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To preprint or not to preprint: A global researcher survey

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Abstract

Open science is receiving widespread attention globally, and preprinting offers an important way to implement open science practices in scholarly publishing. To develop a systematic understanding of researchers' adoption of and attitudes toward preprinting, we conducted a survey of authors of research papers published in 2021 and early 2022. Our survey results show that the United States and Europe led the way in the adoption of preprinting. The United States and European respondents reported a higher familiarity with and a stronger commitment to preprinting than their colleagues elsewhere in the world. The adoption of preprinting is much stronger in physics and astronomy as well as mathematics and computer science than in other research areas. Respondents identified free accessibility of preprints and acceleration of research communication as the most important benefits of preprinting. Low reliability and credibility of preprints, sharing results before peer review and premature media coverage are the most significant concerns about preprinting, emphasized in particular by respondents in the life and health sciences. According to respondents, the most crucial strategies to encourage preprinting are integrating preprinting into journal submission workflows and providing recognition for posting preprints.

1 | INTRODUCTION

Posting preprints is an open science practice that helps to make scholarly publishing faster and more transparent. Preprint servers enable research papers to be shared openly before peer review (Hu et al., 2015). The adoption of preprinting has increased massively over the past three decades (Xie et al., 2021). Posting papers on a preprint server nowadays is a common practice in several disciplines, such as physics and mathematics (Brown, 2001; Larivière et al., 2014; Puebla et al., 2021). In other disciplines preprinting is less common (Kaiser, 2017), and in some disciplines it is hardly done at all.

The level of adoption of preprinting varies around the world. In the life sciences, for instance, Abdill et al. (2020) showed that the United States and the United Kingdom contribute a disproportionately large number of preprints to bioRxiv compared with other countries. This could be due to a variety of reasons, such as differences between countries in the level of awareness of preprinting or the implementation of open science policies. The specific features of the scholarly publishing system in countries such as China (Hyland, 2023; Ren, 2013; Wang et al., 2021) are also likely to play a role. Nevertheless, in recent years, there seems to be an increasing interest in preprinting in many parts of the world, as shown for instance by the emergence of regional preprint

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servers such as AfricArXiv, ChinaXiv, Jxiv, and SciELO Preprints (Chaleplioglou & Koulouris, 2023).

Preprinting may offer several benefits to authors, readers, and potentially also to other stakeholders, such as reviewers and editors. It enables immediate publication of research papers and may help to avoid duplicate work and prevent other researchers from pursuing unproductive research directions (Puebla et al., 2021). Preprinting also allows authors to receive fast feedback on their work (Malički et al., 2021; Rzyayeva et al., 2023), to claim priority for their work (Ginsparg, 2016; Vale & Hyman, 2016) and to get “scoop protection” (Pulverer, 2016). In addition, as permanent citable records, preprints can be used as proof of productivity, especially for early-career researchers and researchers who do not intend to publish their work in journals (Kim et al., 2020; Malički et al., 2021; Vale, 2015). Preprints also offer a way to attract early attention from readers and editors (Barrett, 2018; Barsh et al., 2016). This may help authors to make their work more visible, which may also increase the number of citations their work receives (Fraser et al., 2020; Fu & Hughey, 2019).

However, there are also challenges that may slow down the adoption of preprinting. Common concerns about preprinting include scooping risks, low reliability and credibility, premature media coverage, geographical disparities in adoption and incompatibility with journal policies (Blatch-Jones et al., 2023; Fraser et al., 2022; Ng et al., 2023; Puebla et al., 2021; Sever et al., 2019; Smart, 2022). Journal policies for posting and citing preprints vary across disciplines. Klebel et al. (2020) found that 91% of the journals in the life sciences and earth sciences allow preprinting, while this is the case for only 45% of the journals in the humanities. In a survey carried out by ASAPbio (2020), it was observed that concerns about preprinting were stronger among respondents who had never posted a preprint than among those who did have experience with preprinting.

Our goal in this article is to develop a systematic understanding of researchers' adoption of and attitudes toward preprinting. We present the results of a global online survey of authors of research papers asking them about their familiarity with preprinting and their experience with reading and posting preprints. Survey participants were also asked to share their views on the benefits of preprinting, concerns about preprinting, and ways in which preprinting can be promoted.

We address the following research questions in this article:

1. What is the level of adoption of preprinting and how does this differ across countries/regions and research areas?
2. What do researchers in different countries/regions and different research areas see as benefits of

preprinting and what are their concerns about preprinting?

3. What do researchers in different countries/regions and different research areas see as ways to encourage preprinting?

2 | METHODS

2.1 | Survey overview

To learn about researchers' adoption of and attitudes toward preprinting, we performed an online survey of corresponding authors of papers published in 2021 and early 2022 and indexed in the Web of Science database. The survey was carried out using the Qualtrics software. Respondents were asked to answer 10 questions about their adoption of and attitudes toward preprinting. The survey also included five demographic questions. The questions in the survey were grouped into three parts:

- Adoption of preprinting. Questions about familiarity with preprinting, ways of learning about preprinting, experience with reading preprints, experience with posting preprints and willingness to post preprints in the future.
- Attitudes toward preprinting. Questions about benefits of preprinting, concerns about preprinting and ways to encourage preprinting.
- Demographic questions. Questions about respondents' gender, country/region in which their organization is based, number of years of research experience, career stage and research area.

The survey questions were partly inspired by earlier surveys on preprinting (ASAPbio, 2020; Fraser et al., 2022; Sever et al., 2019; Soderberg et al., 2020).

The survey form and the raw survey data are available in Zenodo (Ni & Waltman, 2023). The survey was carried out in English, except for the survey that was sent to researchers in China, which was made available both in English and in Chinese. Ethical approval to carry out the survey was granted by the Ethics Review Committee of the Social Sciences at the Faculty of Social and Behavioral Sciences of Leiden University. We consulted the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) to report the survey results (Eysenbach, 2004).

2.2 | Survey data collection

Our study was initially designed as a study of preprinting practices in specific parts of the world, but we ultimately

TABLE 1 Summary of survey data collection.

	China	The United States	Europe	Other
# Email addresses	422.8 K	329.8 K	556.2 K	622.0 K
# Invitations	31,100	31,000	31,000	31,000
# Bounced or failed	4677	1935	2636	2832
# Responses (response rate)	395 (1.5%)	985 (3.4%)	1447 (5.1%)	1143 (4.1%)
# Completed (response rate)	321 (1.2%)	901 (3.1%)	1326 (4.7%)	958 (3.4%)
% Completion rate	81.3%	91.5%	91.6%	83.8%
Period	Nov–Dec 2022	Jan 2023	Feb 2023	Mar 2023

decided to broaden our scope and take a global perspective. Given the initial design of our study, data was collected separately for different parts of the world. We ran our survey first for researchers in China, then for researchers in the United States and Europe, and finally for researchers in the rest of the world (“other”). Researchers invited to participate in the survey were selected as follows:

1. All papers published in 2021 and early 2022 and indexed in the Web of Science database were selected. We made use of the in-house version of the Web of Science database available at CWTS, Leiden University, updated until week 13 in 2022. The database includes four Web of Science citation indices: the Science Citation Index Expanded, the Social Sciences Citation Index, the Arts & Humanities Citation Index, and the Conference Proceedings Citation Index. We considered papers of all document types.
2. For the selected papers, corresponding authors with an affiliation in a particular country/region (i.e., China, the United States, Europe, other) were identified and the email addresses of these authors were selected.
3. The selected email addresses were deduplicated.
4. A random sample of the deduplicated email addresses was taken and an invitation to participate in our survey was sent to these addresses.

In the first question in the survey, respondents were asked to indicate their familiarity with preprinting. Respondents who answered that they were not familiar with preprinting at all ($N = 283$) skipped the remaining questions about preprinting and went directly to the demographic questions at the end of the survey.

We sent the survey invitations in batches between November 2022 and March 2023. The survey was fully anonymous. For each country/region, we first sent a

small number of invitations to test the survey process. We then sent another 30,000 invitations. Table 1 reports for each country/region the number of invitations that were sent and the number of responses that were received. Only completed responses are considered in our analysis of the survey results. In total, we received 3506 completed responses to our survey. There were large differences between countries/regions in the response rate. The response rate was highest for researchers in Europe (4.7%) and lowest for researchers in China (1.2%).

