Who, What, Where: Tracking the development of COVID-19 related PsyArXiv preprints

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Abstract

Given the need for a rapid and supposed critical response from behavioural sciences during times of crisis, this study aimed to track the development of COVID-19 psychology-related preprints. We tracked the first 211 COVID related preprints on the repository PsyArXiv. Specifically, we tracked who was submitting preprints, what the preprints were investigating, and whether the preprints lead to publications and their impact (measured by Google Scholar citations). We then followed up with the preprints about a year later to determine the number of preprints that lead to publication and the number of citations they received. The results showed that males from western countries submitted most preprints. Fifty-one per cent of preprints used a survey design, and the most common topic for covid-19 related preprints was mental health. Eighty-three per cent of preprints did not meet credible open science measures. 54% of the sampled preprints had been published in peer-reviewed journals, with a median time between preprint upload and publication of 105 days. Metascience preprints were more likely to be published, and preprints with reviews had lower citation rates. Overall, the results demonstrate that some of the structural problems in research are still in play despite global efforts to mobilise research efforts during the pandemic.

Keywords: Preprints, COVID-19, metascience, PsyArXiv, Open Science, Psychology.

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The Challenges of Crisis Relevant Research

During periods of crisis and instability, psychological research plays a critical role in informing short and long-term policies (O'Connor et al., 2020). The COVID-19 pandemic is one such crisis: a major public health emergency where policies need to be implemented rapidly based on the best scientific evidence (Ruggeri et al., 2020).While cognitive and behavioural sciences can aid in our understanding of the world around us, some scholars are skeptical that certain social and behavioural sciences fields are advanced enough to have such knowledge, particularly when dealing with life-or-death problems like a pandemic. Rather than urging policymakers to acknowledge the importance of behavioural science, some note that the field should establish the credibility necessary to inform policy (IJzerman et al., 2020).

Obstacles to pandemic prevention are largely behavioural, as noted by scientists over a century ago. An article on the Spanish Flu pandemic's learnings appeared in *Science* magazine more than a century ago (Soper, 1919). With highly transmittable diseases, people are often unaware of the dangers of transmission and unwittingly become persistent threats to themselves and others. As was the case then (with the Spanish Flu), heeding advice from epidemiologists and public health experts necessitates significant behavioural changes and puts considerable psychological strain on people (Van Bavel et al., 2020). These psychological and behavioural concerns can be best informed by evidence and insight from psychological science. Behaviour change was identified as one of the top scientific priorities in the early stages of the pandemic (Hargreaves & Davey, 2020). For example, psychological research could help inform best practice for supporting individuals with mental health challenges during isolation (Moreno et al., 2020; Talevi et al., 2020). Psychological research could also advise social media platforms and

governments on communicating accurate information while mitigating damage from COVID-19 related conspiracy theories (Romer & Jamieson, 2020; Uscinski et al., 2020). These are just a few areas in which psychological science could have significant positive implications in the context of COVID-19.

However, the crisis-relevance of psychological *research* depends not only on whether the field produces knowledge that informs the challenges of COVID-19, but also whether that new knowledge is shared in a timely fashion and whether the evidence is valid (Whitty, 2015). During a crisis, the rapid production and dissemination of knowledge is as much a critical factor as the quality of the information (Lipworth, Gentgall, Kerridge, & Stewart, 2020). Policy decisions and health interventions in a rapidly evolving crisis need to be made immediately, not months later when the research is available (Whitty, 2015). Psychological research can therefore only inform rapid decision-making if it is available on time.

The dissemination of research has traditionally taken place through the medium of journal articles. Researchers submit their findings in a manuscript, which is then reviewed by experts in the field ("peer review") and undergoes an often lengthy revision process before it is finally published. The average duration of the review process for psychology submissions has been estimated to be 20 weeks (Huisman & Smits, 2017). In the context of COVID-19 biomedical research, even just a month taken to review and revise manuscripts (which may only improve the quality minimally; Carneiro et al., 2020) can mean thousands of new COVID cases (Lewandowsky, 2020). Thus, there is a need for timely knowledge production during times of crisis.

Preprints are publicly available scientific papers that have yet to be reviewed or are in the process of peer review (Mudrak, 2020). Crucially, they are submitted to a public server ahead of

the journal publication process (although servers may also host "post-prints", i.e., accepted manuscripts that are shared openly outside the journal's paywall), which means they allow the scientific community and members of the public, including journalists, policy-makers, and practitioners, to have early access to research. Preprint servers have existed since 1991, and first became common in mathematics, computer science, and physics (Vlasschaert, Topf, & Hiremath, 2020). Since then, many fields have developed dedicated repositories, including psychology, which has the PsyArXiv server (Vlasschaert, Topf, & Hiremath, 2020).

Preprints could offer a solution to accelerated knowledge production without unnecessarily compromising quality. For example, preprints facilitated novel analyses and new data throughout the Ebola and Zika outbreaks, and the bulk of those that were matched to peer-reviewed papers was accessible more than 100 days before journal publication (Johansson, Reich, Meyers, & Lipsitch, 2018). During the COVID-19 pandemic, preprints have proliferated, especially in the biomedical field (Gianola, Jesus, Bargeri, & Castellini, 2020). For instance, 50-100 daily COVID-19 related preprints were posted to the clinical repository medRxiv in April 2020. The accessibility to research that preprints offer goes beyond rapid dissemination: preprints can encourage comments, share information, and potentially increase the vigour of methodologies (Vlasschaert, Topf, & Hiremath, 2020). Preprints have also been critiqued and assessed amongst the scientific community on social media platforms such as Twitter (Carlson & Harris, 2020).

