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The Role of Preprints in Neuroscience Scholarly Communication: A Citation Analysis

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ABSTRACT

Preprints, scientific manuscripts publicly shared prior to peer-review, are now part of scholarly communication as emerging information resources. While neuroscience researchers have increasingly published preprints, the impact of preprints in this field remains unclear. Through a bibliometric approach, this case study explored preprint citation patterns. Results yielded over 33,000 citations to preprints within Scopus-indexed neuroscience documents (1993-2022). Trends of citations and citation motivations were investigated. Findings indicated that 1.62% of neuroscience publications cited at least one preprint, with citations peaking at 6% in 2021. Review and journal articles cited preprints more frequently, compared to books, notes, and conference papers ($X^2 = 1909.015$, $p < 0.001$). The most commonly cited servers were bioRxiv, arXiv, medRxiv, and PsyArXiv. Regarding journals, a moderate positive correlation ($r_s = 0.353$, $p < 0.01$) was found between publications citing preprints and journals' CiteScores. Using Scite.ai, 93% of citations were classified as 'mentioning,' with considerably fewer being supporting or contrasting. Most preprint citations appeared in Introduction and Discussion, highlighting their role in framing research questions and contextualizing results. The global overview of these results may help contextualize citation behavior in relation to structural and cultural factors, such as disciplinary norms, policy frameworks, researchers' attitudes, and health emergencies.

Keywords: Open Science, Open Access, Scientometrics, Bibliometrics, Science Studies, Research Output.

Peer Review: https://www.webofscience.com/api/gateway/wos/peer-review/10.1162/QSS.a.490

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1. INTRODUCTION

Preprints, defined as complete scientific manuscripts publicly uploaded to servers before formal peer-review (Alfonso & Crea, 2023), have become an increasingly prominent component of the (open) scholarly communication ecosystem (Joshi, 2024; Maggio & Fleerackers, 2023; Scotti, 2025), as a timely and free of charge method for disseminating scientific findings (Sever et al., 2019). They have been part of scholarly publishing since the 1960s (Smart, 2022) with physical mail as the primary distribution method until the 1990s. In 1991, physicist Paul Ginsparg at Los Alamos National Laboratory launched an automated email server for high-energy physics preprints (Berg et al., 2016), which evolved into arXiv as the first official preprint server. ArXiv inspired the creation of other preprint servers, such as the Social Science Research Network in 1994 (Xie et al., 2021) and Research Papers in Economics (RePEc) in 1997 and since 2010, numerous new preprint servers have emerged, many supported by the Centre for Open Science (COS) and the Open Science Foundation (OSF)[1]. The Covid-19 pandemic was one of the key factors accelerating the growth of both preprtins and preprint servers, when the urgent need for rapid information sharing became more important (Biesenbender, Toepfer, & Peters, 2024; Fleerackers et al., 2024; Henke, 2024; Smart, 2022; Tian et al., 2024; Wang et al., 2025).

Preprints offer several benefits, including the immediate sharing of results, the opportunity to receive early feedback from the scientific community, as well as enhanced visibility (Maggio & Fleerackers, 2023; Tian et al., 2024). They also contribute to transparency with the dissemination of non-significant or contradictory findings (da Silva, 2018). With regard to readership and visibility, higher citation counts for peer-reviewed publications previously published as preprints (Fraser et al., 2020; Lemke & Peters, 2023) can influence authors' preprinting behavior (Fraser et al., 2022). However, the rapid dissemination of non-reviewed manuscripts can raise significant concerns. The lack of peer-review is a primary limitation, calling into question the reliability, quality, and credibility of the information shared (Maggio & Fleerackers, 2023; Ni & Waltman, 2023, 2024; Scotti, 2025; Smart, 2022). In this respect, some studies have elaborated on potential concerns and risks associated with the dissemination of non-peer-reviewed health-related works (Bagdasarian et al., 2020; Ng, Chow, et al., 2024; Ng, Santoro, et al., 2024), yet other studies on preprinted peer-reviewed publications have provided counterarguments, reporting only limited changes and overall consistency between the preprint and the peer-reviewed version of the same scholarly work in terms of findings and conclusions (Bai et al., 2023; Brierley et al., 2022).

The debate over preprint reliability and transparency is widespread, but their adoption and impact vary significantly across different scientific fields. While physics and computer science have long-established preprint cultures (Alvarez & Caregnato, 2017), the life and biomedical sciences have only recently started to integrate them into their workflows. Within this latter group, preprints have gained more popularity, with the development of platforms like bioRxiv (Abdill & Blekhman, 2019; Penfold & Polka, 2020) and with a growing number of biomedical journals accepting preprints for submission (Bove Fenderson et al., 2018; Massey et al., 2020). In the neuroscience domain, however, the pattern of the use of preprints remains unclear. Neuroscience as a field has been at the forefront of adopting and implementing new technologies and practices. Similarly, new initiatives such as Preprints of the R-fMRI Network (PRN) are emerging to address the specific publishing needs of the neuroscience community, complementing traditional publishing with rapid dissemination and opportunities for feedback (Yan et al., 2015). While previous studies suggest that neuroscience community has adopted publishing preprints (Pagliaro, 2021), their impact on this field remains underexplored. In particular, there remains a gap in understanding how neuroscience researchers incorporate preprints as information resources in their research outputs.

[1] A list of cited preprint servers in the neuroscience Scopus-indexed documents along with their number of records, launch year, and maintaining organization is provided in the Supplementary Material.

2. LITERATURE REVIEW

There is no consensus on the citability of preprints (Bove Fenderson et al., 2018) as perspectives on citing preprints vary widely across the academic and publishing communities. A restrictive approach argues against citing preprints since lacking peer-review makes their findings potentially unreliable and suggests that "*preprints could promote confusion and distortion*" (Sheldon, 2018). For example, according to *Journal of Mammalogy* author guidelines, preprints cannot be cited in a peer-reviewed article. According to this approach, citing non-peer-reviewed references, including preprints, is not a common practice (Tenopir et al., 2016). Conversely, a more permissive viewpoint posits that preprints are a part of scholarly communication and should be freely citable (Ettinger et al., 2022; Sarabipour et al., 2019). According to this viewpoint, preprints are like dissertations and proceedings abstracts, with less formal peer-review process (Pickler, 2019) and are thus citable. For example, *Portland Press* has declared that "*preprints can be cited in all Portland Press journals*". Likewise, *PLOS Computational Biology* and *eLife* have been noted for supporting citations to preprints (Bertin & Atanassova, 2022). A third, more cautious approach represents a middle ground, allowing citations to preprints but with significant caveats (COPE Council, 2018; JHL Editorial Team, 2021; Worster, 2024). For instance, a joint position statement from the American Medical Writers Association (AMWA), the European Medical Writers Association (EMWA), and the International Society for Medical Publication Professionals (ISMPP) recommends that preprints be cited as a personal communication, appearing as in-text references (using the preprint link, DOI, or both) rather than in the bibliography, and the authors have to clearly disclose that the cited reference is a preprint (Dyer, 2024).

That said, preprints are now regularly cited in peer-reviewed journal articles, books, and conference papers (Pagliaro, 2021); however, the practice of citing pre-publication work is not new as preprints were cited as early as 1922 (Larivière et al., 2014). In one of the oldest studies on citing preprints, Youngen (1998) addressed the growing importance of electronic preprints in the published literature and their future role in scholarly communication. The research indicated that electronic preprints were becoming an increasingly important tool for disseminating primary research, particularly in physics and astronomy, where a long-standing culture of sharing preprints already existed. Youngen's analysis of data from 1988 to 1996 showed that while citations to traditional paper preprints declined, citations to electronic preprints, or "e-prints," nearly doubled every year since their introduction in 1992. Similarly, Brown (2001) analyzed the citations to preprints in physics and astronomy journals and found the number of citations and citations rates to be large and increasing. Another research confirmed that the number of high-energy physics researchers citing preprints grew by a factor of approximately 1.25 annually (Prakasan & Kalyane, 2004). Nevertheless, beyond the rising number of preprints and citations to them, preprint supporters note that "*the focus has shifted to how preprints should be cited rather than whether preprints should be cited*" (Blatch-Jones et al., 2023).

Further investigations into the use of preprints show that the majority of studies analyzing citations to preprtins are published after 2010. For instance, Larivière et al. (2014) found that in physics, mathematics, and astronomy and astrophysics, arXiv preprints are cited more quickly but their citations decay faster than those of their published journal articles. This study also highlighted that the arXiv versions of papers, whether published or not, tend to have lower overall citation rates than their final, published counterparts. Another study showed an increase in the number of citations to four subject repositories of arXiv, RePEc, Social Science Research Network, and PubMed Central (Li et al., 2015). This was further confirmed by another study reporting that arXiv preprints in physics and astronomy, mathematics, computer science, and engineering were the most frequently cited (Noruzi, 2016). Furthermore, a survey among members of the Association for Computational Linguistics revealed that 54% of respondents cited preprints at least occassionally (Foster et al., 2017). Another survey revealed that among 174 respondents, 66 cited preprints very often, often, or sometimes, while 100 respondents cited them rarely or never (Kelly, 2018). In another survey, Ni and Waltman (2024) found that respondents had concerns about the citability of preprints. Conversely, a survey among 218 Slovenian scientists showed that 119 respondants had already cited an arXiv article, while only 21 indicated that they had not (Metelko & Maver, 2023).