2.3 | Survey participants

Figure 1 provides an overview of the demographics of the survey participants. More details can be found in Table A1. Exactly 66% of the survey participants identified as men and 29% as women. Only 5% chose “prefer not to say” or “prefer to self-describe.” More than half of the survey participants reported having at least 15 years of research experience, revealing a strong overrepresentation of senior researchers among the participants. Only 2% of the participants had fewer than 3 years of research experience. Full professors accounted for the largest proportion of survey participants (29%), followed by associate professors (21%) and assistant professors (15%). Survey participants were active in research areas across the sciences, social sciences, and humanities. They were requested to choose their research area from a list of 13 predefined areas. Survey participants that felt they did not fit in any of these 13 areas could choose “other.” Because the number of survey participants in some of the 13 areas was quite small, we decided to merge some areas, reducing the number of areas to 9. In the presentation of the survey results in the next section, participants in the “other” category are excluded when results are reported by research area. In total, survey responses were received from 114 countries/regions.

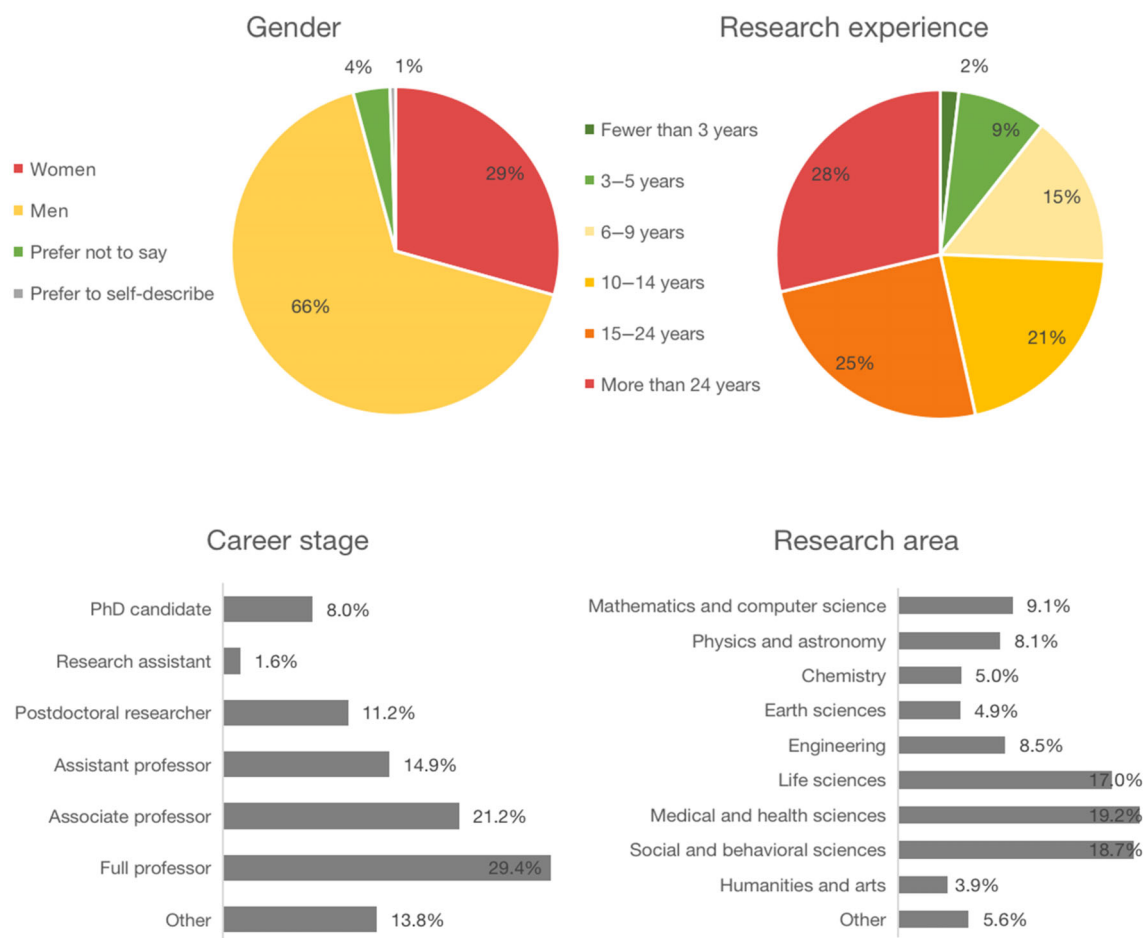


FIGURE 1 Demographics of survey participants ($N = 3506$).

3 | RESULTS

3.1 | Adoption of preprinting

3.1.1 | Familiarity with preprinting

Survey participants were asked to report their familiarity with preprinting. Figure 2 shows the familiarity with preprinting by country/region and research area. The differences between research areas are substantial. The highest familiarity with preprinting across all countries/regions can be found in physics and astronomy as well as mathematics and computer science. For example, around 85% of the US respondents in these areas reported to be “very familiar” or “extremely familiar” with preprinting. There are also large differences between countries/regions. In most research areas, the familiarity with preprinting is highest in the United States, followed by Europe, and lowest in China.

Within Europe, there are substantial differences between countries in the familiarity with preprinting. Overall, 45% of the European survey participants reported

to be “very familiar” or “extremely familiar” with preprinting. Focusing on the 10 European countries with the largest number of respondents, respondents from Germany (52%), the UK (51%), Switzerland (49%), Spain (48%), the Netherlands (47%), and France (47%) turn out to be more likely to be “very familiar” or “extremely familiar” with preprinting than respondents from Sweden (38%), Italy (36%), Norway (34%), and Poland (30%).

Of the survey participants from the rest of the world, overall 38% reported to be “very familiar” or “extremely familiar” with preprinting. A breakdown by the seven geographical regions distinguished by the World Bank shows that this percentage is higher for respondents from Europe and Central Asia (46%; mainly respondents from Russia and Turkey), North America (43%; mainly respondents from Canada), South Asia (42%), and Sub-Saharan Africa (41%) and lower for respondents from East Asia and Pacific (33%), Middle East and North Africa (33%), and Latin America and Caribbean (32%).

Reading preprints is the most important way to learn about preprinting (Figure 3). In each country/region, more than half of the survey participants reported that

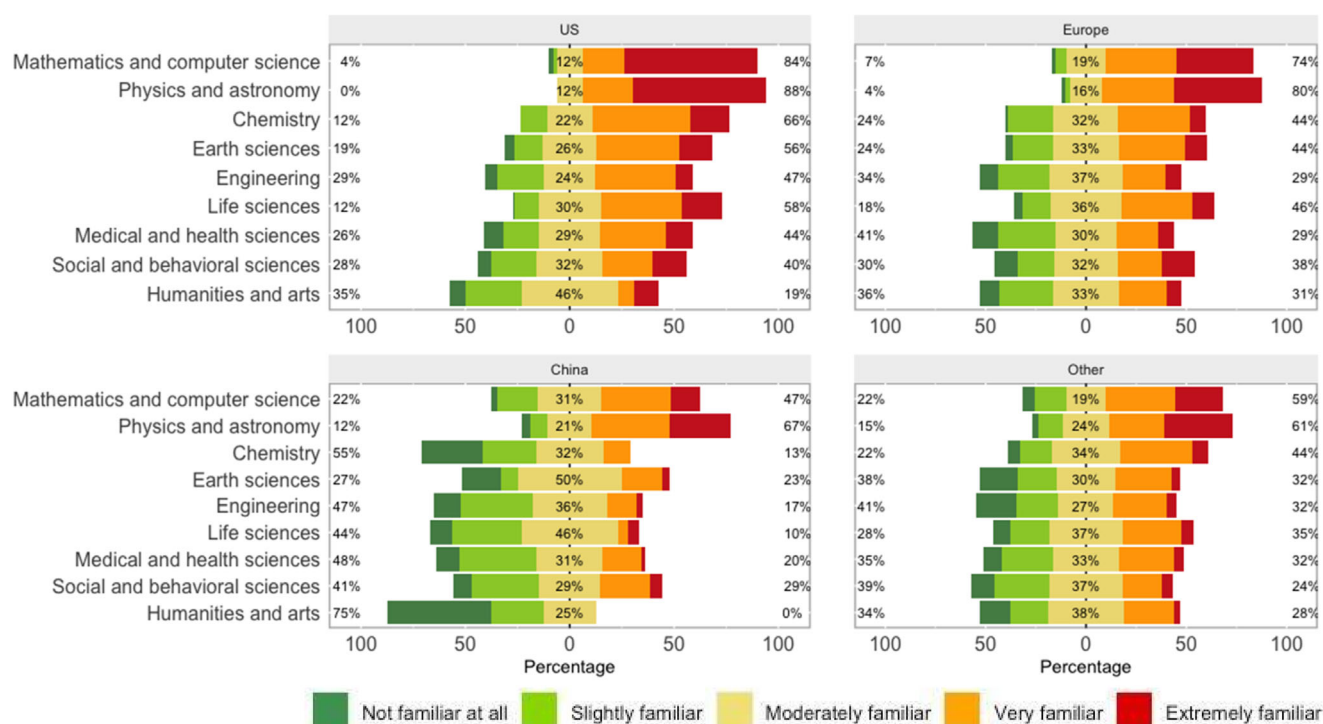


FIGURE 2 Familiarity with preprinting.

they had learned about preprinting by reading preprints. Learning about preprinting through formal training is uncommon. It was mentioned by only 4% of the respondents. Interestingly, results for China differ substantially from the rest of the world. 58% of the respondents in China reported they had learned about preprinting when submitting a paper to a journal. This percentage is much lower for respondents in other countries/regions. Compared with other countries/regions, far fewer respondents in China had learned about preprinting from a colleague (17%).