Another crucial aspect is that publishing preprints comparatively to published peer-reviewed papers is more accessible to a greater range of authors, potentially lowering barriers to participation (e.g., Sarabipour et al., 2019). This is an important consideration, given that the academic publishing system underrepresents women and minority groups (Clark & Horton,

2019; Mertkan et al., 2016), in part due to bias and discrimination in the peer review process (Silbiger & Stubler, 2019). Therefore, in the context of COVID-19, preprints may facilitate the rapid dissemination of relevant psychological research findings from a more diverse research base.

While quicker communication and accumulating evidence benefit scientific research, the drawback with rapid, open dissemination may be the diminishing quality of evidence. There have been concerns about poor quality research and its detrimental effects on an evidence-based pandemic response, especially when the media recklessly amplifies questionable findings (Glasziou, Sanders, & Hoffmann, 2020; IJzerman et al., 2020). Issues surrounding generalisability, replicability, and validity could constrain the relevance of psychological research, even if it is produced in a timely fashion (Landy et al., 2020). There appears, *prima facie*, to be a tension between the need for knowledge production to be rapid *and* rigorous. However, one should not conflate "rigour" with the journal peer-review process. The generalisability, replicability, and validity of published psychological research has been debated long before the pandemic hit (Open Science Collaboration, 2015), and high profile retractions of rapid COVID-19 research appeared in a high-profile journal (e.g., The Lancet, 2020) as well as a preprint server (e.g., bioRXiv). Overall, the peer review process can improve the quality of published research, but the improvements are small (Carneiro et al., 2020), begging the question of whether withholding publication of crisis-related research throughout the lengthy peer-review process is worth the gain in quality. As Whitty (2015) states, "An 80% right paper before a policy decision is made is worth ten 95% right papers afterwards, provided the methodological limitations imposed by doing it fast are made clear."

With these issues in mind, we set out to investigate the role that preprints could play in supporting crisis-relevant psychological research by studying the characteristics of PsyArXiv preprints early in the COVID-19 pandemic (posted mid-May 2020). We approached this question by examining whether, as an early sample of the rapid psychological research produced as part of the pandemic response, these preprints contributed new knowledge that represented diverse perspectives ("who"), included content that addressed crisis-relevant psychology issues and promoted transparency and replicability ("what"), and was subsequently cited and published traditionally ("where" they gain traction).

Who is Posting PsyArXiv Preprints?

Crisis-relevant research needs to provide adequate coverage of the situation globally and consider people from multiple backgrounds. For example, there have been many reports about clinical trials underrepresenting people from black, Asian, and ethnic minority backgrounds (NIHR, 2020). In the context of psychology, of studies that reported the nationality of participants, 94 percent focused exclusively on WEIRD (Western, educated, industrialized, rich and democratic countries) samples (Rad, Martingano, & Ginges, 2018). During times of crisis, a lack of diversity in research could limit policymakers' ability around the world to inform policies on research-based evidence. As such, it is useful to determine the level of global diversity represented by crisis-relevant psychological preprints.

The COVID-19 pandemic has also had an impact on researchers. For example, female researchers in Australia were 1.5 times more likely to lose their short-term researcher positions due to the pandemic. Since women are already underrepresented as first authors in major research journals, this finding must be cause for concern (Rapid Research Information Forum - ATSE, 2020). Women were also significantly underrepresented across high profile

multidisciplinary and neuroscience journals. For example, women accounted for about 25% of first authors in *Nature* and *Science* and around 35% of first authors in *PNAS* (Shen, Webster, Shoda, & Fine, 2018). Since the crisis began in January 2020, women comprised about a third of all authors who have published papers on COVID-19 (not including preprints). Women also had far less presence in the first and last authorship positions (Pinho-Gomes et al., 2020). The gender differences could be a result of increased care-work demands since the beginning of the pandemic.

What kind of PsyArXiv preprints are being posted?

Van Bavel et al. (2020) catalogued several psychological science research streams (e.g., communication and mental health, to name a few) that could have a positive impact on managing the outbreak and improving the lives of individuals during the pandemic. Thus it is of interest to investigate what areas of psychological science in the context of COVID-19 have been investigated in the early phases of the pandemic.

Where are PsyArXiv Preprints gaining traction and impact?

Assessing where the preprints are going and the elapsed time to publication could provide insights into the extent to which preprints offered early access to crisis-relevant research. Currently, the extent to which these preprints end up as timely publications is unclear. As stated, accelerated development of information without compromising quality could have substantial benefits during crises. Preprints are offered as a potential solution. Thus investigating the extent to which preprints lead to publication and the factors that predict publication and citation could indicate whether preprints facilitate accelerated research development without substituting quality.

The Current Study

The present study analyzed the psychological preprint repository PsyArXiv (PsyArXiv, 2020). We determined the topics of PsyArXiv preprints, how long they took to be published, where they were submitted, and by whom. Determining where the preprints were submitted could indicate whether crisis-relevant research covers multiple cultures and provides insights into the situation globally. Analysing who is conducting the research could provide insights into the impact the pandemic has had on researchers and their diversity. We analyzed the dissemination trajectories of the first 211 preprints of PsyArXiv that were posted on COVID-19 (collected on 13 May 2020).

Methods

Data Collection and Procedure

We collected metadata for 218 COVID-related preprints on PsyArXiv using the search key "COVID". After removing duplicates and preprints that were later withdrawn (except preprints that were withdrawn due to green open access/self-archiving conflicts post-publication), we obtained a final sample of 211 preprints.

We recorded the corresponding author's name, preprint URL, upload date, study title, disciplines, tags, and the number of downloads for each preprint. The *disciplines* metadata enable the preprint author(s) to categorise the preprint into psychology subfields (e.g. health psychology). A *tag* allows the author(s) to describe the preprint's content (e.g., mental health could be a standard tag in a clinical psychology preprint). We also recorded the countries of the corresponding authors' institutional affiliations. Metadata collection commenced on 13 May 2020 and was completed on 14 May 2020.