Recent analyses revealed that the frequency of citing preprints has increased over the past decade, with the Covid-19 pandemic reinforcing their adoption in medicine and life sciences (Biesenbender, Toepfer, & Peters, 2024). Analyzing over 8,460 preprint citation contexts within seven different *PLOS* journals, Bertin and Atanassova (2022) demonstrated that the number of citations to preprints has been increasing rapidly since 2011, a trend consistent with the creation and development of new preprint servers (e.g., bioRxiv). In addition, Pagliaro (2021) investigated citation patterns of preprints across three major preprint servers: bioRxiv, ChemRxiv, and Research Square and showed that preprints from bioRxiv and ChemRxiv, accounting for more than 93% of total citations, were predominantly cited in original research and review articles. Furthermore, preprints on bioRxiv were cited in conference papers at a rate three times higher than those on ChemRxiv. Also, until late 2018, neuroscience was the leading subject for preprints posted on bioRxiv. In terms of where preprints are cited within scholarly articles, an analysis of PLOS journals found that preprint citations appeared mostly in the Methods section, with explicit terminology identifying them as preprints (Bertin & Atanassova, 2022). In another study on medical journals, a significant portion of preprint citations appeared in the Introduction and Background sections, often to reference rapidly evolving research or provide timely context (Gehanno et al., 2022).

Preprints are cited not only in research outputs but also in patents and policy documents. Wang et al. (2025) explored the influence of preprints on technological innovation and showed a growing trend of bioRxiv preprint citations in patents (2013-2021), peaking in 2020 driven by the Covid-19 pandemic. Although Biotechnology and pharmaceutical companies cited preprints more frequently given their need for early access to the latest research, academic institutions favored peer-reviewed articles and in case of citing preprints, they would opt for preprints with a corresponding published version. The study concluded that preprints enhance early visibility and knowledge transfer, whereas journals remain key for rigor. Similarly, Xu and Zong (2024) found that Covid-19 preprints published with open peer-review were significantly more likely to be cited in policy documents.

However, the decision to cite scholarly works is influenced by multiple factors beyond publication type. Current evidence indicates that structural and cultural factors, including geographic location, scientific discipline, and career stage can shape researchers' motivations and practices in citing preprints (Biesenbender, Smirnova, et al., 2024; Janda et al., 2022; Sommer et al., 2023; van Schalkwyk, 2024). Recent studies suggest that even author prestige (Miura & Sakata, 2025) and affiliations (Nishioka et al., 2022) can predict citation patterns, with preprints including disproportionate citations to papers from authors highly recognized in traditional journals or affiliated with reputable institutions. Several theories have been proposed to explain citation behavior: normative theory (citations as acknowledgments of intellectual influence) (Small, 2004), constructivist theory (citations as rhetorical tools for persuasion) (Bao & Teplitskiy, 2024), and Social Systems Citation Theory (SSCT – integrating both perspectives). SSCT conceptualizes citations as communicative acts within scientific communities and distinguishes between an author's motives and the social system of publications (Tahamtan & Bornmann, 2022). Recent research emphasizes the role of social conformity in citation practices. It identifies multiple levels of conformity (normative, informational, identification) and their influence on citation choices. Additionally, coauthorship and citation networks further reinforce social group cohesion and conformity in citation behavior. Therefore, social conformity and network effects are integral to understanding why and how preprints are cited, complementing cognitive and rhetorical explanations (Tan et al., 2025).

In view of the arguments above, the rapid growth of the field of neuroscience, which has demonstrated the potential to respond quickly to global health-related events, such as Covid-19 (Senden, 2025, 2026) may encourage increasing engagement with preprints and their use of as sources of recent findings. Given the complex structural and cultural dimensions underlying citation behavior, a global overview of how preprints are engaged with and cited in the neuroscience literature can provide an empirical basis for contextualizing the role of preprints in this field and possibly others. Therefore, this bibliometric case study of Scopus-indexed neuroscience publications aims to provide evidence-based insights into how rapidly disseminated, non-peer-reviewed work is integrated into formal scholarly communication over time. By quantifying citation patterns, this study addresses these two research questions:

RQ1) to what extent are neuroscience researchers citing preprints? And
RQ2) what are their motivations for citing preprints (supporting, contrasting, or mentioning)?

3. MATERIALS AND METHODS

Data were collected from Scopus using two specific queries and analyzed through bibliometric methods. Scopus was chosen for its wide coverage of over 28,000 scholarly sources and the possibility of searching within cited references. The first query retrieved Scopus-indexed neuroscience documents (2004-2022) (Query 1). The second query retrieved neuroscience documents citing at least one preprint, including 35 OSF-listed servers (as of September 20, 2023) and medRxiv (as "*the preprint server for health sciences*", hosting preprints related to neuroscience as the study of the nervous system function, drawing on different fields, such as pharmacology, psychology, and genetics (Burk, 2008) included in medRxiv Subject Areas). This query included the titles of preprint servers listed on the OSF portal, and medRxiv. The term "preprint" was added to specific (i.e. PeerJ, CoP, Law Archive, and FocUS Archive) to avoid potential confusion with journal titles (Query 2).

Query 1
The Scopus query for retrieving neuroscience publications

SUBJAREA (neur) AND PUBYEAR<2023

Query 2
The Scopus query for retrieving neuroscience publications with citation(s) to preprint(s)

*REFSRCTITLE ('OSF Preprints' OR 'open science foundation Preprints' OR *africarxiv* OR *agrixiv* OR *arabixiv* OR *arxiv* OR *biohackrxiv* OR *biorxiv* OR *bodoarxiv* OR *cogprints* OR *eartharxiv* OR *ecoevorxiv* OR *ecsarxiv* OR *edarxiv* OR *engrxiv* OR *frenxiv* OR 'INA-Rxiv' OR *indiarxiv* OR *lawarxiv* OR 'LIS Scholarship Archive' OR *marxiv* OR *mediarxiv* OR *metaarxiv* OR mindrxiv OR *nutrixiv* OR paleorxiv OR 'Preprints.org' OR psyarxiv OR *repec* OR *socarxiv* OR *sportrxiv* OR 'Thesis Commons' OR 'CoP preprint' OR 'FocUS Archive preprint' OR 'PeerJ preprint' OR 'Law Archive preprint' OR *medrxiv*)*

The search yielded 1,299,390 records (2004-2022) with the first query (all document types as specified in Scopus) and 19,941 records (article, book/book chapter, conference paper, review, note) with the second (2004-2022). The dataset, downloaded as a CSV file, included titles, DOIs, sources, and EIDs. References from each publication were split using Python, placing each reference and its citing document's EID on separate lines in a text file for analysis. From the text file, 33,754 references containing preprint server titles were extracted using Python codes. In documents with multiple preprint references, each preprint reference was counted individually. To ensure relevance, 100 randomly selected references were manually verified to confirm that all the 100 references were published on a preprint server. All data were screened for completeness and consistency prior to analysis. Collected demographic characteristics included the proportion of documents citing preprints per 100 Scopus documents, the distribution of document types citing preprints, cited preprint servers, journals citing preprints, and the geographic origins of documents citing preprints.

To calculate journal-based proportion of documents citing preprints, neuroscience journals were derived from 1,598,108 neuroscience records (1993 – 2022), filtered by "Source title" and exported to Excel. From 1,008 initial journal titles, duplicates were consolidated by matching ISSNs, accounting for spelling variations and title changes. During the ISSN retrieval process, it was discovered that some journal titles with minor differences in naming were associated with the same ISSN (e.g., "Multiple Sclerosis Journal" and "Multiple Sclerosis") and were thus deduplicated. Additionally, some journals had undergone a title change (e.g., "Perception Psychophysics" was changed to "Attention, Perception, & Psychophysics"). The publication counts for these duplicates or merged titles were combined, and the redundant entries were removed. After this deduplication process, 843 unique journals remained in the dataset. Subsequently, these ISSNs were searched on the Scopus Sources website (https://www.scopus.com/sources) to determine their CiteScore. Among those, 637 journals had a CiteScore (out of 843 journals, ~76%), while 203 did not (their CiteScore was recorded as N/A). Finally, three ISSNs could not be found on Scopus Sources website. In terms of geographic origins of Scopus-indexed documents citing preprints, countries were extracted from institutional affiliations of all authors as indexed in Scopus.

To answer the first research question, collected data on trends of citations to preprints were descriptively summarized using the IBM SPSS Statistics – version 23.0 (IBM Corp, 2015) to contextualize preprint citation trends. To answer the second research question on motivations for citing preprints and explore the citation context, a random sample of 653 citations was selected from 33,754 citations to preprints within neuroscience documents. The sample size was determined using the Survey System tool, with a 99% confidence level and a confidence interval of 5%. Random selection was performed in MS Excel using the RAND() function, which assigned random numbers, sorted them, and extracted the first 653 records for detailed analysis. The records containing the sampled citations were identified, their DOIs were retrieved, searched on Scite.ai (Nicholson et al., 2021) to identify (1) the location within the document where the preprint was cited (e.g., Introduction, Methods) and (2) the motivation underlying citations (mentioning, supporting, or contrasting).