3.1.2 | Experience with reading preprints

We also asked survey participants how often they read preprints (Figure 4). Overall, the frequency of reading preprints is quite similar across countries/regions. Regardless of the country/region, more than half of the respondents in physics and astronomy reported that they read preprints at least a few times per week. Reading preprints is also quite common in mathematics and computer science. It is much less common in other research areas.

3.1.3 | Experience with posting preprints

In terms of posting preprints, physics and astronomy as well as mathematics and computer science show the

highest adoption of preprinting (Figure 5), in line with the familiarity with preprinting in these areas (Figure 2). In physics and astronomy, 72% of the respondents in the United States reported that they had posted all or most of their papers on a preprint server, and 64%, 67%, and 56% of the respondents in Europe, China, and the rest of the world reported the same. Interestingly, the situation in mathematics and computer science varies strongly between countries/regions. Exactly 67% of the US respondents and 53% of the European respondents reported that they had preprinted all or most of their papers, while this is the case for only 15% and 32% of the respondents in, respectively, China and the rest of the world.

Survey participants who reported that they had posted papers on preprint servers were asked which preprint servers they had used and at what stage they had posted preprints (Figure 6). In terms of preprint servers, arXiv was mentioned most frequently by respondents (39%), particularly in Europe, followed by bioRxiv (24%), which turns out to be especially popular in the United States. ChinaXiv, a preprint server based in China, was mentioned almost exclusively by respondents in this country. Additionally, a relatively high percentage of respondents in China reported the use of Research Square (16%) or SSRN (15%). Presumably, most papers are posted on these commercial preprint servers when authors submit a paper to a Springer Nature or Elsevier journal. OSF Preprints, a multidisciplinary preprint server, PsyArXiv, a preprint server for psychological sciences, and SocArXiv, a preprint



FIGURE 3 How do researchers learn about preprinting?

server for social sciences, were mentioned more often by respondents in the United States and Europe than by their colleagues in China and the rest of the world. Based on the free-text responses in the “other” category, 4% and 3% of all respondents with preprinting experience reported having used medRxiv and ResearchGate, respectively. While ResearchGate is sometimes seen as a preprint server (e.g., <https://asapbio.org/preprint-servers>), it can best be characterized as an academic social networking platform. Sharing of research papers is one of the functions it provides.

In terms of the stage at which preprints are posted, many survey participants responded that they had posted their work on a preprint server before submitting it to a journal (25%) or when submitting it to a journal (31%). Exactly 15% of the participants had posted their work as a preprint after it had been accepted by a journal. Such preprints are sometimes referred to as postprints.

3.1.4 | Willingness to post preprints

Survey participants were also asked to report their willingness to post preprints in the future (Figure 7). The willingness to post preprints is strongest in physics and astronomy. The percentage of respondents that expect to post most or all of their future papers on a preprint server varies between 59% and 78% for different countries/regions. In mathematics and computer science, on the other hand, there are large differences between countries/regions. Exactly 78% of the US respondents and 54% of the European respondents expect to preprint most or all of their future papers, while this is the case for only 14% of the respondents in China. Respondents in the medical and health sciences expressed the lowest willingness to post preprints. Less than 10% of the respondents in this area plan to preprint most or all of their future

papers. Apparently, the COVID-19 pandemic has not led to a major shift in attitudes toward preprinting in the medical and health sciences.

Interestingly, while the United States has a relatively high percentage of respondents that expect to preprint most or all of their future papers (24% across all research areas), it also has the highest percentage of respondents that do not plan to preprint any of their future papers (39%). This percentage is substantially lower in Europe (30%) and China (30%). Hence, attitudes toward preprinting seem more polarized in the United States than in other countries/regions.

3.1.5 | Association with gender and level of experience

We used ordered-logit regression to analyze how different aspects of the adoption of preprinting are associated with respondents' gender and their number of years of research experience, in addition to their country/region and their field. The results are reported in the coefficient plots presented in Figure A1.

The coefficient plots reveal that, other things equal, men on average show a higher adoption of preprinting than women. In addition, researchers with fewer years of research experience on average have more experience with reading preprints and are more willing to post preprints.

3.2 | Attitudes toward preprinting

3.2.1 | Benefits of preprinting

Figure 8 shows the attitudes of survey participants toward nine statements about potential benefits of



FIGURE 4 Frequency of reading preprints.

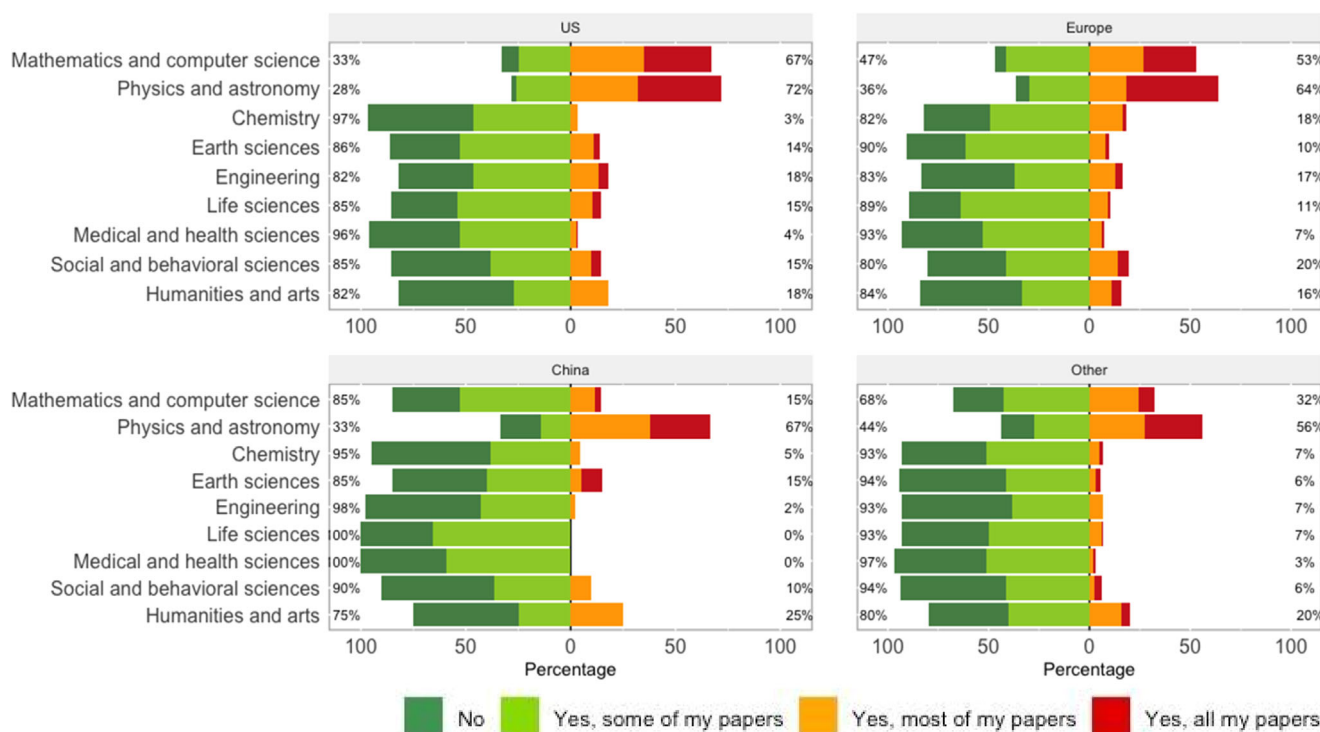


FIGURE 5 Frequency of posting preprints.

preprinting. The research areas distinguished in Section 3.1 have been grouped into three broad fields: physical sciences and engineering (PS&E), life and health

sciences (L&HS), and social sciences and humanities (SS&H). The benefits of preprinting tend to get most recognition in the physical sciences and engineering, but