We recorded the gender of the author, whether there was evidence of multinational collaboration, and checked for indicators of open science practices. In order to record the gender

of the author, in case it wasn't possible based on their name, we researched them. We used two indicators of open science practices: whether authors had pre-registered the methods and analysis and/or shared their data and materials in an open repository (at least one of the two indicators was required). Computational reproducibility or shared code/data provide an upper bound on the validity of this cue for the reliability of a preprint (Obels et al., 2020). Further, the preprint had to contain at least two authors based in different countries to be considered multinational.

We then reviewed the research to determine critical aspects of each preprints' methodology. For example, common methodological elements included experiments, surveys, correlational designs, reviews, and metascience. If a paper contained several methodological aspects, all were recorded.

Finally, we collected the number of citations that each preprint had received, as provided by the "cited by" feature in Google Scholar. We did this at two-time points: 15 May 2020 and a follow-up on 2 March 2021. At the follow-up, we also recorded whether the preprint had been published in a journal and, if so, the name of the journal, publication date (if available), and the number of citations of the published manuscript.

Data Analysis

Our research question tackled three aspects of COVID-19 PsyArXiv preprints: who produced the preprints, what was featured in the preprints, and where did the preprints gain traction and generate impact. We used a mix of analysis methods to assess these different aspects.

First, we used non-parametric tests to investigate breakdowns by first author gender and the countries (grouped by regions for analysis, see Table 1) of the institutions where authors

were affiliated. We analysed which countries accounted for the preprint first authors and whether authors hailed from institutions within the same country or multiple countries.

To investigate the contents of the preprints, we used word clouds to identify common themes in the titles, author-selected disciplines, and tags of the preprints. We also coded and reported the methodologies (e.g., experimental, correlational, review) reported in the preprints. Also, we assessed using non-parametric tests whether preprints included at least one of two established open science measures: preregistration and open data.

Finally, to assess the traction and impact of the preprints over time and factors that might predict them, we analysed publication and citation data for the preprints (and the published manuscripts, where relevant). We used multiple regression analyses on the publication and citation data. As our analyses were not planned, we complement the typical frequentist statistics with Bayesian analyses. We provide a brief explanation here of Bayesian methods and the difference from frequentist statistics; the interested reader is encouraged to see Kruschke & Liddell (2018) for a more detailed comparison.

The frequentist approach (i.e., null hypothesis significance testing) computes the probability of obtaining a statistic (e.g., a *t*-statistic) if the null hypothesis were true (i.e., no effect), resulting in the rejection of the null hypothesis if the probability is small enough (traditionally $p < .05$). In contrast, Bayesian analyses quantifies how many more times the data are likely to occur under two models: one model for the null hypothesis vs. one model for the alternative (i.e., a model where the predictor variable(s) are related to the dependent). This ratio of evidence likelihood is quantified in terms of a Bayes Factor (BF), where BF10 reflects the strength of evidence for Model 1 (with the relevant predictors) over the null model, and BF01 the strength of evidence for the null model over Model 1.

Our frequentist regression and Bayesian analyses were performed in R using the lm and glm functions and the BFpack R package, respectively (Mulder, 2019). BFpack computes default Bayes Factors that do not require prior external knowledge about the magnitude of the parameters (Mulder, 2019).

Disclosures

Open data and analyses

The data and codes used to reproduce the analyses reported here are available on the Open Science Framework (https://osf.io/nufjh/?view_only=7b8d73e831d645ed8b1b4a3c64315ab4). The project was exploratory and not pre-registered.

Reporting

We report all data exclusions, all manipulations, and all measures in the study. Our sample sizes were a product of the number of preprints available on the PsyArXiv repository at the time.

Ethics Approval

The study was approved by the University of Bristol Ethics Committee.

Results

Who posts preprints?

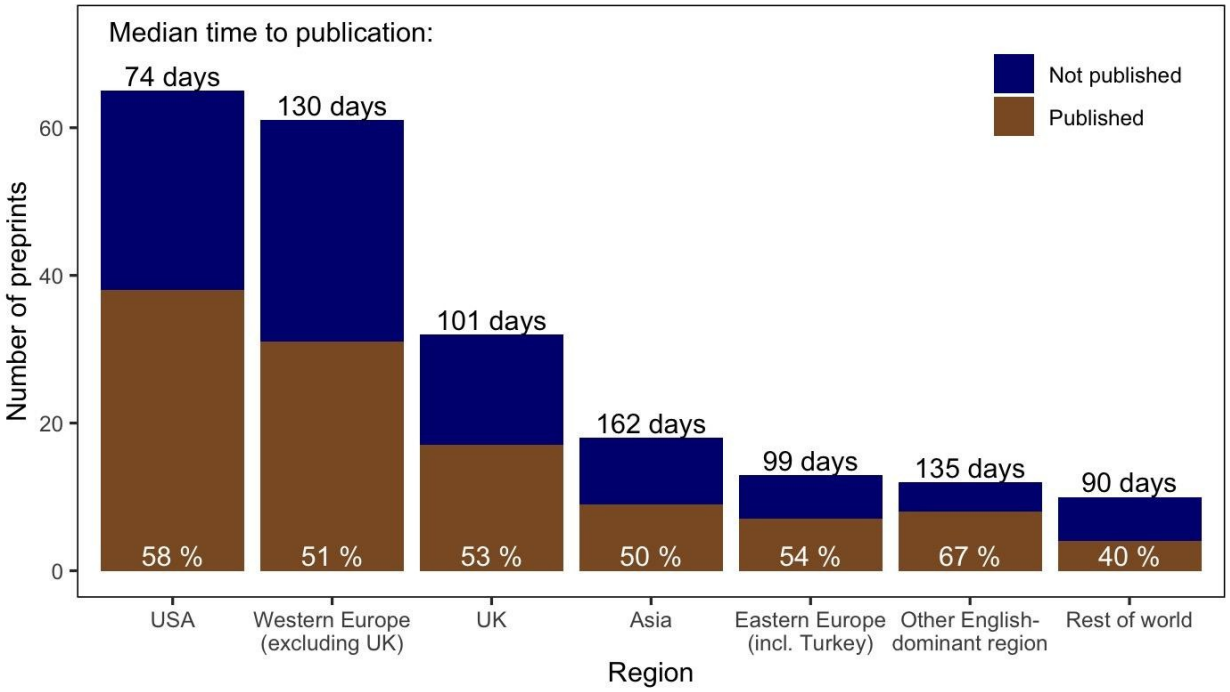
Of preprints where we could determine gender of first author (n = 210), significantly more first authors were male (65%), $\chi 2(N = 210, df = 1) = 18.31$, $p < .001$. Table 1 shows the country of provenance of the preprints, with authors from the USA making up 31% of all preprints in the sample. Preprints were overwhelmingly from authors in Western European countries (nearly half the sample) and only 5% of preprints originated from African or South