The Scite.ai web tool was employed to objectively categorize citations and detect self-citations. The Scite.ai ingestion pipeline consists of four main stages: 1) regular retrieval of full-text scholarly documents; 2) identification of in-text citations and matching them with references within the document; 3) linking references to their DOIs in bibliographic databases; and 4) automated classification of citation statements using supervised deep learning models. Citation contexts are categorized as ‘supporting’, ‘contrasting’, or ‘mentioning’ using a pretrained language model based on BERT (Beltagy et al., 2019), trained on a large expert-annotated dataset. ‘Mentioning’ citations provide background context, ‘supporting’ citations confirm previous findings, and ‘contrasting’ citations challenge them. More precisely, rather than performing sentiment analysis, this tool classifies citations based on the factual information within the citation context (e.g., experimental facts, reproducibility results, or theoretical agreement/disagreement). The training dataset was generated through a rigorous multiblind expert annotation process, with independent review and consensus reconciliation, resulting in nearly 50,000 labeled citation statements and high inter-annotator agreement. A fixed holdout set ensured unbiased evaluation, while oversampling techniques addressed class imbalance to improve detection of rare citation types, especially contrasting. The Scite.ai database includes over 800 million classified citation statements derived from more than 25 million scholarly publications, enabling large-scale analysis of citation context across the scientific literature (Nicholson et al., 2021).

Overall, an overview of how preprints are cited in the neuroscience literature is presented for the past two decades. To substantiate results of this study, Pearson’s Chi-Square and Spearman’s rank-order correlation tests were conducted via the IBM SPSS Statistics – version 23.0 (IBM Corp, 2015) to investigate associations between preprint citation counts and document types, explore the relationship between journals’ CiteScores and citations to preprints, and identify potiential differences in motivations underlying citations to preprints.

4. RESULTS

In total, 19,633 Scopus-indexed neuroscience documents with at least one preprint citation were identified. Figure 1 illustrates the temporal trend of Scopus-indexed neuroscience documents with at least one citation to a preprint.

Figure 1 *Documents citing preprints per 100 Scopus documents*

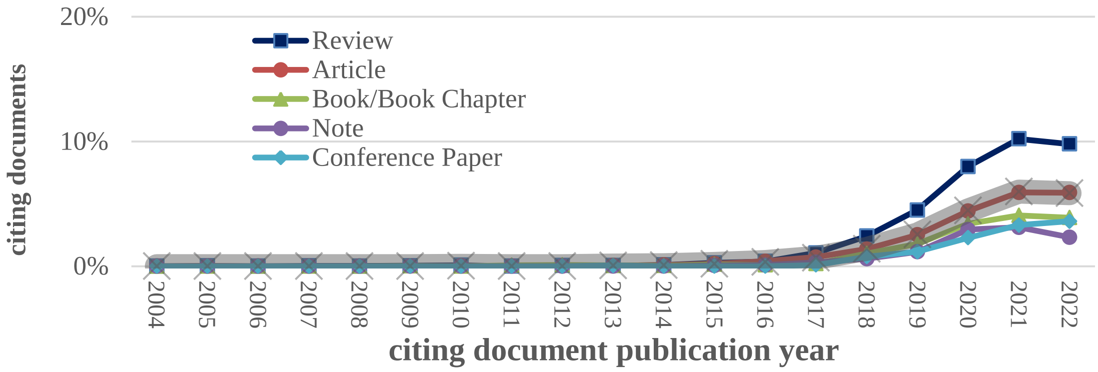


Figure 1 shows a steady rise in the number of neuroscience documents citing preprints per 100 Scopus documents, starting below 1% in the early 2000s and increasing notably after 2014, reaching about 6% in 2021. From 2016 onward, citation patterns vary across document types: reviews cite preprints most frequently, followed by journal articles, which align with the general upward trend. Conference papers, book chapters, and notes exhibit similar, lower citation rates. Table I complements this figure by summarizing the proportions of publications that cite ("Yes") or do not cite ("No") preprints across different document types in neuroscience.

Table I *Descriptive representation and Chi-Square test results of citations to preprints (1993-2022) in different document types*

		Review	Article	Chapter	Note	Conference	Total
Citing Preprints	No	124,684 (97.09%)	960,720 (98.45%)	40,644 (99.09%)	29,487 (99.21%)	35,216 (99.51%)	1,190,751 (98.38%)
	Yes	3,735 (2.91%)	15,117 (1.55%)	375 (0.91%)	234 (0.79%)	172 (0.49%)	19,633 (1.62%)
Total		128,419	975,837	41,019	29,721	35,388	1,210,384

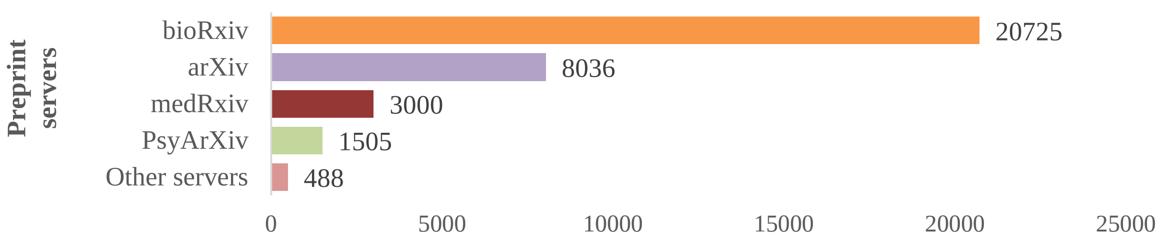
	Pearson's Chi-Square Test		
	Value	**df**	**Asymptotic Significance (2-sided)**
Pearson Chi-Square	1909.015[a]	4	.000
Likelihood Ratio	1819.511	4	.000
N of Valid Cases	1210384		

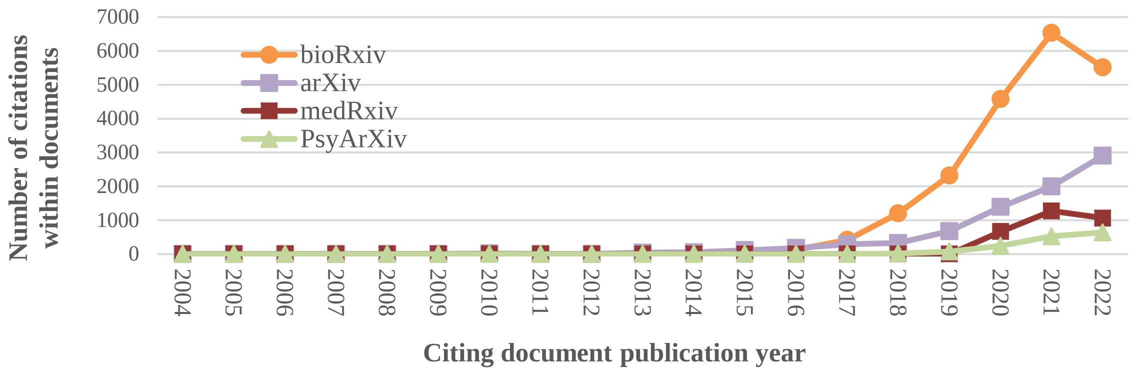
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 482.09.

As shown in Table I, Chi-Square test results indicated a statistically significant association between document type and the likelihood of citing preprints. Reviews and journal articles are significantly more likely to cite preprints compared to book chapters, notes, and conference papers (X^2 = 1909.015, $p<0.001$).

In total, 33,754 preprint citations were identified. Figure 2 provides a server-based overview of the number of citations to preprints within Scopus documents in the field of neuroscience.

Figure 2 *Number of citations to preprint servers in neuroscience Scopus-indexed documents (total and per year)*





As Figure 2 represents, bioRxiv emerges as the most frequently cited preprint server, with a substantial count of 20,725 citations from all Scopus-indexed neuroscience documents. Following bioRxiv, arXiv ranks second with 8,036 cited preprints. On the third and fourth places, medRxiv and PsyArXiv have 3,000 and 1,505 cited preprints, respectively. The category 'Other servers' encompasses not commonly cited preprint servers (i.e. OSF Preprints, SocArXiv, MetaArXiv, EcoEvoRxiv, RePEc, CogPrints, MindRxiv, SportRxiv, ChinArxiv, EdArXiv, Preprints.org, engrXiv, NutriXiv, PaleorXiv, AfricArXiv, BioHackrXiv, EarthArXiv, Frenxiv, INA-Rxiv, LIS Scholarship Archive, and Thesis Commons) with a total of 488 cited preprints. Also, an increasing trend in citations to preprint servers are observed, particularly over the last few years. Regarding the trend of citations to preprint servers, bioRxiv has emerged as distinctively more frequently cited since 2018 along with a consistent increase in the number of citations to other preprint servers.