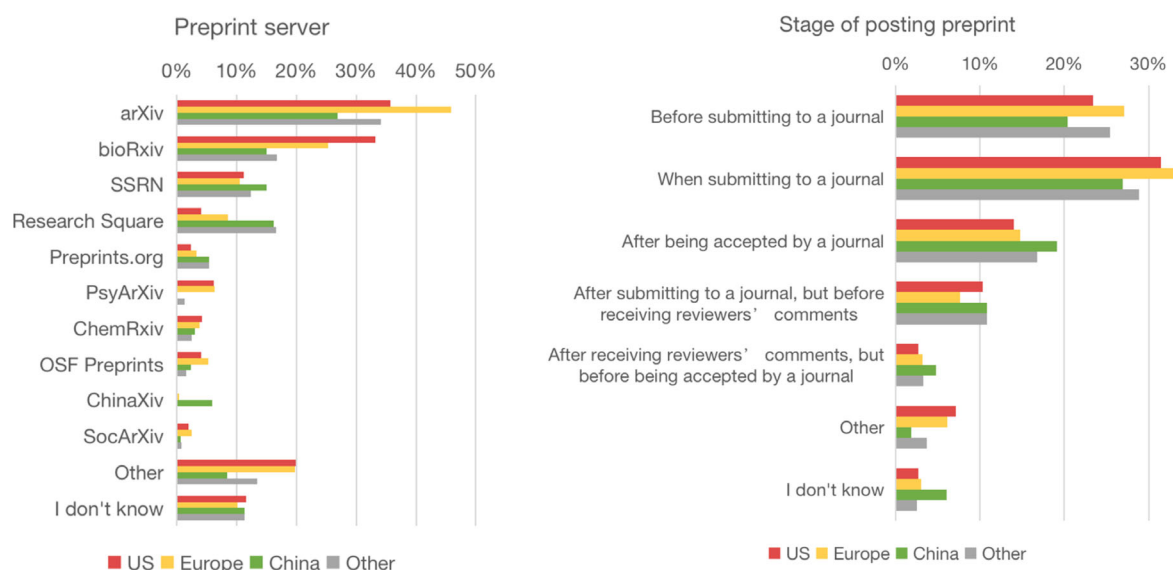


FIGURE 6 Preprint servers and stage of posting preprints.

disciplinary differences are relatively small. The attitudes of respondents in different countries/regions are also fairly similar. Being free to read is seen as the most beneficial feature of preprints. Approximately half of the respondents regarded this as very beneficial. Nearly 40% of the respondents considered the increase in the speed of research communication to be very beneficial. Free posting, getting additional exposure, and establishing priority are also seen as significant benefits of preprinting. In comparison, only about one-fifth of the respondents stated that preprints are very beneficial in enabling authors to receive early feedback, to receive more citations, to share results that do not fit in journals and to demonstrate progress in the context of evaluation for grants or jobs.

3.2.2 | Concerns about preprinting

When asked about concerns about preprinting, survey participants in different countries/regions and different fields responded differently (Figure 9). Low reliability and credibility of preprints, sharing results before peer review and premature media coverage of preprints are the most important concerns. These concerns were raised in particular by respondents in the life and health sciences, with US respondents being most concerned. For example, 53% of the US respondents in the life and health sciences indicated that they are very concerned about premature media coverage. Interestingly, respondents in the life and health sciences in China were more concerned about the risk of preprint authors getting scooped and the lack of recognition for posting preprints, with

respectively 35% and 30% of the respondents indicating being very concerned about this. These percentages are much lower for respondents in other countries/regions, and also for Chinese respondents in other fields. Only a small share of all respondents expressed strong concerns about harmful comments on preprints and information overload.

Paradoxically, while some respondents see preprinting as a tool that researchers can use (or misuse) to scoop others, there are also respondents who fear that preprinting may increase the risk of being scooped. However, by facilitating early registration of timestamped versions of research papers, preprinting enables researchers to make priority claims, which offers protection against being scooped. Some respondents do not seem to be aware of this, which suggests a need to develop a better understanding of preprinting in relation to the issue of scooping.

Free-text responses confirm some of the concerns about preprinting described above and also reveal additional concerns. The 303 valid responses were coded by one of us, resulting in the identification of a broad range of concerns. Important concerns include:

- **Quality of preprints ($N = 59$).** A major concern relates to low-quality preprints. Some respondents witnessed a surge of low-quality preprints during the COVID-19 pandemic (e.g., “As COVID demonstrated, without peer review, much rubbish is published,” man from Macau, China working as full professor in the social and behavioral sciences). Without quality assurance by peer reviewers, respondents worried about the credibility of scientific work (e.g., “They are not peer-reviewed

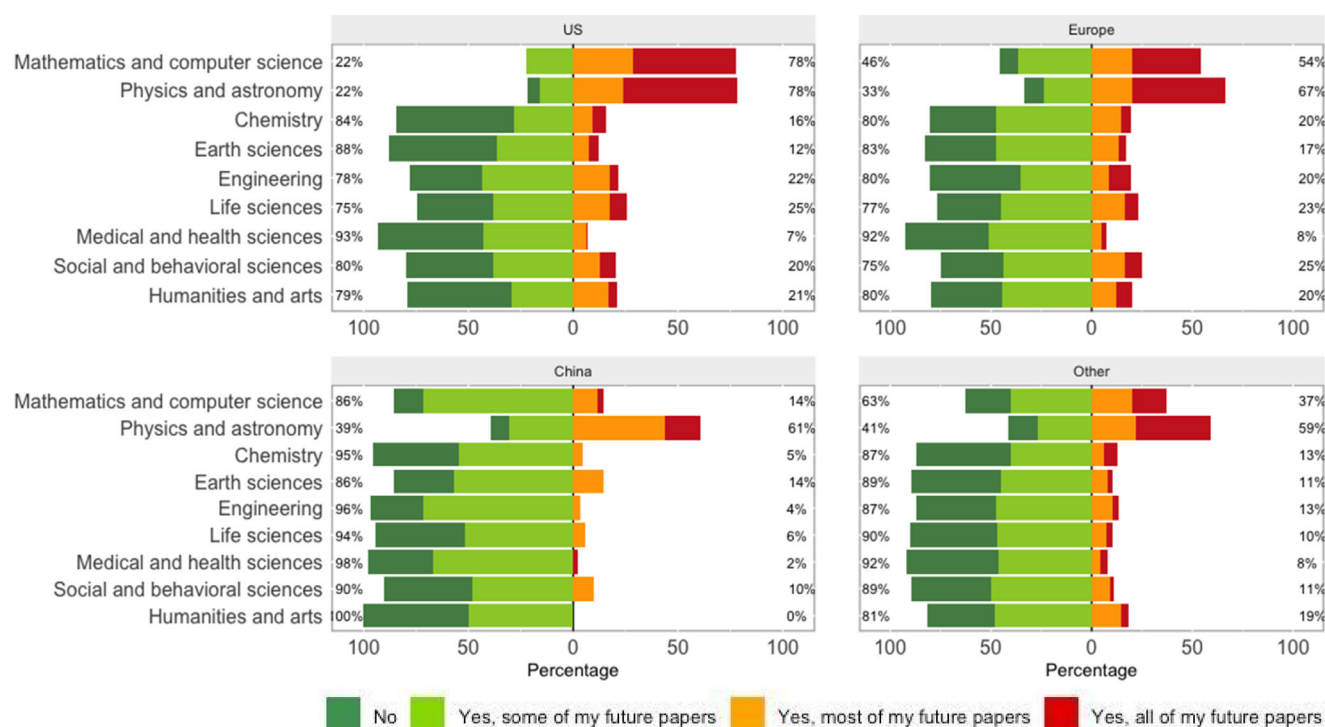


FIGURE 7 Willingness to post preprints in the future.

and can undermine the credibility of peer-reviewed science,” man from the United States working as practitioner in the earth sciences).

- Multiple versions of the same paper ($N = 34$). This concern is about the risk of confusion caused by having multiple versions of the same paper (e.g., “Confusion between the status of the preprint and the final peer-reviewed article,” woman from Canada working as full professor in earth sciences; “The possibilities for confusion with the ‘final’ version,” woman from Ireland working as academic developer in education).
- Citation of preprints ($N = 24$). Another concern relates to the citability of preprints. Respondents felt uncertain about citing preprints in their papers (e.g., “I feel a little bit reluctant to cite a preprint of a study in my current research. The reviewers might question that,” man from China working as assistant professor in the social and behavioral sciences). Respondents were not sure how to cite preprints and how to distinguish them from peer-reviewed papers (e.g., “It gets confusing when there is a pre-print and peer-reviewed version of a paper and dilutes citations,” man from the United States working as associate professor in the medical and health sciences).
- Accusation of self-plagiarism ($N = 7$). Respondents expressed their worry that reviewers and journals may consider a journal submission to be self-plagiarized if

the paper has already been posted on a preprint server (e.g., “I had this problem that after publishing as a pre-print, journals that submitted my paper had reported plagiarism!!!!,” man from Iran working as assistant professor in the medical and health sciences; “Reviewers often do not know about preprints and reject articles for plagiarism (personal experience),” woman from Italy working as full professor in chemistry).

