servers can complement other venues for scientific communication, including peer-reviewed journals. Preprint servers offer the opportunity for public review before submission for peer review (17–21), and they are rarely paywalled. This availability potentially improves scientific quality or presentation. Preprint servers allow researchers to post detailed documentation of their data sources, methods, and results for the community to build upon, seek to replicate, and critique. Preprints thus augment other channels increasingly used for rapid communication, such as blog posts, podcasts, or short videos. Researchers are now under substantial pressure to participate in the popular media. Twitter and other social media platforms were important venues to disseminate findings during the pandemic. The quality of these discussions was vastly improved because researchers could link sound-bite social media posts to detailed, high-quality preprints. Preprints and other forms of scientific communication need not threaten the peer-review model: Preprints can drive interest in the latest scientific findings, with social media posts further raising both popular and scientific attention (22, 23). Meta-research based on over 70,000 papers revealed that articles with a preprint averaged a 49% higher Altmetric Attention Score and 36% more citations than those without a preprint.

THE VALUE OF PEER REVIEW FOR THE QUALITY OF INDIVIDUAL MANUSCRIPTS IS OVERSTATED

Peer review does not necessarily substantially improve the quality of published manuscripts. A recent review reported that the conclusions of only 7% of non-COVID-19–related and 17% of COVID-19–related abstracts changed between the release of a preprint and the corresponding publication, and most changes did not qualitatively alter the conclusions of the paper. Thus, peer review is at best serving largely a gatekeeping role, preventing or delaying publication of some manuscripts. Peer review also serves to sort—coarsely and at the expense of long publication delays—weaker or less important papers into lower-prestige journals. But peer review certainly does not guarantee high-quality papers, as illustrated by frequent retractions (24) and other challenges (25, 26).

Many of the benefits of peer review are accumulated over decades as scientists learn from one another, and the weakest science is downgraded or publication is slowed substantially. Peer review likely has large indirect value as researchers anticipate and try to pre-empt the critiques of colleagues, improving their research prior to submission. This suggests that peer-reviewed journals are valuable over the long-term as a component of the ecosystem of scientific communication. If individual papers report important scientific findings, however, the time between completion of the manuscript and publication in a peer-reviewed journal is usually time needlessly lost.

THE CRITIQUES OF PREPRINT SERVERS

Do preprint servers allow some very weak or even utterly terrible papers to be posted? Certainly. Are the pernicious consequences of weak research likely to be substantially elevated because they are posted on a preprint server? We think not. Consider what happens when a truly egregious paper is posted on a preprint server. That paper will most likely be ignored. However, if the paper is taken up and championed, serious scientists in the field have all the information needed to critique and dismiss it. Further, shared knowledge about the context in which mistakes were made allows other scientists to rectify the assumptions, test alternative methods, or update misleading results. This voluntary act should be credited as a service to the scientific community: It is similar to the journal reviews to which nearly all serious scholars contribute. Reviewing preprints has even been championed as a valuable professional development activity for students (27). Prominent cases of fruitful scientific debate about preprints occurred during the COVID-19 pandemic, debate that elicited revisions (28).

Altman's reasonable call for "less research, better research" (29, p.283) sometimes morphs into a belief that reducing research output would naturally improve the quality of published papers. This logic does not follow. To improve the quality of research output, we need to invest in the raw materials for good science: training of excellent researchers, protected time and support to lead innovative research, and thriving scientific communities to give feedback, argue, critique, and challenge. Gatekeeping via the peer-review process assures none of those goals and may instead stifle scientific conversation by preventing the most critical voices from ever having a hearing.

The critiques of preprints often seem tinged with a worry that the public cannot be trusted to interpret papers not properly vetted by peer scientists. We believe most people who dip into medRxiv can grasp the concept of peer review and understand the difference in credibility between preprints and published manuscripts. In the event that a misguided preprint becomes influential, scientists can respond just as they do when a misguided peer-reviewed manuscript becomes influential. Many journals have had long-standing norms against discussing research with the media prior to publication. However, journalists play a key role in research dissemination. Cooperation between journalists and researchers is needed to ensure adequate scientific communication: The burden of clearly contextualizing preprint findings falls upon both researchers and journalists.

The growing role of preprints and other alternative mechanisms for scientific communication merits meta-research to better understand how scientific information and misinformation moves from scientists to the public and interacts with public action and public policy. With the rapid pace of social media, preprints are not obscure documents limited in readership to a small part of the scientific community (30). Further work must be done to better characterize these information and attention flows, learn how errors are corrected, and ultimately improve scientific communication.

CONCLUSION

Scientific journals were created to enable conversations among scientists, providing opportunities to share and debate about research methods and results. The essence of the model dates back centuries, and it is no surprise that new approaches are needed (31). Many of the critiques of the use of preprints are based on idealizing the peer-review process. The contemporary scientific publishing model was already shaky before the pandemic due to controversies about the quality of peer review, ghost authorships, and the scandalous pricing schemes of for-profit presses. The pandemic conclusively demonstrated the need for new approaches. Preprint servers are an important complement to peer-reviewed journals. Journals that refuse to publish work previously posted on preprint servers are slowing scientific progress, committing themselves to irrelevance, and antithetical to the movement towards more openness, transparency, and diversity in science (32, 33).

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