American countries. We classified the countries into 7 regions for analysis (as indicated in Table 1; see Figure 1 for an illustration that includes publication status of the preprints). Most (65%) preprints had authors all based in institutions of the same country, $\chi 2(N = 211, df = 1) = 18.81$, $p < .001$. Thus, overall it appears that the majority of preprints had male first authors based at Western institutions, and authors within the same country.

Table 1 about here (see Tables and Figures Section for larger tables)

Figure 1

Number of preprints published (or not) from the different world regions.



Note. Each bar shows the overall number of preprints with corresponding authors in the x-axis region, with blue and brown areas indicating the share of unpublished and published preprints respectively. Percentages are given for proportion of brown areas, i.e., proportion of preprints from the region that were published (as of 2 March 2021). Median days from submission of preprint to publication is given at the top of the bars. Publication status was determined by a search in Google Scholar for a journal article version of the preprint.

What features in PsyArXiv preprints?

Figure 2 shows a word cloud depicting the common themes in the preprints' tags (created using https://www.wordclouds.com/). The words "COVID", "pandemic", and "coronavirus" were removed in the word cloud analysis as they overrepresented space in the cloud and were not informative (since all preprints were selected based on their reporting of COVID-19 related studies). The word clouds indicated a high prevalence of studies on social and mental health-related topics among the preprints, with words such as "health", "mental", and "social" standing out predominantly.

Figure 2

Common tags for COVID-19 PsyArXiv preprints.

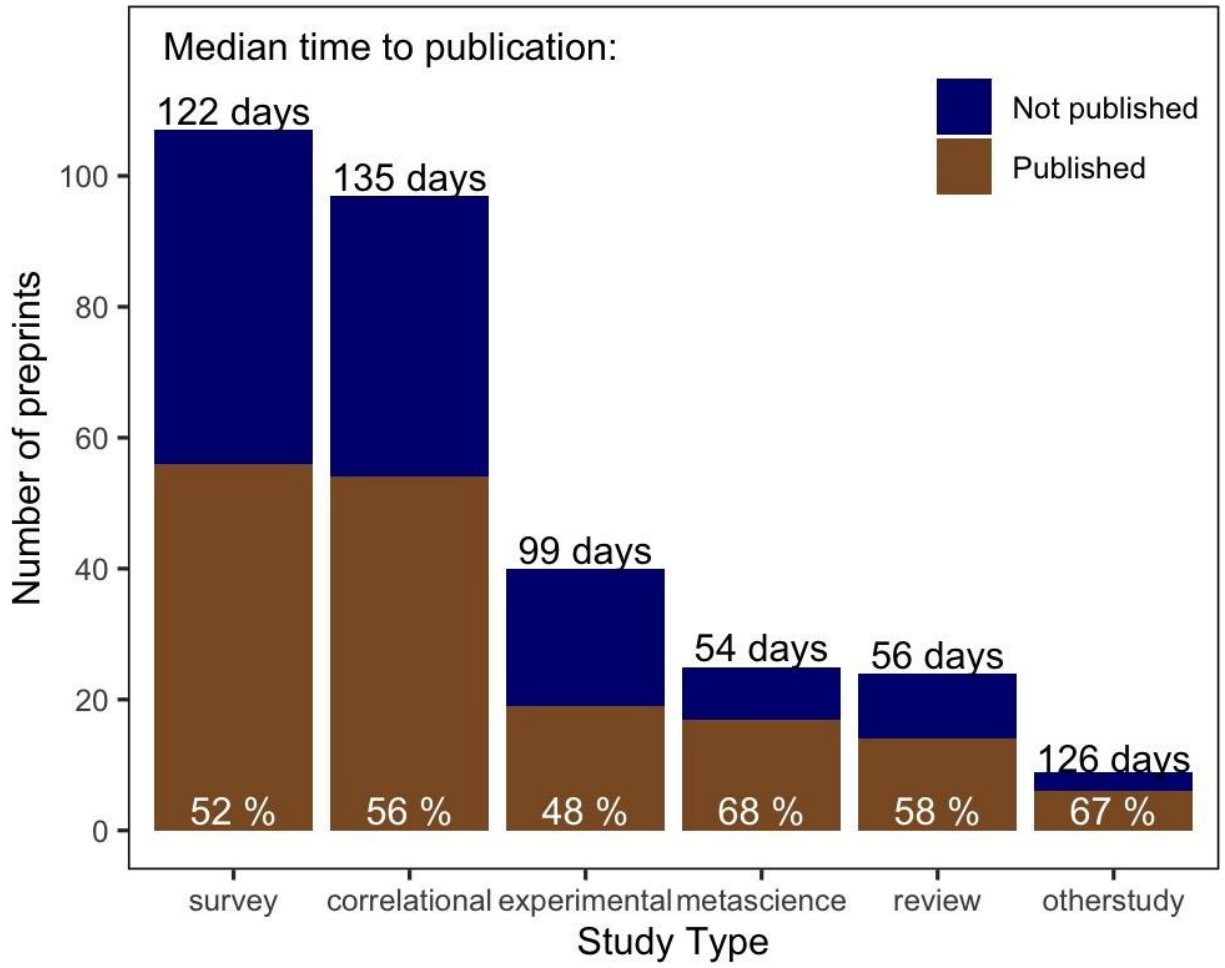
We coded each preprint as to whether it contained different study types as illustrated in Figure 3 (one preprint could include more than one type). Fifty-one percent of preprints in the sample reported surveys that the authors had conducted (e.g., on public attitudes, behaviour), 46% looked at relationships between variables, 19% included experimental manipulations, 12% looked at the scientific process (i.e., "metascience"), 11% were reviews (broadly speaking, including meta-analyses and descriptive reviews). Four percent used methods that did not fall into any of the above categories: secondary data analysis (1), big data mining (e.g., search trends; 4), case studies (2), and proposals for future work (2).