3.2.3 | Encouraging preprinting

To encourage preprinting, survey participants emphasized the importance of integrating preprinting in journal submission workflows (Figure 10). For most combinations of a country/region and a field, about one-third of the respondents considered this integration very important. Likewise, providing recognition to researchers for preprinting their work is an important way to encourage preprinting, especially in China and in the social sciences and humanities. Recognition was regarded as very important by 45% of the Chinese respondents in the social sciences and humanities. Approximately a quarter of the respondents stated that encouraging or mandating preprinting by research funders, research institutions, and journals is very important.

Free-text responses varied widely. Of the 382 valid responses, almost half ($N = 174$) expressed that the

respondent does not want to encourage preprinting or even opposes preprinting, usually because of the lack of peer review and the low credibility of preprints (e.g., “... *I don't think that preprinting before peer-review should be encouraged. I think the risks of media/lay people sharing misinformation are too high and that we should aim to amend the peer review process,*” woman from the United States working as postdoctoral researcher in the life sciences). Many respondents indicated that better support for preprinting from journals ($N = 49$) is one of the most effective ways to promote preprinting (e.g., “*Consistent policy of journals regarding preprints,*” woman from Germany working as PhD candidate in the social and behavioral sciences; “*Optional preprinting as journal submission process,*” man from an unknown country/region working as full professor in physics and astronomy; “*Journal policies need to change,*” genderqueer respondent from the United States working as assistant professor in the social and behavioral sciences). In addition, recognition of preprints ($N = 15$) was identified as an important way to encourage preprinting (e.g., “*Forcing recruitment commissions in federal-founded research institutions to count preprints as a publication ...,*” man from France working as postdoctoral researcher in the social and behavioral sciences; “*Recognizing preprints (or working papers that are not just lines on the CV but actually circulable) would encourage the practice,*” man from the United States working as assistant professor in the social and behavioral sciences).

3.2.4 | Association with gender and level of experience

We used ordered-logit regression to analyze how the attitudes of respondents are associated with their gender and their number of years of research experience, in addition to their country/region and their field. The results are reported in the coefficient plots presented in Figures A2–A4. Results are shown for the four most important benefits of preprinting, the four most important concerns about preprinting and the two most important ways to encourage preprinting.

The coefficient plots reveal that, other things equal, men on average are less concerned about preprinting than women and tend to be more focused on the benefits of preprinting. To encourage preprinting, researchers with fewer years of research experience on average put more emphasis on the importance of integrating preprinting in journal submission workflows and providing recognition for posting preprints.

4 | DISCUSSION AND CONCLUSION

We conducted a survey to investigate researchers' adoption of preprinting and their views on benefits of preprinting, concerns about preprinting, and ways in which preprinting can be promoted. We focused in particular on analyzing differences between countries/regions and research areas.

4.1 | Main findings

Compared with China and the rest of the world, the United States and Europe lead the way in the adoption of preprinting. While reading preprints is more or less equally common in different countries/regions, survey participants in the United States and Europe reported a higher familiarity with preprinting and a stronger commitment to posting preprints than their colleagues in China and the rest of the world.

There are large differences between research areas in the adoption of preprinting. Our survey results show that the adoption of preprinting is strongest in physics and astronomy, followed by mathematics and computer science. It is much weaker in other research areas. Many researchers in these other areas are at least somewhat familiar with preprinting and they occasionally read a preprint, but posting preprints is less common for them.

Survey participants perceived the free accessibility of preprints for readers as the most important benefit of preprinting. Speeding up research communication was seen as another major benefit. Respondents identified being free to post, getting additional exposure, and establishing priority as other significant benefits of preprinting.

Survey participants in different countries/regions and different fields show substantial differences in their concerns about preprinting. Low reliability and credibility of preprints, sharing results before peer review and premature media coverage of preprints are the most important concerns, raised in particular by respondents in the life and health sciences and especially by US respondents. Compared with respondents in other countries/regions and other fields, respondents in China in the life and health sciences expressed strong concerns about the lack of recognition for posting preprints and the risk that researchers who post preprints may get scooped.

Integrating preprinting in journal submission workflows was identified as the most important way to promote preprinting. Providing recognition to researchers for preprinting their work is another important way in which preprinting can be encouraged, emphasized in

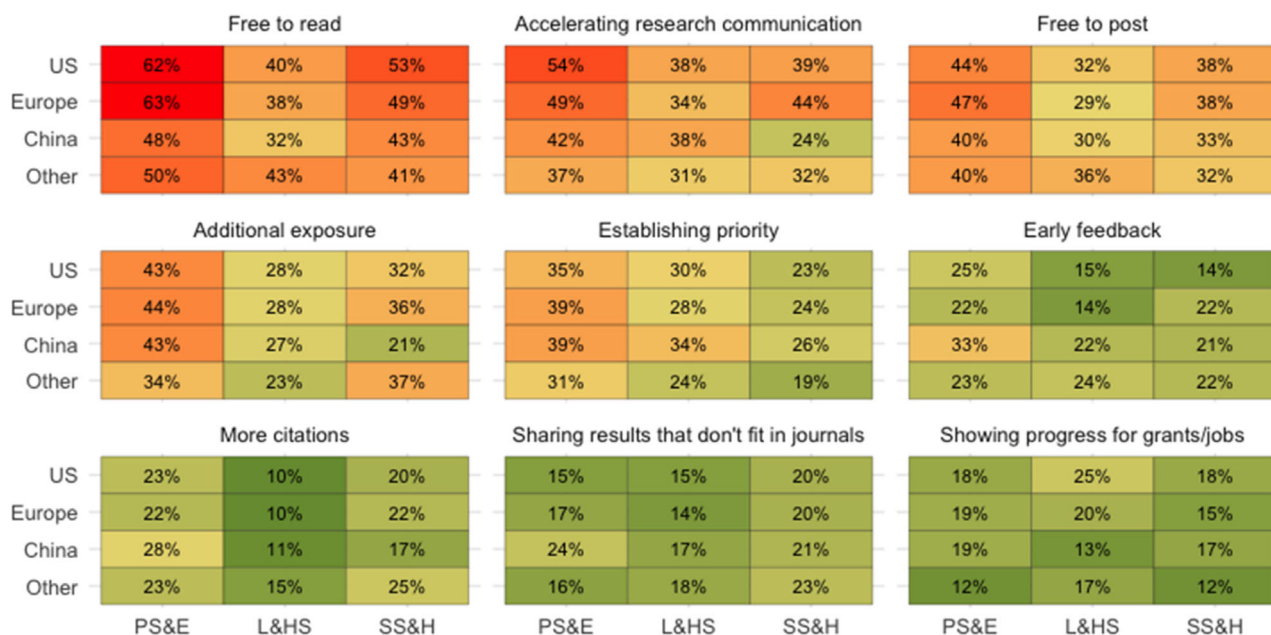


FIGURE 8 Attitudes toward benefits of preprinting. Survey participants were asked about their attitudes toward nine benefits of preprinting. The choices included “not at all beneficial,” “somewhat beneficial,” “very beneficial,” and “do not know.” The figure shows the percentage of “very beneficial” responses. PS&E, L&HS, and SS&H refer to physical sciences and engineering ($N = 1245$), life and health sciences ($N = 1270$), and social sciences and humanities ($N = 794$), respectively.