An analysis of Scopus-indexed neuroscience journals (1993 – 2022) reveals that in 62% of these journals (524 out of 843 journals), one preprint was at least cited. Table II shows the 20 neuroscience Scopus-indexed journals most commonly citing preprints and presents the total ratio of documents citing preprints per 100 journal publications in the field of neuroscience.

Table II *Top 20 Scopus-indexed journals most commonly citing preprints*

Journal	No. of publications (1993-2022)	No. of publications citing preprints	Documents citing preprints (%)	CiteScore 2023
Network Neuroscience	232	74	31.9	6.4
Neurobiology of Language	80	20	25.0	5.9
Neuroscience of Consciousness	114	28	24.6	6.9
Frontiers in Neuroinformatics	898	184	20.5	4.8
Neuroimage Reports	130	20	15.4	1.9
Frontiers in Computational Neuroscience	1673	254	15.2	5.3
Brain Informatics	175	25	14.3	9.5
Biological Psychiatry Global Open Science	61	8	13.1	4
eLife	14091	1815	12.9	12.9
Current Opinion in Behavioral Sciences	1188	147	12.4	10.9
PLoS Computational Biology	9562	1106	11.6	7.1
Brain Computer Interfaces	140	16	11.4	4
Personality Neuroscience	27	3	11.1	2.9
Current Biology	4094	452	11.0	11.8
Frontiers in Synaptic Neuroscience	469	51	10.9	7.1
Current Protocols	607	65	10.7	4
Journal for the Cognitive Science of Religion	64	6	9.4	1.7
Neuronal Signaling	108	10	9.3	4.6
Frontiers in Neural Circuits	1513	139	9.2	6
Cognitive Computation	984	90	9.1	9.3

According to Table II, journals frequently citing preprints (e.g., *eLife*) tend to have relatively higher CiteScores. A statistical analysis of the correlation between the number of publications citing preprints (per 100 publications) in Scopus-indexed journals and journals' CiteScores was performed via Spearman's rank-order correlation.

Table III *Correlation test results of citations to preprints and journals' CiteScores*

			Citing preprints (%)	**CiteScore 2023**
Spearman's rho	**Citing Preprints (%)**	Correlation Coefficient	1.000	.353**
		Sig. (2-tailed)	.	<.001
		N	637	637
	CiteScore 2023	Correlation Coefficient	.353**	1.000
		Sig. (2-tailed)	<.001	.
		N	637	637

** Correlation is significant at the 0.01 level (2-tailed).

Table III shows a moderate positive correlation between journal CiteScore and the proportion of documents citing preprints (r_s = 0.353, p = 0.01). However, Pearson test results showed that there is no significant correlation between the number of publications citing preprints (per 100 publications) and the total number of journal publications (r_s = -0.046, p = 0.248).

Table IV displays the number of publications within 20 countries with the highest number of publications citing preprints. Also, it provides context by presenting the ratio of documents citing preprints per 100 country publications.

Table IV *Top 20 countries by preprint citation count and ratio*

No.	**Country**	**No. of publications citing preprints**	**Documents citing preprints (%)**	**No.**	**Country**	**No. of publications citing preprints**	**Documents citing preprints (%)**
1	United States	9264	1.1	**11**	Spain	736	1.4
2	United Kingdom	3571	1.8	**12**	Japan	638	0.5
3	Germany	2731	1.5	**13**	Sweden	540	1.2
4	China	1795	1.3	**14**	India	498	1.6
5	Canada	1575	1.3	**15**	Belgium	463	1.7
6	France	1266	1.3	**16**	Israel	387	1.5
7	Netherlands	1236	1.9	**17**	Denmark	372	1.7
8	Australia	1092	1.5	**18**	Norway	336	2.4
9	Italy	983	1.0	**19**	Brazil	335	0.8
10	Switzerland	924	2.0	**20**	Austria	334	1.6

As presented in Table IV, the United States leads in the total number of publications citing preprints, followed by the United Kingdom, Germany, China, and Canada. However, considering the ratio of documents citing preprints per 100 country publications, several European countries, namely Norway, the Netherlands, and Switzerland, exhibit higher ratios as compared to North America.

To answer our question regarding motivations for citations to preprints, Scite.ai identified 1450 citation statements within 451 out of 653 (68% of the research sample) retrievable neuroscience-related publications. Out of the 1450 citations, Scite.ai identified 865 and categorized them as 'mentioning', 'supporting', or 'contrasting' (Figure 3).

Figure 3 *Types of citations to preprints and their locations in neuroscience Scopus-indexed documents*

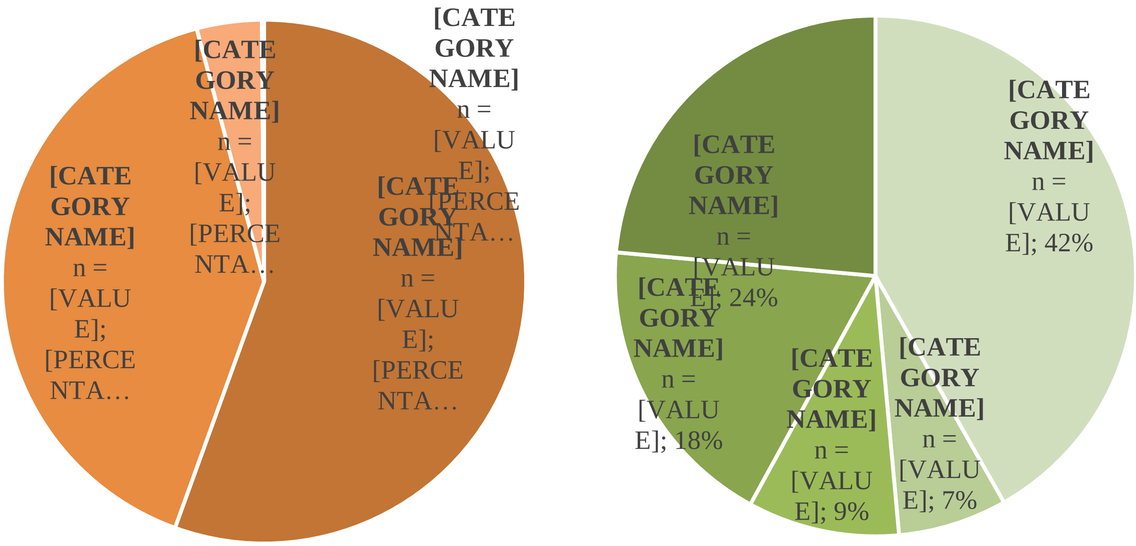


Figure 3 provides an overview of the nature of preprint citations within a sample of Scopus-indexed neuroscience documents, with 'mentioning' being the most prevalent, occurring 805 times. An example of a 'mentioning' citation is "*To the best of our knowledge, two other methods* ***have recently been proposed*** *in [11; a preprint, 12]*" (de Weck et al., 2018). However, 'supporting' citations are less frequent with 58 instances. An example of a 'supporting' citation is "***This is consistent with*** *conclusions from (Elliott et al., 2019; a preprint) who reported that the test–retest interval had little impact on reliability estimates*" (Hassel et al., 2020). Nonetheless, 'contrasting' citations are the least common, occurring only two times. An example of a 'contrasting' citation is "***In contrast with a recent preprint*** *(Saldaño et al., 2021; a preprint), the predicted flexibility values failed to correlate with their pLDDT values, ...*" (del Alamo et al., 2022). As observed in the last example, the lexical content – a recent preprint – can be also informative of the attitude towards preprints. It should be noted, however, that the remaining 585 unclassified citations account for 40% of the total mentions which Scite.ai was unable to categorize.

Table V *Chi-Square test results of differences in the type of citations to preprints*

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2091.250[a]	2	.000
Likelihood Ratio	2413.804	2	.000
N of Valid Cases	2595[b]		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 288.33.
b. In SPSS, each category had 865 rows. For example, in the 'Mentioning' category, there were 865 rows: 805 with 'Yes' and 60 with 'No' answers. This consistency across categories is why the total number of valid cases is 2595.

Table V indicates a statistically significant difference among different types of citations to preprints (contrasting, mentioning, or supporting; r = 2091.250, $p<0.001$). Based on the results, the likelihood of a study citing a preprint is significantly higher in the 'mentioning' category.

Figure 3 also represents the context where preprints are most frequently cited in Scopus-indexed neuroscience documents. Scite.ai could only locate 828 out of 1450 citation statements, revealing that preprints were most frequently cited in the 'Introduction' section (195; 24%), followed by the 'Discussion' (153; 18%) and 'Methods' (78; 9%) sections. The location of a considerable number of citations (346; 42%), however, was not appropriately identified by Scite.ai, so they were categorized as 'miscellaneous'.

On a complementary note, the ratio of self-citations to preprints in neuroscience-related Scopus-indexed documents were investigated using Scite.ai. Author self-citation refers to citing one's own previously published work in an upcoming publication (Sri-Ganeshan et al., 2021). Out of 451 records of the research sample found by Scite.ai, 77 (17%) were identified as author self-citations to preprints.