Preprints are often heralded as an element of "open science". They should therefore go hand in hand with other "open science" practices, such as preregistration or open data sharing. We found that 81% of the preprints contained neither pre registration nor open data (excluding 33 reviews and theoretical papers where preregistration and open data would not be applicable).

When we looked at combinations of other factors, as shown in Figure 4, significantly fewer female first-authored preprints contained preregistration and/or open data (only 5 out of 61), $\chi 2(N = 178, df = 1) = 5.57$, $p = .018$. There was no significant difference in the proportion of preprints with preregistration and/or open data from authors in single or multiple countries, $\chi 2(N = 178) = 0.23$, $p = .628$.

Figure 3

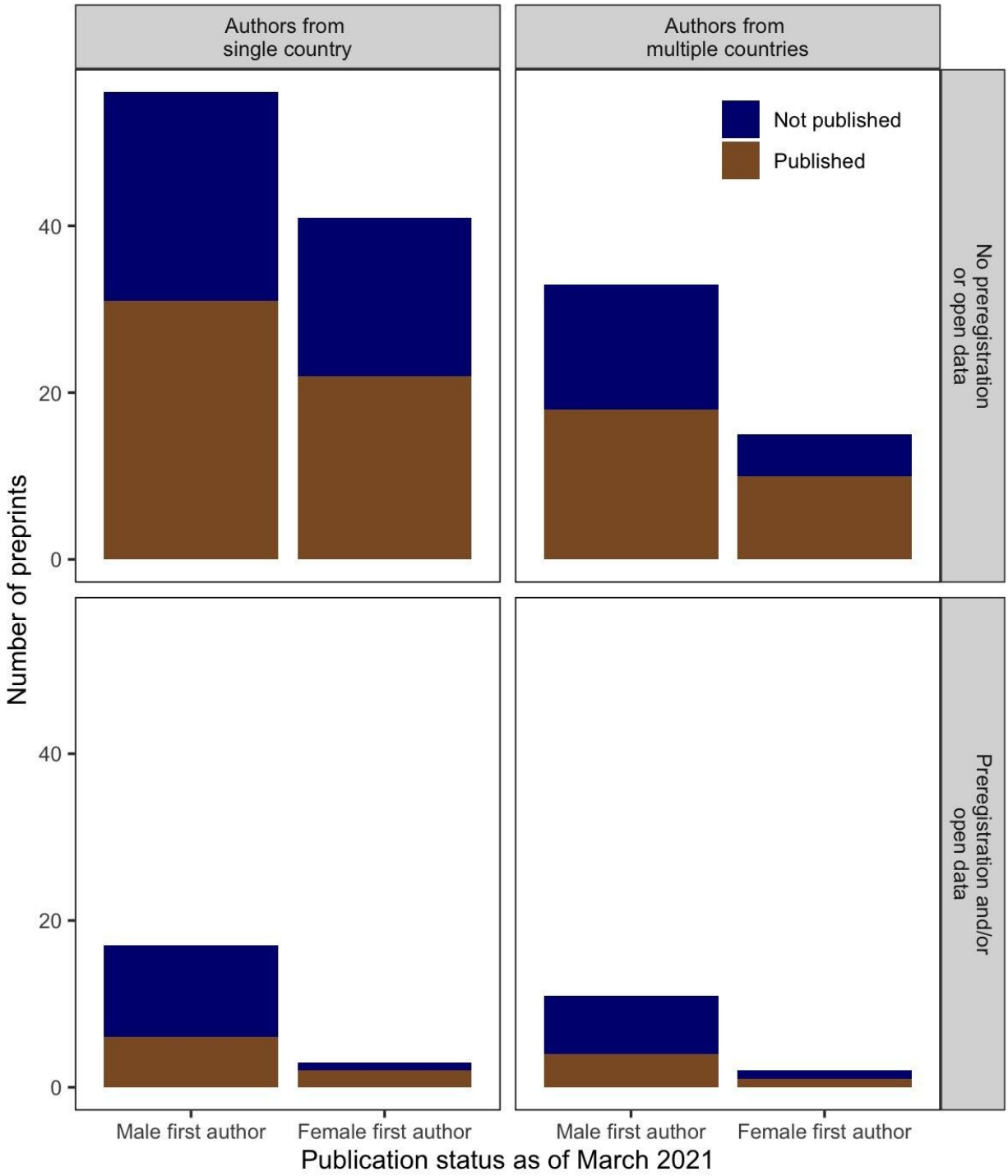
Number of preprints including different study/analysis methods and whether they have been published or not.