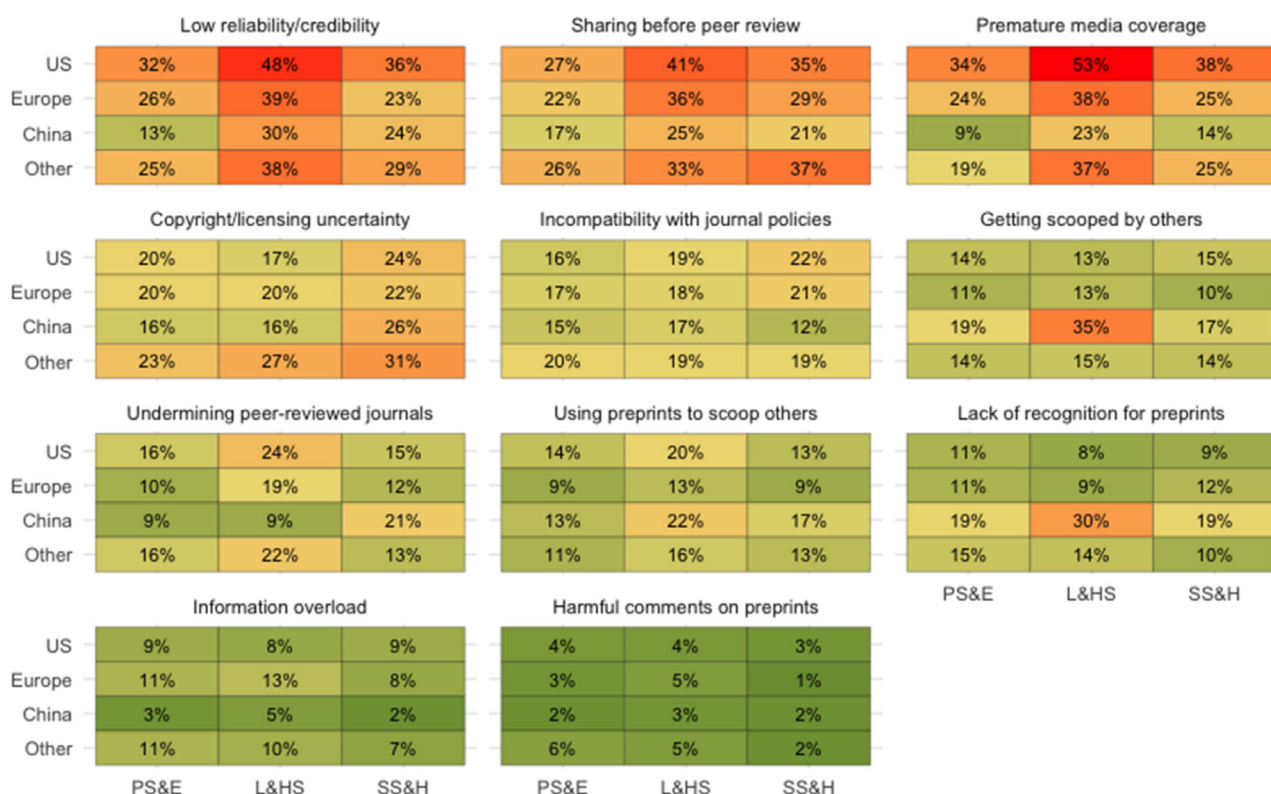


FIGURE 9 Attitudes toward concerns about preprinting. Survey participants were asked about their attitudes toward 11 concerns about preprinting. The choices included “not at all concerning,” “somewhat concerning,” “very concerning,” and “do not know.” The figure shows the percentage of “very concerning” responses. PS&E, L&HS, and SS&H refer to physical sciences and engineering ($N = 1245$), life and health sciences ($N = 1270$), and social sciences and humanities ($N = 794$), respectively.

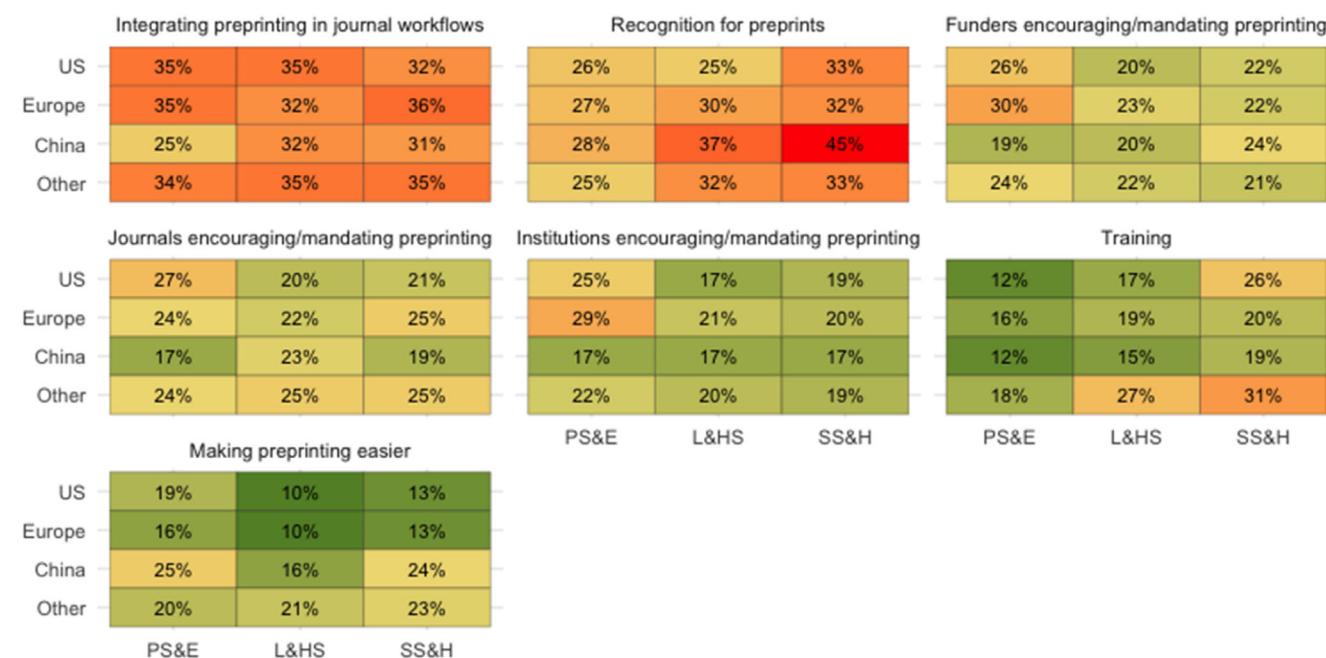


FIGURE 10 Attitudes toward different ways to encourage preprinting. Survey participants were asked about their attitudes toward seven ways to encourage preprinting. The choices included “not important at all,” “somewhat important,” “very important,” and “do not know.” The figure shows the percentage of “very important” responses. PS&E, L&HS, and SS&H refer to physical sciences and engineering ($N = 1245$), life and health sciences ($N = 1270$), and social sciences and humanities ($N = 794$), respectively.

particular by respondents in China and respondents in the social sciences and humanities.

4.2 | Recommendations

Our survey results show that researchers have mixed opinions on preprinting. Some are strong proponents of preprinting. Others are generally supportive, but have practical concerns, for instance about the lack of integration in journal workflows or the lack of recognition for preprinting. There are also researchers that have more fundamental concerns, for instance because they fear that sharing results before peer review may be harmful.

Preprinting is an important element in the broader open science agenda that is currently receiving considerable attention in many countries, both from researchers and from science policy makers. Widespread adoption of preprinting would be a major step in the transition to more open ways of doing science. However, to promote preprinting, the concerns that researchers have need to be taken seriously. To address these concerns and to encourage researchers to preprint their work, we make the following recommendations based on the results of our survey:

1. *Integrating preprinting in journal submission workflows.* The importance of integration of preprinting in

journal submission workflows is emphasized by researchers in all countries/regions and all fields. This integration is therefore likely to offer a powerful mechanism to promote preprinting, and in some cases it may even enable journals to mandate preprinting.

2. *Developing new approaches for quality assurance and peer review of preprints.* Some of the negative attitudes toward preprinting stem from concerns about the reliability and credibility of preprints, as preprints typically have not been peer-reviewed. However, preprinting also enables innovative new approaches to quality assurance and peer review (Avisar-Whiting et al., 2023; Polka et al., 2022). To address concerns about the reliability and credibility of preprints, investments in these new quality assurance approaches should be made.
3. *Providing recognition to researchers for preprinting their work.* Research institutions and research funders should recognize and reward researchers for preprinting their work. This is especially important for early-career researchers.
4. *Providing guidance to researchers on citation practices and copyright issues in relation to preprinting.* Citing preprints should be normalized, with clear guidance on appropriate citation practices (Berg et al., 2016). In addition, it should be made clear to researchers that they own the copyright of their papers, at least as long as they do not hand it over to a journal. Journals

should clearly inform authors about their policy with respect to preprinting (Klebel et al., 2020).

4.3 | Limitations

An important limitation of our study is that our survey results may overestimate the level of support for preprinting. Researchers who are familiar with preprinting and have a positive attitude toward it may have been more likely to complete our survey. We received seven emails from researchers informing us that they decided not to participate in the survey because of their lack of knowledge of preprinting. Another limitation is that senior researchers with extensive research experience are overrepresented among our survey respondents. Survey invitations were sent to corresponding authors of papers, resulting in an overrepresentation of senior researchers.

While our primary focus has been on regional and disciplinary differences regarding preprinting, future studies could explore differences between early-career researchers and more senior researchers. A deeper analysis of differences between countries or organizations with different infrastructures, policies, and research cultures would also be of major interest.