5. DISCUSSION

The current study provides insights into preprint citation patterns within the neuroscience domain, showing that 1.62% of neuroscience publications included at least one preprint citation, with an annual increase. Preprints, as a relatively new reference type, display citation rates comparable to other less formally peer-reviewed sources such as dissertations and conference proceedings (Pickler, 2019). A previous study showed that conference proceedings were cited in 1.7% of natural sciences and engineering and 2.5% of social sciences and humanities publications (Lisée et al., 2008), while Rasuli et al. (2018) found that approximately 1.5% of all Scopus-indexed documents contained at least one citation to theses/dissertations. A relevant study with a different perspective on citation counts of working papers (i.e., equivalent of preprints in economics and business studies) reported relatively low citation engagement. The results of this study indicatd that among 4,065 working papers retrieved from EconStor, only 1,613 (35%) were found in Crossref, of which 14% had at least one citation and 8% had exactly one citation (Nuredini & Peters, 2019). While these results are not directly comparable with those of the present study, they nevertheless suggest that citation engagement with non-peer-reviewed research outputs may be discipline-specific.

While the trend of citing preprints is on the rise, the overall citation rate remains low at 1.62%, likely reflecting researchers' attitudes towards preprints. Notably, despite the general upward trend, citations to bioRxiv and medRxiv preprints declined in 2022. Given that these servers primarily host preprints on biology and health sciences, this decrease may be linked to the reduced urgency for rapid dissemination following the acute phase of the Covid-19 pandemic. During the pandemic, the need for immediate access to emerging evidence may have driven higher citation of preprints, whereas citation practices may have since shifted back toward more established norms and greater reliance on peer-reviewed sources. Additionally, findings from a recent survey on preprinting reported substantial decreases in the number of Covid-19 preprints posted across multiple servers in 2022, compared to 2020 – 2021 (Biesenbender, Toepfer, & Peters, 2024). This preprint citation pattern appears consistent with preprinting trends in life and medical sciences as well as in social and behavioral sciences (Rzayeva et al., 2025). These observations suggest a possible association between the number of available preprints and citation frequencies. Nonetheless, these explanations remain relatively speculative and need to be more systematically investigated in future research.

Regarding quality-related arguments, in a recent survey, 36% (110 out of 392) of researchers in medicine expressed their concerns about potential harms of disseminating non-peer-reviewed works (Ng, Santoro, et al., 2024), which might also impact the use of preprints. While changes between a preprint and its peer-reviewed published version are a legitimate concern, the findings of a recent study on Covid-19 randomized controlled trials showed that the main results and conclusions remained consistent in 98% of peer-reviewed published versions (Bai et al., 2023). Another study on bioRxiv and medRxiv records showed changes in the conclusions of 17.2% of Covid-19 and 7.2% of non-Covid-19 preprints after peer-review, though most changes did not alter the overall qualitative interpretation (Brierley et al., 2022).

Besides neuroscience preprints, citations to arXiv preprints in physics and astronomy have also increased (Brown, 2001). Conversely, the reception of e-prints in chemistry has been notably poor, with no citations in traditional literature (Brown, 2003). However, more recent studies indicate a shift in citation patterns. For instance, a meta-research on Covid-19 studies found that 29.3% of articles in major medical journals cited at least one medRxiv preprint (Gehanno et al., 2022). Another meta-research revealed that bioRxiv preprints with a published version received 2,021 citations while preprints without a published version received 2,258 citations (Fraser et al., 2020). According to these findings, the early 2000s witnessed a relatively low rate of citations to preprints. Yet, findings of the present study showed slight changes from 2014 onwards in how neuroscience researchers engage with preprints and illustrated a potential rise in the recognition of preprints as citable sources (Sterling, 2018), which could have been accelerated more recently by the spread of Covid-19 leading to a tsunami of preprints (Rzayeva et al., 2025; Watson, 2022). Also, until 2014, there were limited number of preprint servers (Li et al., 2015), but the number has since expanded at institutional, national, and global levels.

The increasing trend in the proportion of neuroscience publications citing preprints can be attributed to the need for timely references in this rapidly evolving field. Neuroscience researchers are often on the cutting edge of knowledge, requiring references that reflect the latest discoveries. This need can be fulfilled through freely available preprint servers for sharing findings with the scientific community (Irawan et al., 2022). As anticipated, review articles demonstrated a larger proportion of citations to preprints, as compared to other publication types. This observation aligns with the perspective of Tentolouris et al. (2021), who noted that "*many preprints are cited by reviews*." Considering that review articles aim to synthesize the existing body of knowledge and identify research gaps within a specific field (Palmatier et al., 2018), they are more likely to include preprints to ensure comprehensive coverage of current developments. Furthermore, as preprints allow immediate dissemination of results, they are more likely to appear more often in review articles where new insights are critically evaluated (Palmatier et al., 2018). It should be, however, noted that review articles typically contain more references overall, which may also explain their higher rate of preprint citations. Empirical investigation of this matter through qualitative research could be further enlightening.

On the other end of the spectrum, books (chapters) remain notably hesitant to cite preprints, likely due to their specific objectives and content since books (chapters) often prioritize well-established and reputable sources rather than the latest findings, as they aim to provide comprehensive and lasting knowledge. This careful selection of references may suggest a cautious approach among authors of books (chapters), given that preprints do not undergo traditional peer-review. Overall, further empirical research is needed to better understand citation behaviors across document types.

A closer look at the journals with more citations to preprints shows that preprint citation trends in a journal may be linked to journals' policy. For instance, *eLife* specifies that "*eLife only peer-reviews submissions that are available as preprints*" and "*reviewers' reports would be published alongside the paper, together with a short editorial assessment of the work's significance and rigour*" to combine "*the immediacy and openness of preprints with the scrutiny of peer-review by experts*"[2]. Conversely, the SLEEP® journal has pointed out that it "*does not allow citation of preprint manuscripts in final published articles. Prior to publication of accepted papers, preprint citations must be replaced with the final, peer-reviewed version of record. If the cited preprint work has not been published by acceptance, it must be removed from the reference list*."[3]. Such policies highlight how journal guidelines can shape researchers' decisions to publish or cite preprints. In relation to this, a survey in the field of complementary, alternative, and integrative medicine revealed that 37% of researchers (112 out of 392) believed preprinting would lower the chances of getting their paper accepted by a journal (Ng, Santoro, et al., 2024).

Additionally, findings of the present study suggest a moderate positive association between citations to preprints and journal CiteScores, implying that high-impact neuroscience journals seem to be more open to citing preprints and might be leading a growing acceptance of preprints in the field. From a geographical perspective, North America, China, and Europe emerge as prominent users of preprints. However, further statistical investigations are warranted to confirm regional differences. Geographical variations in the use of preprints can be attributed to several factors, including funding policies that formally recognize and endorse preprints (Kaiser, 2017). Notably, the European Commission recently promoted the development of policies supporting open research practices (European Commission, 2023). On the other hand, restrictive measures, such as the Australian Research Council's preprint ban in grant applications (Ciriminna et al., 2021) can discourage the use of preprints. These findings, in line with the literature, suggest the role of policy-driven open science practices, particularly in terms of citing and potentially posting preprints within neuroscience and possibly in other disciplines.

[2] https://web.archive.org/web/20231006105925/https://elife-rp.msubmit.net/html/elife-rp_author_instructions.html#process
[3] https://academic.oup.com/sleep/pages/General_Instructions

The analysis of preprint citation motivations showed that 'mentioning' citations were the most prevalent. This pattern suggests that researchers may be more cautious about citing preprints, often citing them in the Introduction section to provide context rather than to endorse or contradict their findings. This aligns with the literature indicating that the Introduction section typically contains most citations to establish context (Bertin & Atanassova, 2022). However, Bertin and Atanassova's (2022) study on *PLOS* journal citations indicated that preprint citations appeared more frequently in the Methods section when considering relative numbers (i.e., the proportion of preprint citations within the Methods section compared to total citations), while the current study focused on absolute numbers.

Regarding self-citations, the present study showed that 17% of preprint citations were self-citations. An overall self-citation rate of 9% was reported across disciplines (varying from 3% to 15%) (Szomszor et al., 2020). The rate of neuroscience researchers' self-citation to preprints is comparable to that in physical sciences (15%). This rate might reflect researchers' motivation to comply with open access requirements from funding agencies, and increase visibility and recognition of their work. However, further research is needed to better clarify patterns and motivations of self-citations to preprints.

By providing empirical evidence of how preprints are cited, this study offers insights into the evolving dynamics of scholarly communication which can contribute to open science policymaking. Despite their free accessibility, preprints are not as commonly used as peer-reviewed publications. Various reasons could be underlying the use or non-use of preprints, indicating the need for further empirical investigations.

5.1. Research Limitations

Considering that this is a case study with limited scope, findings are neither temporally stable nor generalizable across fields. Particularly, preprint citatioins should be further investigated in light of the Covid-19 pandemic which significantly accelerated scientific publications and preprints, initially leading to a 60% increase in submissions to Elsevier journals and a tenfold increase in submissions on medRxiv (Jocalyn, 2023). With respect to data sources, neuroscience documents were retrieved exclusively from Scopus which offers a wide coverage of scholarly sources. However, this may constrain the generalizability of the findings across bibliometric platforms. Future investigations integrating multiple databases and cross-database comparisons could expand on the present results. Along the same lines, this study relied on a predefined list of preprint servers to identify preprint citations. This approach enabled a targeted, transparent, and reproducible search strategy while maintaining a balance between coverage and precision. However, some citations may not have been captured due to variations in reference formatting, Scopus indexing, or journal citation styles (e.g., only a DOI/URL is provided, server name appears only in auxiliary fields such as the note field). Nevertheless, some of these variations are likely to be partially mitigated during Scopus indexing. Furthermore, despite careful quality assurance, considering that massive amounts of data were managed and processed using python codes, some citations might have been missed in our final dataset.