Note. Preprints could contain more than a single method (e.g., a preprint might report an experimental study along with a survey). For example, many surveys also contained correlational analyses. Percentages are given for proportion of brown areas, i.e., proportion of preprints from the region that were published (as of 2 March 2021). Median days from submission of preprint to publication is given at the top of the bars. Publication status was determined by a search in Google Scholar for a journal article version of the preprint.

Figure 4

Whether preprints that had been published according to gender of first author, whether the preprint included preregistration and/or open data/whether the authors were from institutions within the same or different countries.



Where do preprints gain traction? Analysis of publication and citation data.

At the time of the follow-up analysis (2 March 2021), 54% of the sampled preprints had been published in peer-reviewed journals, with the median time between preprint upload and publication being 105 days (mean = 116 days; excluding 11 postprints in the sample that had been uploaded after or at the same time of publication). On average the preprints had received a median of 13 citations (IQR = 4-33); for published manuscripts this was a median of 17 citations (IQR = 5-45). Since the number of citations received was, naturally, related to the time since submission (or publication), $r = 0.23$, $p < .001$ ($r = 0.23$, $p = .021$), we calculated a citation rate (citations per day) for each preprint. The median total citation rate was 0.04 citations per day (calculated based on time of preprint submission; IQR = 0.01-0.10) and 0.08 citations per day for the published versions (calculated based on time of publication; IQR = 0.03-0.20). This data was, predictably, highly skewed, for total citation rate, skewness = 9.23, kurtosis = 108.93; for citation rate of published manuscripts, skewness = 5.01, kurtosis = 33.26. We therefore used a log transformation on the citation rates before analysis. (Resulting skewness = 0.27 and 0.01, kurtosis = 2.74 and 2.52 respectively). Unsurprisingly, published preprints had a higher citation rate than unpublished ones, $t(253.46) = 30.80$, $p < .001$, $d = 0.41$ (95% CI [0.13, 0.69]).

We used logistic regressions to analyse whether (1) gender of first author, open science measures (preregistration and/or open data), and authors institution diversity; (2) world region of first author; and (3) study methodology were related to whether or not the preprint was published. Neither gender, open science measures, institution diversity, nor world region were significantly related to a preprint's publication status (all ps > 0.10, see Table 2 for all coefficients and odds ratios). The Bayesian analysis also found moderate to strong evidence that these variables were not predictive of publication status (BF10 = 0.07-0.37). The regression with

study methodology showed that studies including correlational and metascience methods were 2.3 and 5.5 times as likely to be published than those not using these methods, p = .043 and .013 respectively (see Figure 5 for an illustration). However, the Bayesian analysis indicated the evidence was moderately in support of metascience studies being more likely to be published, BF10 = 3.00, while for the correlational studies, they were almost as likely as not to be published compared to those without correlational methods, BF = 1.05. The other study methods were not significant predictors of publication, all ps > .05, with evidence in favour of no effects (BF10 = 0.19-0.82).

We used linear regressions with the same three fixed effects models to estimate the effects of these variables on the (log) citation rate for the preprint (see Table 2), and for those with published manuscripts, the time to publication and (log) citation rate for the published manuscript (see Table 3). Only one variable significantly predicted (log) citation rates: preprints reporting reviews were cited at a significantly lower rate than non-review preprints, β = -0.27, p = .009. The Bayesian analysis found moderate evidence for this relationship, BF10 = 3.38. There were no significant effects for all other variables and interactions (including for time to publication and log citation rate for the published manuscript), all ps > .05. There was also weak to strong evidence in favour of no effect of these variables and interactions, BF10 = 0.06-0.64.

Tables 2 and 3 about here (see tables and figures section)

Discussion

Summary of Findings and Implications

Who posted PsyArXiv preprints?

The study aimed to provide a snapshot of the diversity of authors posting preprints. We specifically investigated the gender and institutional background of the first author of each

preprint, finding that the first 211 psychology preprints on the pandemic were dominated by males in Western countries working with authors within the same country. Preprints were mostly posted by authors in Western European countries (nearly half the sample) and only 5% of preprints originated from African or South American countries.

Previous studies have demonstrated that females made up for about 25% of first authors in *Nature* and *Science* and around 35% of first authors in *PNAS* (Shen, Webster, Shoda, & Fine, 2018). Our data show a similar pattern with preprints (35%), and corresponds with the data in other fields (Viglione, 2020). As author gender was not predictive of subsequent preprint publication, we posit that the gender gap in publishing is being exacerbated by barriers to producing research, such as the greater impact of COVID-19 on women in terms of the increased burden in unpaid caring duties (Xue & McMunn, 2021). Since COVID has required more people to work from home and provide care for dependents, it is reasonable to suggest that this gap could worsen. Further research and initiatives are therefore needed to address this issue.

Most of the preprints coming from Western countries could also create some cause for concern. A lack of representation in science can hinder policymakers' capacity to base policies on research-based evidence worldwide in times of crisis. More needs to be done to address the disparity to provide comprehensive coverage of the psychological implications during crises.

What featured in PsyArXiv preprints?

As per the word cloud of preprint tags, most papers focused on the mental health consequences from the pandemic and related measures (e.g., lockdown) and potential solutions. Fifty-one percent of preprints in the sample reported on surveys authors had conducted (e.g., public attitudes, behaviour).

Although research into the pandemic's mental health consequences is of clear importance, there seems to be a disparity in the amount of research conducted on this issue compared to other topics such as compliance with behavioural measures and misinformation, to name a few. Belief in misinformation, for example, predicts less compliance with COVID regulations (Roozenbeek et al., 2020). In this context, behavioural science could have an important role in informing policies to promote compliance. The findings could suggest that further focus is needed on these issues to increase the usefulness of behavioural science during times of crisis.