AUTHOR CONTRIBUTIONS

Conceptualization: Rong Ni, Ludo Waltman. Data curation: Rong Ni, Ludo Waltman. Formal analysis: Rong Ni. Investigation: Rong Ni. Methodology: Rong Ni, Ludo Waltman. Project administration: Ludo Waltman. Supervision: Ludo Waltman. Validation: Rong Ni, Ludo Waltman. Visualization: Rong Ni. Writing – original draft: Rong Ni. Writing – review and editing: Rong Ni, Ludo Waltman.

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CONFLICT OF INTEREST STATEMENT

Rong Ni has no competing interests. Ludo Waltman is advocating for preprinting, for instance as member of the ASAPbio Board of Directors, as co-organizer of the ASAPbio Publish Your Reviews initiative, and as one of the initiators of MetaROR, a new publication and peer review platform in the field of meta-research.

DATA AVAILABILITY STATEMENT

The data analyzed in this paper is available in Zenodo (Ni & Waltman, 2023).

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APPENDIX A

TABLE A1 Demographics of survey participants.

	Total		The United States		Europe		China		Other	
	(N = 3506)		(N = 901)		(N = 1326)		(N = 321)		(N = 958)	
	No.	%	No.	%	No.	%	No.	%	No.	%
<i>Gender</i>										
Woman	1028	29.3	302	33.5	408	30.8	47	14.6	271	28.3
Man	2332	66.5	563	62.5	862	65.0	254	79.1	653	68.2
Prefer not to say	127	3.6	29	3.2	50	3.8	18	5.6	30	3.1
Prefer to self-describe	19	0.5	7	0.8	6	0.5	2	0.6	4	0.4
<i>Research experience</i>										
Fewer than 3 years	64	1.8	11	1.2	18	1.4	11	3.4	24	2.5
3–5 years	308	8.8	52	5.8	129	9.7	35	10.9	92	9.6
6–9 years	526	15.0	105	11.7	194	14.6	53	16.5	174	18.2
10–14 years	732	20.9	165	18.3	245	18.5	98	30.5	224	23.4
15–24 years	868	24.8	234	26.0	336	25.3	77	24.0	221	23.1
More than 24 years	1003	28.6	332	36.9	401	30.2	47	14.6	223	23.3
Missing	5	0.1	2	0.2	3	0.2	0	0.0	0	0.0
<i>Career stage</i>										
PhD candidate	281	8.0	50	5.6	115	8.7	30	9.4	86	9.0
Research assistant	55	1.6	9	1.0	16	1.2	4	1.3	26	2.7
Postdoctoral researcher	392	11.2	52	5.8	202	15.2	16	5.0	122	12.7
Assistant professor	523	14.9	161	17.9	174	13.1	41	12.8	147	15.3
Associate professor	742	21.2	145	16.1	303	22.9	91	28.4	203	21.2
Full professor	1030	29.4	338	37.5	323	24.4	124	38.6	245	25.6
Other	483	13.8	146	16.2	193	14.6	15	4.7	129	13.5
<i>Research area</i>										
Chemistry	175	5.0	32	3.6	62	4.7	31	9.7	50	5.2
Earth sciences	171	4.9	43	4.8	55	4.1	26	8.1	47	4.9
Engineering	298	8.5	49	5.4	90	6.8	64	19.9	95	9.9
Humanities and arts	138	3.9	26	2.9	72	5.4	8	2.5	32	3.3
Life sciences	596	17.0	178	19.8	218	16.4	39	12.1	161	16.8
Mathematics and computer science	318	9.1	50	5.5	137	10.3	36	11.2	95	9.9
Medical and health sciences	674	19.2	200	22.2	227	17.1	54	16.8	193	20.1
Physics and astronomy	283	8.1	50	5.5	116	8.7	24	7.5	93	9.7
Social and behavioral sciences	656	18.7	221	24.5	266	20.1	34	10.6	135	14.1
Other	197	5.6	52	5.8	83	6.3	5	1.6	57	5.9

Note: The 10 European countries with the largest number of respondents are the United Kingdom (191, 14.4%), Germany (143, 10.8%), Italy (137, 10.3%), Spain (98, 7.4%), France (91, 6.9%), the Netherlands (90, 6.8%), Switzerland (47, 3.5%), Poland (46, 3.5%), Sweden (45, 3.4%), and Norway (41, 3.1%). The 11 Other countries with the largest number of respondents are India (121, 12.6%), Canada (80, 8.4%), Australia (72, 7.5%), Brazil (70, 7.3%), Japan (56, 5.8%), Russia (50, 5.2%), Turkey (40, 4.2%), Israel (24, 2.5%), Nigeria (22, 2.3%), Argentina (21, 2.2%), and South Africa (21, 2.2%).

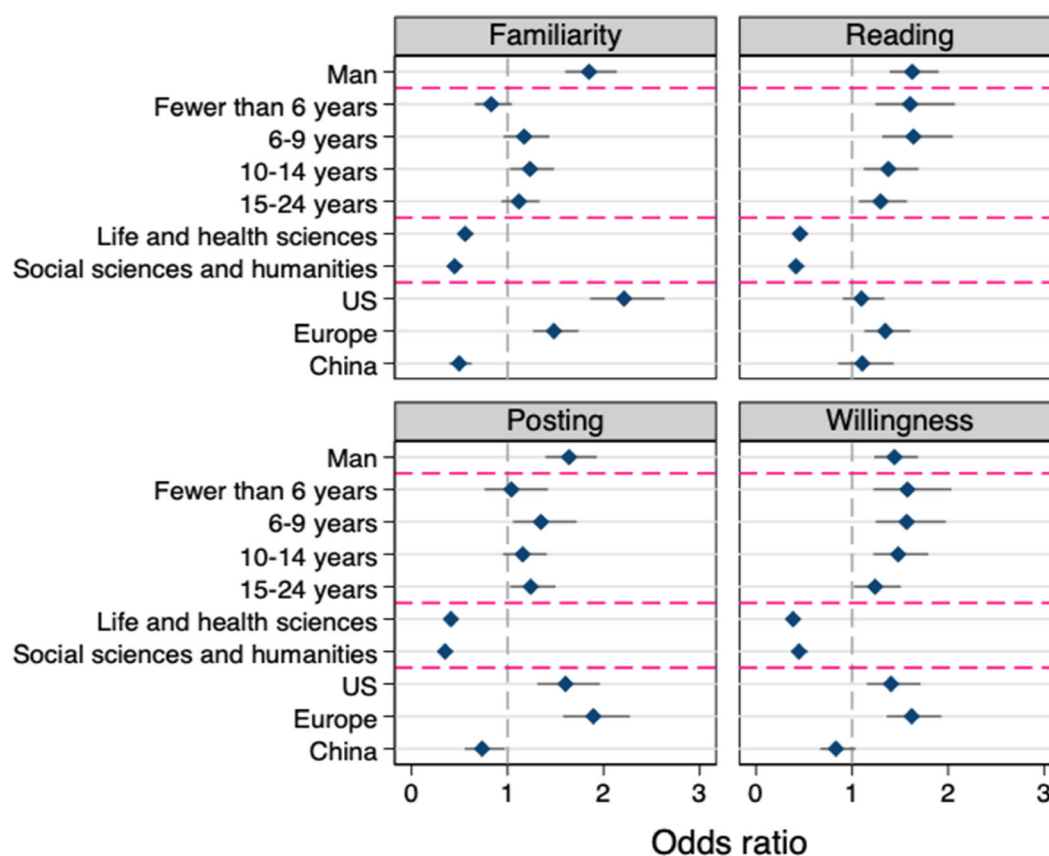


FIGURE A1 Coefficient plots for regression analyses for four aspects of the adoption of preprinting. Ordered-logit regression predicting survey participants' adoption of preprinting. Familiarity with preprinting is measured on a 5-point scale: 1, "not familiar at all"; 2, "slightly familiar"; 3, "moderately familiar"; 4, "very familiar"; 5, "extremely familiar." Experience with reading preprints is measured on a 5-point scale: 1, "never"; 2, "a few times per year"; 3, "a few times per month"; 4, "a few times per week"; 5 "almost daily." Experience with posting preprints is measured on a 4-point scale: 1, "no"; 2, "yes, some of my papers"; 3, "yes, most of my papers"; 4, "yes, all my papers." Willingness to post preprints is measured on a 4-point scale: 1, "no, I won't"; 2, "yes, some of my future papers"; 3, "yes, most of my future papers"; 4, "yes, all my future papers." Reference groups for gender, research experience, field, and country/region are women, more than 24 years, physical sciences and engineering, and the rest of the world. For each odds ratio, the plots show a point estimate and a 95% confidence interval.