Finally, although the artificial intelligence-based tool (Scite.ai) effectively facilitated a more objective and reproducible bibliometric analysis, it could not be fully automated and required supervision. More precisely, Scite.ai identified only 68% of the research sample. In terms of context, Scite.ai could only locate 828 out of 1450 (57%) citation statements with 42% categorized as miscellaneous. For instance, if a Scopus-indexed document included a subsection in the Introduction section, Scite.ai could not attribute citations in that subsection to the Introduction, requiring manual corrections. This output can possibly have broader methodological implications in terms of the importance of standardized reporting practices to enable reliable automated extraction of information from publications. Regarding motivations for citing preprints, Scite.ai classified 865 out of 1450 citation statements (60%) of which 40% were classified as miscellaneous, indicating a considerable proportion of missed cases. Nevertheless, the identification of context of citations and classification of motivations for citing preprints remained fully automated via Scite.ai and post-hoc manual completion of the outputs was deliberately avoided for two primary methodological reasons. First, to maintain methodological consistency and ensure reproducibility, any author-driven modifications that could compromise comparability with future replication studies were avoided. Second, exclusively algorithmic classification by Scite.ai was conducted to avoid conflating automated outputs with authors' subjective classifications, particularly with respect to motivations for citations to preprints. Integration of manual classifications would have introduced outcome bias and interpretative variability and could have jeopardized methodological transparency and internal validity of the study.

5.2. Future Research Recommendations

The present study revealed that a small but growing number of neuroscience publications cite preprints. This increase may reflect the easier accessibility of preprints or a rising acceptance of their use in scholarly communication. From a cross-disciplinary perspective as well, publication/citation behavior can have significant implications. For example, although preprinting has increased in economics over the recent years (Rzayeva et al., 2025), citation counts for such outputs remain limited (Nuredini & Peters, 2019). A similar dynamic might be underlying publication/citation behavior in neuroscience. The reasons underlying this pattern, as well as systematic cross-disciplinary comparisons of preprint-related practices, warrant further investigation. Also, since different lexical expression are used when citing preprints (Bertin & Atanassova, 2022), linguistic content analysis could help assess perceived credibility of preprints within the scientific community.

Moreover, investigating scientific profiles of the authors of cited preprints can can clarify who benefits most from them. A recent survey on familiarity with preprints (Ni & Waltman, 2024) highlighted that 55-96% of researchers (in disciplines other than mathematics, computer science, physics and astronomy) had never read a preprint, suggesting the need for a survey on researchers' attitudes towards preprinting and citing preprints. Such research would also help clarify whether authors who are more supportive of open access are also more likely to cite preprints. In this respect, a previous case study on preprint citations during Covid-19 found that authors with lower open access affinity cited higher proportions of closed-access literature (Lemke et al., 2024). Along the same lines, qualitative research approaches (e.g., interviews, focus groups, content analysis of policy documents) can provide insights into attitudes towards preprints among not only researchers and research institutions, but also funding associations and publishers. Such studies can further contextualize how preprints are evaluated and integrated into evaluation frameworks and potentially inform relevant policy development practices.

Given the (current) limitations of artificial intelligence-based citation analysis using Scite.ai, future studies incorporating multiple automated tools/platforms can enable validation of citation classifications. Additionally, sensitivity analyses evaluating the stability of results under different classification parameters can provide a more robust appraisal of artificial intelligence-assisted bibliometric inferences.

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AUTHOR CONTRIBUTIONS

Behrooz Rasuli: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Project administration, Visualization, Writing – original draft, Writing – review & editing. Fatemeh Seyfzadeh: Methodology, Investigation, Data curation, Project administration, Visualization, Writing – original draft, Writing – review & editing. Aurore Thibaut: Supervision, Writing – review & editing. Olivia Gosseries: Funding acquisition, Supervision, Writing – review & editing.

COMPETING INTERESTS

None

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DATA AVAILABILITY

All relevant data are posted on Zenodo: https://doi.org/10.5281/zenodo.8356108 (Rasuli et al., 2023). Supplementary Material is also published online alongside the article.

REFERENCES

Abdill, R. J., & Blekhman, R. (2019). Tracking the popularity and outcomes of all bioRxiv preprints. *eLife*, *8*, e45133. https://doi.org/10.7554/eLife.45133

Alfonso, F., & Crea, F. (2023). Preprints: a game changer in scientific publications? *European Heart Journal*, *44*(3), 171-173. https://doi.org/10.1093/eurheartj/ehac665

Alvarez, G. R., & Caregnato, S. E. (2017). Preprints in scholarly communication of high energy physics: Analysis of submissions to the arXiv repository (2010-2015) [Review]. *Perspectivas em Ciencia da Informacao*, *22*(2), 104-117. https://doi.org/10.1590/1981-5344/2830

Bagdasarian, N., Cross, G. B., & Fisher, D. (2020). Rapid publications risk the integrity of science in the era of COVID-19. *BMC Med*, *18*(1), 192. https://doi.org/10.1186/s12916-020-01650-6

Bai, A. D., Jiang, Y., Nguyen, D. L., Lo, C. K. L., Stefanova, I., Guo, K., Wang, F., Zhang, C., Sayeau, K., Garg, A., & Loeb, M. (2023). Comparison of Preprint Postings of Randomized Clinical Trials on COVID-19 and Corresponding Published Journal Articles: A Systematic Review. *JAMA Network Open*, *6*(1), e2253301-e2253301. https://doi.org/10.1001/jamanetworkopen.2022.53301

Bao, H., & Teplitskiy, M. (2024). A simulation-based analysis of the impact of rhetorical citations in science. *Nature Communications*, *15*(1), 431. https://doi.org/10.1038/s41467-023-44249-0

Beltagy, I., Lo, K., & Cohan, A. (2019). SciBERT: A pretrained language model for scientific text. Proceedings of the 2019 conference on empirical methods in natural language processing and the 9th international joint conference on natural language processing (EMNLP-IJCNLP), Hong Kong, China.

Berg, J. M., Bhalla, N., Bourne, P. E., Chalfie, M., Drubin, D. G., Fraser, J. S., Greider, C. W., Hendricks, M., Jones, C., Kiley, R., King, S., Kirschner, M. W., Krumholz, H. M., Lehmann, R., Leptin, M., Pulverer, B., Rosenzweig, B., Spiro, J. E., Stebbins, M., . . . Wolberger, C. (2016). Preprints for the life sciences. *Science*, *352*(6288), 899-901. https://doi.org/10.1126/science.aaf9133

Bertin, M., & Atanassova, I. (2022). Preprint citation practice in PLOS. *Scientometrics*, *127*(12), 6895-6912. https://doi.org/10.1007/s11192-022-04388-5

Biesenbender, K., Smirnova, N., Mayr, P., & Peters, I. (2024). The emergence of preprints: comparing publishing behaviour in the Global South and the Global North. *Online Information Review*, *49*(8), 1-22. https://doi.org/10.1108/OIR-04-2023-0181

Biesenbender, K., Toepfer, R., & Peters, I. (2024). Life scientists' experience with posting preprints during the COVID-19 pandemic. *Scientometrics*, *129*(10), 6407-6434. https://doi.org/10.1007/s11192-024-04982-9

Blatch-Jones, A. J., Recio Saucedo, A., & Giddins, B. (2023). The use and acceptability of preprints in health and social care settings: A scoping review. *PLOS ONE*, *18*(9), e0291627. https://doi.org/10.1371/journal.pone.0291627

Bove Fenderson, E., Duffy, K., & Mannstadt, M. (2018). Broadening Our Horizons: JBMR and JBMR Plus Embrace Preprints. *JBMR Plus*, *2*(2), 59-61. https://doi.org/10.1002/jbm4.10042

Brierley, L., Nanni, F., Polka, J. K., Dey, G., Pálfy, M., Fraser, N., & Coates, J. A. (2022). Tracking changes between preprint posting and journal publication during a pandemic. *PLOS Biology*, *20*(2), e3001285. https://doi.org/10.1371/journal.pbio.3001285

Brown, C. (2001). The E-volution of preprints in the scholarly communication of physicists and astronomers. *Journal of the American Society for Information Science and Technology*, *52*(3), 187-200. https://doi.org/10.1002/1097-4571(2000)9999:9999%3C::AID-ASI1586%3E3.0.CO;2-D

Brown, C. (2003). The role of electronic preprints in chemical communication: Analysis of citation, usage, and acceptance in the journal literature. *Journal of the American Society for Information Science and Technology*, *54*(5), 362-371. https://doi.org/10.1002/asi.10223