Although preprints are ostensibly important for promoting transparency in research, the results also suggest that most of the preprints (83%) lacked an indication of open science practices. Of course, the goal is to have as many papers adopt open science measures as possible. More than 120 other journals now offer registered reports, in fields as diverse as cancer research, political science, and ecology as of 2018 (Kupferschmidt 2018). This sharp increase could be a consequence of the recent and critical spotlight placed on transparency, replicability, and validity in psychological research calls for more studies to adopt open science measures (Landy et al., 2020; Open Science Collaboration, 2015; Shrout & Rodgers, 2018). The results from the present study could result in some concern. It is reasonable to suggest that more work is needed to encourage researchers to adopt open science practices to improve psychological science. It is reasonable to suggest that the implementation of open practices necessitates a shift in mindset and efficiency standards, which academics at all levels and funders must accept (Allen & Mehler, 2019; Norris & O'Connor, 2019). However, it is perhaps not an option but a key requirement for research and should be promoted wherever possible.

Where did the preprints gain traction and impact?

Overall, 54% of the sampled preprints had been published in peer-reviewed journals, with a median time between preprint upload and publication of 105 days. There were few predictors of publication; only correlational and metascience features were significantly predictive of publication status, and our complementary Bayesian analyses indicated support only for metascience preprints being more likely to be published. If we consider publication to be an indication of a paper's academic importance, the greater likelihood of metascience preprints to be published during the COVID pandemic period could indicate a greater amount of reflection about the way psychology research is conducted. Reflections about how research has, or should, change in light of COVID-19 have been prominent in other domains, for example, clinical research (Park et al., 2021).

Publication was also the most significant predictor overall of how much a preprint was cited; published preprints overwhelmingly received more citations than unpublished ones. Surprisingly, the only other factor that predicted citation count (after taking into account publication status) was whether the preprint contained a review—and these were *less* likely to be cited than preprints without reviews. One reason for this could be that our sample, captured early in the pandemic, would not yet have had the chance to review large numbers of COVID psychology studies (given they would not have been completed yet). Subsequent researchers might then not have found these reviews as informative as other individual studies.

Limitations

This study has some limitations. The analysis focused on preprints from a specific time frame. The excluded studies could provide useful insights into how the direction of COVID-19 related PsyArXiv preprints shift over time and in relation to current events. Although the analysis accounted for the elapsed time to publication for preprints, we did not have data on the

elapsed time to publication for manuscripts that were not submitted as preprints. This information could provide a direct method of comparison to how preprints might affect publication.

Conclusions

Given the central importance of Non-Pharmaceutical Interventions to the pandemic, it is perhaps surprising that such a small proportion is experimental, and the bulk of studies rely on survey data. Given that this is an arena in which psychology (and the behavioural sciences more generally) compete with commercial surveys and thus occupies a non-unique role, this raises some questions about the pandemic 'readiness' of the discipline. At the same time, the geographic concentration of authors, already a limitation in normal times, seems regrettable in the context of a truly global pandemic. While deeper analysis (involving far more than just preprints) will be required to examine these issues, it does tentatively suggest that some of the structural problems in the behavioural sciences remained in operation even in a pandemic context with mass mobilisation of researchers.

Author Contributions

Muhsin Yesilada contributed to the conceptualisation (input on study design), contributed to data curation, project administration, contributed to data analysis, contributed to methodology, contributed to visualisation, contributed to writing [original draft and review & editing]. Dawn Liu Holford, Marlene Wulf, and Ulrike Hahn contributed to the conceptualisation (project idea, input on study design), contributed to data analysis, project administration, contributed to the methodology and reconsidered draft posts. Stephan Lewandowsky contributed to the conceptualisation (input on study design), contributed to methodology, and edited drafts. Stefan M. Herzog contributed to the conceptualisation (input on study design), and editing of drafts.

Marta Radosevic, Erik Stuchly, Katie Taylor, Siyan Ye, Gaurav Saxena, and Gail El-Halaby contributed to data curation, investigation, and reviewing and editing drafts.

Conflict of Interests

The authors declare that there were no conflicts of interest with respect to the authorship or the publication of this article.

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Tables

Table 1

Number of preprints with corresponding authors from the different countries and regions.

Corresponding author country	Number of preprints	Region classification	Number of preprints
USA	65	USA	65
UK	33	UK	33
Germany	12	Western Europe (excluding UK)	61
Spain	9		
Italy	8		
Netherlands	7		
Denmark	5		
France	5		
Switzerland	5		
Norway	4		
Ireland	3		
Sweden	2		
Belgium	1		
Luxembourg	1		
China	7	Asia	18
Japan	4		
India	2		
Bangladesh	1		
Israel	1		
Pakistan	1		
Singapore	1		
UAE	1		

Poland	7	Eastern Europe (including Turkey)	13
Slovakia	2		
Turkey	2		
Croatia	1		
Slovenia	1		
Canada	8	Other English-dominant region	12
Australia	2		
New Zealand	2		
Nigeria	2	Rest of world	10
Brazil	1		
Kenya	1		
Peru	1		
South Africa	1		
Unknown	4		

Table 2

Coefficients and Bayes Factors in logistic and linear regression with effects of predictors on publication status (published or not) and citation rate (log) of preprints.*