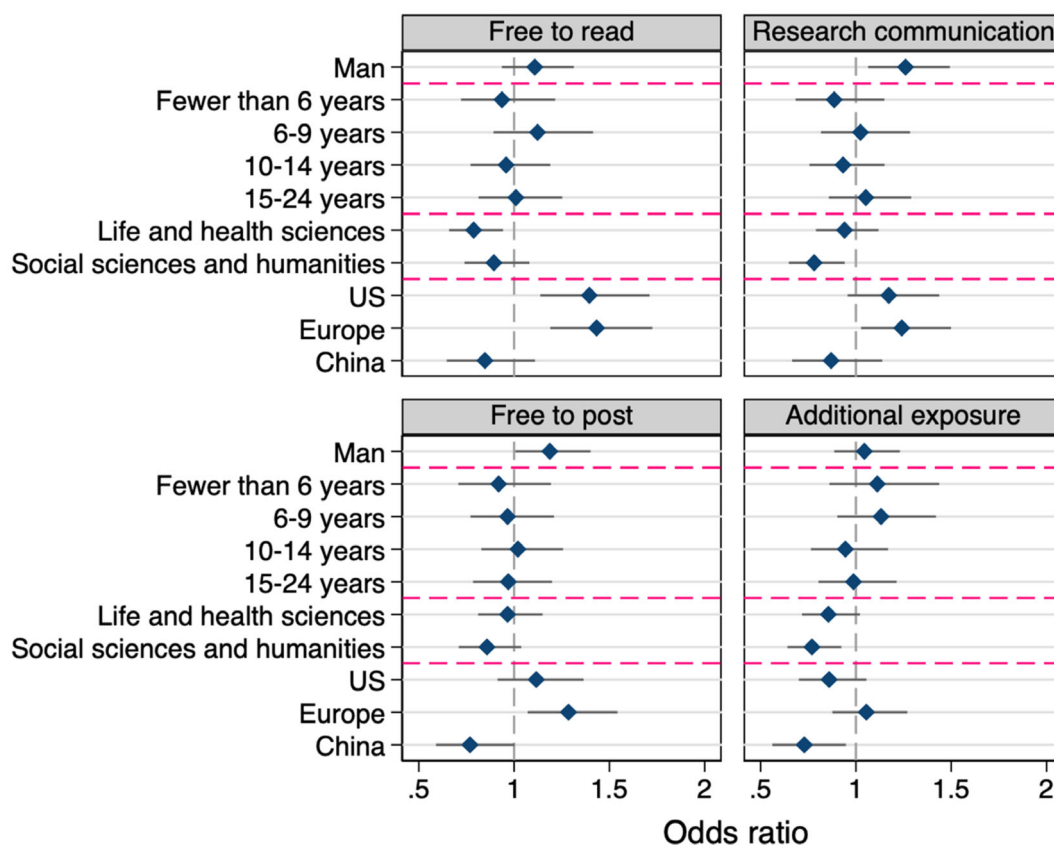


FIGURE A2 Coefficient plots for regression analyses for four benefits of preprinting. Ordered-logit regression predicting survey participants' attitudes toward four benefits of preprinting. Benefits are measured on a 3-point scale: 1, "not at all beneficial"; 2, "somewhat beneficial"; 3, "very beneficial." Reference groups for gender, research experience, field, and country/region are women, more than 24 years, physical sciences and engineering and the rest of the world. For each odds ratio, the plots show a point estimate and a 95% confidence interval.

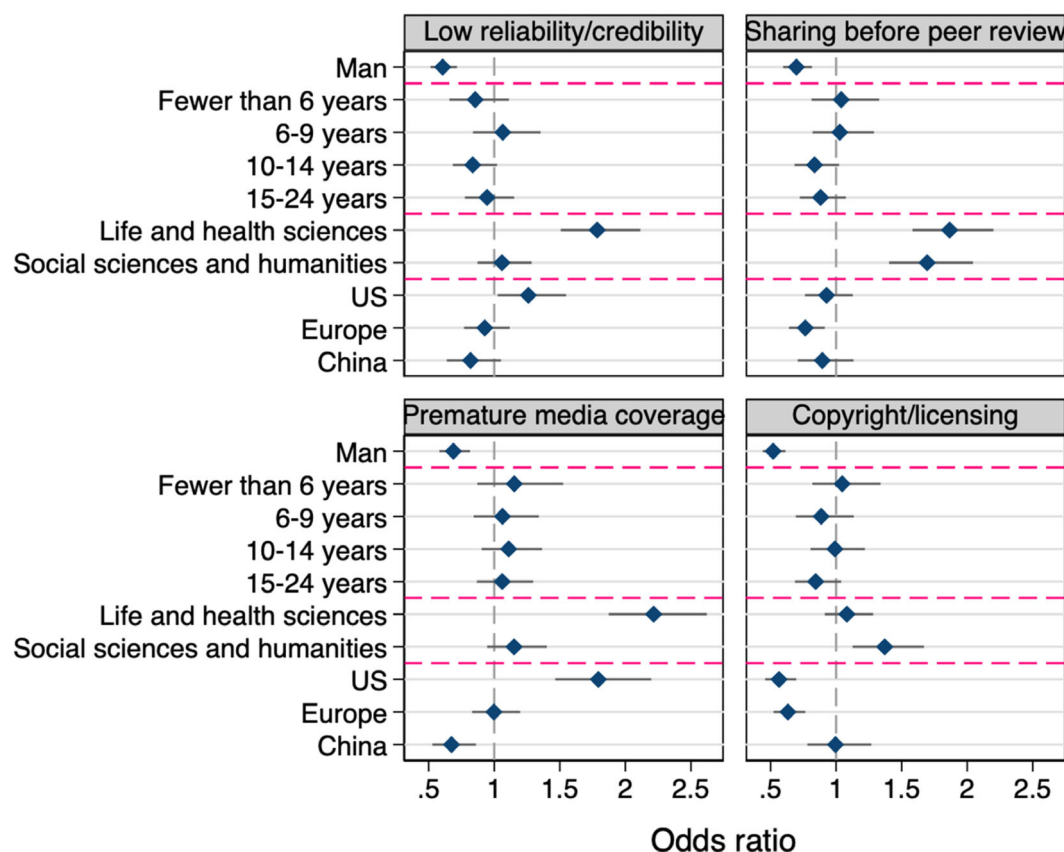


FIGURE A3 Coefficient plots for regression analyses for four concerns about preprinting. Ordered-logit regression predicting survey participants' attitudes toward four concerns about preprinting. Concerns are measured on a 3-point scale: 1, "not at all concerning"; 2, "somewhat concerning"; 3, "very concerning." Reference groups for gender, research experience, field, and country/region are women, more than 24 years, physical sciences and engineering, and the rest of the world. For each odds ratio, the plots show a point estimate and a 95% confidence interval.

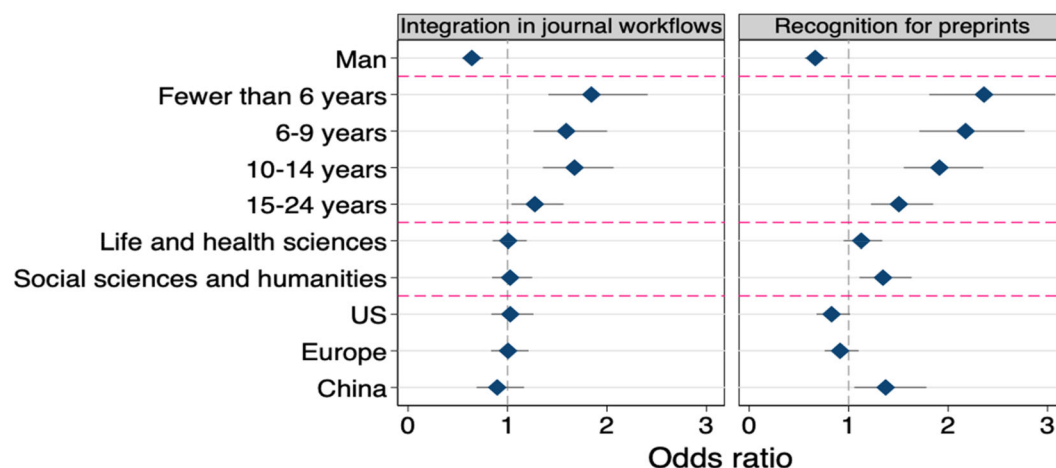


FIGURE A4 Coefficient plots for regression analyses for two ways to encourage preprinting. Ordered-logit regression predicting survey participants' attitudes toward the importance of two ways to encourage preprinting. Importance is measured on a 3-point scale: 1, "not at all important"; 2, "somewhat important"; 3, "very important." Reference groups for gender, research experience, field, and country/region are women, more than 24 years, physical sciences, and engineering and the rest of the world. For each odds ratio, the plots show a point estimate and a 95% confidence interval.