Burk, J. A. (2008). Neuroscience. In *Encyclopedia of Educational Psychology* (Vol. 2, pp. 725-729). SAGE Publications Inc. https://doi.org/10.4135/9781412963848.n194

Ciriminna, R., Scurria, A., Gangadhar, S., Chandha, S., & Pagliaro, M. (2021). Reaping the benefits of open science in scholarly communication. *Heliyon*, *7*(12), e08638. https://doi.org/10.1016/j.heliyon.2021.e08638

COPE Council. (2018). *COPE Discussion Document: Preprints*. Committee on Publication Ethics. https://doi.org/10.24318/R4WByao2

da Silva, J. A. T. (2018). The preprint debate: What are the issues? *Medical Journal Armed Forces India*, *74*(2), 162-164. https://doi.org/10.1016/j.mjafi.2017.08.002

de Weck, A., Golji, J., Jones, M. D., Korn, J. M., Billy, E., McDonald, E. R., III, Schmelzle, T., Bitter, H., & Kauffmann, A. (2018). Correction of copy number induced false positives in CRISPR screens. *PLOS Computational Biology*, *14*(7), e1006279. https://doi.org/10.1371/journal.pcbi.1006279

del Alamo, D., Sala, D., McHaourab, H. S., & Meiler, J. (2022). Sampling alternative conformational states of transporters and receptors with AlphaFold2. *eLife*, *11*, e75751. https://doi.org/10.7554/eLife.75751

Dyer, M. (2024). Preprints: Why and how to use them. *Medical Writing*, *33*(3), 104-107. https://doi.org/10.56012/nwco8539

Ettinger, C. L., Sadanandappa, M. K., Görgülü, K., Coghlan, K. L., Hallenbeck, K. K., & Puebla, I. (2022). A guide to preprinting for early-career researchers. *Biology Open*, *11*(7), bio059310. https://doi.org/10.1242/bio.059310

European Commission. (2023). *The EU's open science policy*. An official website of the European Unio. Retrieved October 01 from https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/open-science_en

Fleerackers, A., Shores, K., Chtena, N., & Alperin, J. P. (2024). Unreviewed science in the news: The evolution of preprint media coverage from 2014–2021. *Quantitative Science Studies*, *5*(2), 297-316. https://doi.org/10.1162/qss_a_00282

Foster, J., Hearst, M., Nivre, J., & Zhao, S. (2017). *Report on ACL Survey on Preprint Publishing and Reviewing* [Policy Report]. Association for Computational Linguistics (ACL). https://doras.dcu.ie/25188/

Fraser, N., Mayr, P., & Peters, I. (2022). Motivations, concerns and selection biases when posting preprints: A survey of bioRxiv authors [Article]. *PLOS ONE*, *17*(11 November), Article e0274441. https://doi.org/10.1371/journal.pone.0274441

Fraser, N., Momeni, F., Mayr, P., & Peters, I. (2020). The relationship between bioRxiv preprints, citations and altmetrics. *Quantitative Science Studies*, *1*(2), 618-638. https://doi.org/10.1162/qss_a_00043

Gehanno, J.-F., Grosjean, J., Darmoni, S. J., & Rollin, L. (2022). Reliability of citations of medRxiv preprints in articles published on COVID-19 in the world leading medical journals. *PLOS ONE*, *17*(8), e0264661. https://doi.org/10.1371/journal.pone.0264661

Hassel, S., Sharma, G. B., Alders, G. L., Davis, A. D., Arnott, S. R., Frey, B. N., Hall, G. B., Harris, J. K., Lam, R. W., Milev, R., Müller, D. J., Rotzinger, S., Zamyadi, M., Kennedy, S. H., Strother, S. C., & MacQueen, G. M. (2020). Reliability of a functional magnetic resonance imaging task of emotional conflict in healthy participants. *Human Brain Mapping*, *41*(6), 1400-1415. https://doi.org/10.1002/hbm.24883

Henke, J. (2024). Public engagement with COVID-19 preprints: Bridging the gap between scientists and society. *Quantitative Science Studies*, *5*(2), 271-296. https://doi.org/10.1162/qss_a_00302

IBM Corp. (2015). IBM SPSS Statistics for Windows (Version 23.0). In: IBM Corp.

Irawan, D. E., Zahroh, H., & Puebla, I. (2022). Preprints as a driver of open science: Opportunities for Southeast Asia [Policy and Practice Reviews]. *Frontiers in Research Metrics and Analytics*, *7*. https://doi.org/10.3389/frma.2022.992942

Janda, G., Khetpal, V., Shi, X., Ross, J. S., & Wallach, J. D. (2022). Comparison of Clinical Study Results Reported in medRxiv Preprints vs Peer-reviewed Journal Articles. *JAMA Network Open*, *5*(12), e2245847-e2245847. https://doi.org/10.1001/jamanetworkopen.2022.45847

JHL Editorial Team. (2021). Policy About Preprints and Other Non-Peer Reviewed Research [Editorial]. *Journal of Human Lactation*, *37*(1), 17-18. https://doi.org/10.1177/0890334421994108

Jocalyn, C. (2023). How covid-19 bolstered an already perverse publishing system. *BMJ*, *380*, p689. https://doi.org/10.1136/bmj.p689

Joshi, P. B. (2024). Preprints as a Modern Publishing Model to Accelerate Scientific Dissemination. In P. B. Joshi, P. P. Churi, & M. Pandey (Eds.), *Scientific Publishing Ecosystem: An Author-Editor-Reviewer Axis* (pp. 175-191). Springer Nature Singapore. https://doi.org/10.1007/978-981-97-4060-4_10

Kaiser, J. (2017). NIH enables investigators to include draft preprints in grant proposals. *SCIENCEINSIDER*. https://doi.org/10.1126/science.aal0961

Kelly, D. (2018). SIGIR Community Survey on Preprint Services. *SIGIR Forum*, *52*(1), 11–33. https://doi.org/10.1145/3274784.3274787

Larivière, V., Sugimoto, C. R., Macaluso, B., Milojević, S., Cronin, B., & Thelwall, M. (2014). arXiv E-prints and the journal of record: An analysis of roles and relationships. *Journal of the Association for Information Science and Technology*, *65*(6), 1157-1169. https://doi.org/10.1002/asi.23044

Lemke, S., Biesenbender, K., & Peters, I. (2024). Preprint citation patterns since the COVID-19 pandemic. 28th International Conference on Science, Technology and Innovation Indicators (STI2024), Berlin, Germany.

Lemke, S., & Peters, I. (2023). Effects of preprints on citations and altmetrics of Covid-19-related research. Proceedings of the 19th International Conference of the International Society for Scientometrics and Informetrics (ISSI 2023), Bloomington, Indiana.

Li, X., Thelwall, M., & Kousha, K. (2015). The role of arXiv, RePEc, SSRN and PMC in formal scholarly communication. *Aslib Journal of Information Management*, *67*(6), 614-635. https://doi.org/10.1108/AJIM-03-2015-0049

Lisée, C., Larivière, V., & Archambault, É. (2008). Conference proceedings as a source of scientific information: A bibliometric analysis. *Journal of the American Society for Information Science and Technology*, *59*(11), 1776-1784. https://doi.org/https://doi.org/10.1002/asi.20888

Maggio, L. A., & Fleerackers, A. (2023). Preprints in Health Professions Education: Raising Awareness and Shifting Culture. *Academic Medicine*, *98*(1). https://journals.lww.com/academicmedicine/fulltext/2023/01000/preprints_in_health_professions_education__raising.12.aspx

Massey, D. S., Opare, M. A., Wallach, J. D., Ross, J. S., & Krumholz, H. M. (2020). Assessment of Preprint Policies of Top-Ranked Clinical Journals. *JAMA Network Open*, *3*(7), e2011127-e2011127. https://doi.org/10.1001/jamanetworkopen.2020.11127

Metelko, Z., & Maver, J. (2023). Exploring arXiv usage habits among Slovenian scientists. *Journal of Documentation*, *79*(7), 72-94. https://doi.org/10.1108/JD-07-2022-0162

Miura, C., & Sakata, I. (2025). From Rapid Release to Reinforced Elite: Citation Inequality Is Stronger in Preprints than Journals [Preprint]. *arXiv Preprint*. https://doi.org/10.48550/arXiv.2506.07547

Ng, J. Y., Chow, V., Santoro, L. J., Armond, A. C. V., Pirshahid, S. E., Cobey, K. D., & Moher, D. (2024). An international, cross-sectional survey of preprint attitudes among biomedical researchers [Article]. *F1000Research*, *13*, Article 6. https://doi.org/10.12688/f1000research.143013.2

Ng, J. Y., Santoro, L. J., Cobey, K. D., Steel, A., Cramer, H., & Moher, D. (2024). Complementary, alternative, and integrative medicine researchers' practices and perceived barriers related to open science: An international, cross-sectional survey. *PLOS ONE*, *19*(5), e0301251. https://doi.org/10.1371/journal.pone.0301251

Ni, R., & Waltman, L. (2023). To Preprint or Not to Preprint: A Global Researcher Survey. In. SocArXiv.