	Publication status					Preprint (log) citation rate				
Predictor	***b***	**95% CI**	***OR***	***p***	**BF10**	***b***	**95% CI**	***β***	***p***	**BF10**
Preregistration and/or open data available (1)	-0.85	-1.98, 0.15	0.43	.571	0.12	-0.52	-1.30, 0.26	-0.13	.191	0.27
Female first author (2)	-0.85	-0.81, 0.70	0.43	.145	0.37	0.06	-0.50, 0.62	0.02	.831	0.05
Authors from single country institution (3)	-0.55	-1.14, 0.45	0.57	.324	0.19	0.34	-0.26, 0.94	0.11	.264	0.16
(1) * (2)	0.15	-1.33, 4.53	1.17	.925	0.07	-0.36	-2.29, 1.57	-0.04	.714	0.15
(1) * (3)	1.25	-1.58, 1.89	3.50	.522	0.13	0.79	-0.46, 2.03	0.13	.214	0.28
(2) * (3)	0.90	-0.44, 2.31	2.46	.196	0.29	-0.33	-1.32, 0.67	-0.07	.518	0.11
(1) * (2) * (3)	-1.44	-5.96, 2.87	0.24	.501	0.13	-0.35	-3.43, 2.74	-0.02	.825	0.15
Compared to rest of the world										
US	1.03	-0.67, 3.06	2.81	.251	0.23	0.34	-0.92, 1.61	0.10	.593	0.09
UK	0.82	-0.96, 2.89	2.27	.382	0.16	0.60	-0.72, 1.92	0.14	.373	0.14
Other English-dominant country	1.39	-0.62, 3.68	4.00	.191	0.30	1.04	-0.45, 2.53	0.16	.170	0.27
Western Europe	0.73	-0.98, 2.75	2.07	.421	0.15	0.75	-0.52, 2.02	0.22	.245	0.20
Eastern Europe	0.85	-1.12, 3.07	2.33	.410	0.16	0.34	-1.12, 1.81	0.05	.645	0.09

Asia	0.69	-1.18, 2.85	2.00	.482	0.14	1.06	-0.34, 2.46	0.19	.138	0.32
Study methodology										
Survey	0.46	-0.30, 1.22	1.58	.238	0.24	-0.15	-0.71, 0.41	-0.05	.598	0.09
Correlational	0.85	0.04, 1.69	2.34	.043	1.05	-0.14	-0.74, 0.47	-0.04	.653	0.08
Experimental	0.47	-0.46, 1.42	1.59	.328	0.19	-0.26	-0.95, 0.43	-0.07	.456	0.11
Metascience	1.70	0.38, 3.08	5.49	.013	3.00	-0.66	-1.64, 0.31	-0.14	.183	0.25
Review	1.30	-0.03, 2.67	3.68	.057	0.82	-1.32	-2.31, -0.33	-0.27	.009	3.38
Others	1.66	-0.05, 3.52	5.25	.063	0.75	0.48	-0.78, 1.74	0.06	.451	0.03

Note. Whether preprint was published was controlled for in the regression analysis for total citations (log) of preprints.

Table 3

Coefficients and Bayes Factors in linear regression with effects of predictors on time to publication and (log) citation rate for published preprints

	Time to publication					(Log) citation rate for publication				
Predictor	***b***	**95% CI**	***β***	***p***	**BF10**	***b***	**95% CI**	***β***	***p***	**BF10**
Preregistration and/or open data available (1)	-43.62	-28.47, 114.60	-0.19	.563	0.14	-0.05	-1.46, 1.36	-0.01	.942	0.09
Female first author (2)	-29.62	-54.87, 24.12	-0.20	.270	0.27	-0.25	-1.03, 0.53	-0.08	.528	0.15
Authors from single country institution (3)	-41.66	-52.88, 33.66	-0.27	.098	0.64	0.39	-0.47, 1.24	0.12	.371	0.06
(1) * (2)	72.28	-223.00, 39.95	0.27	.412	0.19	-1.04	-3.62, 1.55	-0.12	.427	0.18
(1) * (3)	-4.84	-125.82, 109.58	-0.02	.958	0.09	1.05	-1.26, 3.37	0.14	.368	0.20
(2) * (3)	53.60	-16.08, 118.62	0.36	.107	0.59	-0.14	-1.47, 1.18	-0.03	.832	0.10
(1) * (2) * (3)	10.64	-211.12, 237.05	0.03	.922	0.09	-1.01	-5.41, 3.39	-0.07	.649	0.12
Compared to rest of the world										
US	-31.84	-143.42, 73.57	0.19	.595	0.14	0.77	-1.39, 2.94	0.25	.479	0.16
UK	-23.90	-136.05, 88.25	0.22	.425	0.18	1.15	-1.08, 3.39	0.28	.309	0.24
Other English-dominant country	25.64	-93.81, 145.10	0.15	.488	0.16	1.63	-0.76, 4.01	0.28	.178	0.38
Western Europe	3.18	-110.42, 107.42	0.28	.414	0.19	1.11	-1.06, 3.28	0.34	.312	0.24
Eastern Europe	-8.67	-154.24, 84.67	0.11	.578	0.14	0.62	-1.81, 3.05	0.10	.613	0.13
Asia	11.07	-108.38, 130.53	0.05	.825	0.10	0.84	-1.54, 3.22	0.15	.484	0.16
Study methodology										

Survey	19.74	-22.02, 59.89	0.14	.325	0.23	0.39	-0.45, 1.23	0.13	.357	0.21
Correlational	20.76	-22.02, 72.55	0.14	.365	0.21	0.62	-0.34, 1.58	0.21	.205	0.34
Experimental	26.21	-33.71, 66.46	0.13	.280	0.26	0.49	-0.52, 1.51	0.13	.338	0.22
Metascience	-24.40	-87.48, 52.77	-0.12	.472	0.17	0.53	-0.90, 1.95	0.13	.466	0.17
Review	-19.39	-87.06, 62.26	-0.09	.590	0.14	-0.07	-1.59, 1.45	-0.01	.931	0.09
Others	58.97	-23.53, 155.46	0.18	.173	0.39	0.67	-1.15, 2.50	0.10	.464	0.17