Ni, R., & Waltman, L. (2024). To preprint or not to preprint: A global researcher survey. *Journal of the Association for Information Science and Technology*, *75*(6), 749-766. https://doi.org/10.1002/asi.24880

Nicholson, J. M., Mordaunt, M., Lopez, P., Uppala, A., Rosati, D., Rodrigues, N. P., Grabitz, P., & Rife, S. C. (2021). scite: A smart citation index that displays the context of citations and classifies their intent using deep learning. *Quantitative Science Studies*, *2*(3), 882-898. https://doi.org/10.1162/qss_a_00146

Nishioka, C., Färber, M., & Saier, T. (2022). *How does author affiliation affect preprint citation count? analyzing citation bias at the institution and country level* Proceedings of the 22nd ACM/IEEE Joint Conference on Digital Libraries, Cologne, Germany. https://doi.org/10.1145/3529372.3530953

Noruzi, A. (2016). arXiv popularity from a citation analysis point of view. *Webology*, *13*(2), 1-7. https://www.webology.org/abstract.php?id=235

Nuredini, K., & Peters, I. (2019). The presence and issues of altmetrics and citation data from Crossref for working papers with different identifiers from Econstor and RePEc in the discipline of Economic and Business Studies. Proceedings of the 17th International Conference on Scientometrics & Informetrics (ISSI 2019), Rome, Italy.

Pagliaro, M. (2021). Did You Ask for Citations? An Insight into Preprint Citations en route to Open Science. *Publications*, *9*(3), 26. https://doi.org/10.3390/publications9030026

Palmatier, R. W., Houston, M. B., & Hulland, J. (2018). Review articles: purpose, process, and structure. *Journal of the Academy of Marketing Science*, *46*(1), 1-5. https://doi.org/10.1007/s11747-017-0563-4

Penfold, N. C., & Polka, J. K. (2020). Technical and social issues influencing the adoption of preprints in the life sciences. *PLOS Genetics*, *16*(4), e1008565. https://doi.org/10.1371/journal.pgen.1008565

Pickler, R. H. (2019). Publishing Preprints. *Nursing Research*, *68*(5), 337-338. https://doi.org/10.1097/NNR.0000000000000378

Prakasan, E. R., & Kalyane, V. L. (2004). Citation analysis of LANL High-Energy Physics E-Prints through Science Citation Index (1991-2002) [Preprint]. *E-Prints of Library and Information Science*. http://hdl.handle.net/10760/5406

Rasuli, B., Schöpfel, J., & Prost, H. (2018, September 26-28). EDT programs after two decades: exploring impact. ETD 2018. Beyond Boundaries of Rims and Oceans: Globalizing Knowledge with ETDs, Taipei, Taiwan.

Rasuli, B., Seyfzadehdarabad, F., Thibaut, A., & Gosseries, O. (2023). *Exploring the Impact of Neuroscience Preprints: A Citation Analysis (Version 1) [Dataset]*. https://doi.org/10.5281/zenodo.8356108

Rzayeva, N., Pinfield, S., & Waltman, L. (2025). Adoption of Preprinting Across Scientific Disciplines and Geographical Regions (1991-2023). In. SocArXiv.

Sarabipour, S., Debat, H. J., Emmott, E., Burgess, S. J., Schwessinger, B., & Hensel, Z. (2019). On the value of preprints: An early career researcher perspective [Article]. *PLOS Biology*, *17*(2), Article e3000151. https://doi.org/10.1371/journal.pbio.3000151

Scotti, V. (2025). Preprints and open archives and social networks. To each his own [Article]. *Recenti Progressi in Medicina*, *116*(2), 100-107. https://doi.org/10.1701/4450.44441

Senden, M. (2025). The Evolving Landscape of Neuroscience. *bioRxiv*. https://doi.org/10.1101/2025.02.13.638094

Senden, M. (2026). The evolving landscape of neuroscience. *Aperture Neuro*, *6*(SI 2). https://doi.org/10.52294/001c.156380

Sever, R., Eisen, M., & Inglis, J. (2019). Plan U: Universal access to scientific and medical research via funder preprint mandates. *PLOS Biology*, *17*(6), e3000273. https://doi.org/10.1371/journal.pbio.3000273

Sheldon, T. (2018). Preprints could promote confusion and distortion [WORLD VIEW]. *Nature*, *559*. https://doi.org/10.1038/d41586-018-05789-4

Small, H. (2004). On the shoulders of Robert Merton: Towards a normative theory of citation. *Scientometrics*, *60*(1), 71-79. https://doi.org/10.1023/b:scie.0000027310.68393.bc

Smart, P. (2022). The evolution, benefits, and challenges of preprints and their interaction with journals. *Sci Ed*, *9*(1), 79-84. https://doi.org/10.6087/kcse.269

Sommer, I., Sunder-Plassmann, V., Ratajczak, P., Emprechtinger, R., Dobrescu, A., Griebler, U., & Gartlehner, G. (2023). Full publication of preprint articles in prevention research: an analysis of publication proportions and results consistency. *Scientific Reports*, *13*(1), 17034. https://doi.org/10.1038/s41598-023-44291-4

Sri-Ganeshan, M., Walker, K. P., Lines, T. J., Neal-Williams, T. J. L., & Taylor, D. M. (2021). Author and journal self-citation in Emergency Medicine original research articles. *The American Journal of Emergency Medicine*, *50*, 481-485. https://doi.org/10.1016/j.ajem.2021.09.005

Sterling, E. (2018). The Rising Popularity of Preprints: More Power to the Community. In J. Watson (Ed.), *Moving through the Grey: Publishing in Action* (pp. 48-60). University of Ottawa Library. https://ojs.scholarsportal.info/ottawa-school/index.php/PA/article/view/138

Szomszor, M., Pendlebury, D. A., & Adams, J. (2020). How much is too much? The difference between research influence and self-citation excess. *Scientometrics*, *123*(2), 1119-1147. https://doi.org/10.1007/s11192-020-03417-5

Tahamtan, I., & Bornmann, L. (2022). The Social Systems Citation Theory (SSCT): A proposal to use the social systems theory for conceptualizing publications and their citation links. *Profesional de la Informacion*, *31*(4). https://doi.org/10.3145/epi.2022.jul.11

Tan, C., Zhou, Y., Zhou, Y., Tu, R., & Li, Y. (2025). Research on influencing factors of researchers' willingness to use preprint platforms in the context of open science. *The Electronic Library*, *43*(3), 368-386. https://doi.org/10.1108/EL-10-2024-0323

Tenopir, C., Levine, K., Allard, S., Christian, L., Volentine, R., Boehm, R., Nichols, F., Nicholas, D., Jamali, H. R., Herman, E., & Watkinson, A. (2016). Trustworthiness and authority of scholarly information in a digital age: Results of an international questionnaire. *Journal of the Association for Information Science and Technology*, *67*(10), 2344-2361. https://doi.org/10.1002/asi.23598

Tentolouris, A., Ntanasis-Stathopoulos, I., Vlachakis, P. K., Tsilimigras, D. I., Gavriatopoulou, M., & Dimopoulos, M. A. (2021). COVID-19: time to flatten the infodemic curve. *Clinical and Experimental Medicine*, *21*(2), 161-165. https://doi.org/10.1007/s10238-020-00680-x

Tian, D., Liu, X., & Li, J. (2024). Accelerated acceptance time for preprint submissions: a comparative analysis based on PubMed. *Scientometrics*, *129*(7), 3787-3807. https://doi.org/10.1007/s11192-024-05056-6

van Schalkwyk, F. (2024). The scientific periphery and new flows of knowledge: the case of regional preprint servers. *Online Information Review*, *48*(6), 1088-1102. https://doi.org/10.1108/OIR-04-2023-0153

Wang, Z., Chen, Y., & Yang, C. (2025). The role of preprints in open science: Accelerating knowledge transfer from science to technology. *Journal of Informetrics*, *19*(2), 101663. https://doi.org/10.1016/j.joi.2025.101663

Watson, C. (2022). Rise of the preprint: how rapid data sharing during COVID-19 has changed science forever. *Nature Medicine*, *28*(1), 2-5. https://doi.org/10.1038/s41591-021-01654-6

Worster, M. G. (2024). JFM in the electronic age. *Journal of Fluid Mechanics*, *1000*, E4, Article E4. https://doi.org/10.1017/jfm.2024.878

Xie, B., Shen, Z., & Wang, K. (2021). Is preprint the future of science? A thirty year journey of online preprint services. *arXiv Preprint*. https://doi.org/10.48550/arXiv.2102.09066

Xu, C., & Zong, Q. (2024). Can open peer review improve uptake of preprints into policies? Evidence from a causal inference. *Science and Public Policy*, *51*(3), 477-490. https://doi.org/10.1093/scipol/scad083

Yan, C.-G., Li, Q., & Gao, L. (2015). PRN: A preprint service for catalyzing R-fMRI and neuroscience related studies [Article]. *F1000Research*, *3*, Article 313. https://doi.org/10.12688/f1000research.5951.2

Youngen, G. K. (1998). Citation Patterns to Traditional and Electronic Preprints in the Published Literature. *College & Research Libraries*, *59*(5). https://doi.org/10.5860/crl.59.5.448