

An Inception Cohort Study Quantifying How Many Registered Studies are Published.

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We quantified how many studies registered on the Open Science Framework (OSF) up to November 2017 are performed but never shared. Examining a sample of 315 registrations, of which 169 were research studies, we found that 104 (62%) were published. We estimate that 5550 out of 9544 (58%) registrations on the OSF are published within at least 4 years. Researchers use registries to make unpublished studies public, and the OSF policy to automatically make registrations public substantially increases the number of performed studies that become known to the scientific community. In responses to emails asking researchers why studies remained unpublished, logistical issues (e.g., lack of time, researchers changing jobs) was the most common reason, followed by null results and rejections during peer review. Our study shows that a substantial amount of data that researchers collect is never publicly shared.

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Not all studies that scientists perform end up in the scientific literature (Franco, Malhotra, & Simonovits, 2014; Greenwald, 1975; Sterling, 1959). Studies remain unpublished for a variety of reasons, such as a lack of resources to analyse the results, a loss of interest, perceived methodological weaknesses, or because the results do not support predictions (Easterbrook, Berlin, Gopalan, & Matthews, 1991; Lishner, 2021). When studies that have the potential to contribute to scientific knowledge go unpublished research resources are wasted (Buxton et al., 2021; Chalmers & Glasziou, 2009). Although it is challenging to quantify how many studies remain unpublished the existence of the proverbial file drawer (Rosenthal, 1979) has been demonstrated in disciplines such as psychology, sociology, economics, and medicine (Dickersin, Min, & Meinert, 1992; Franco et al., 2014; Gerber, Malhotra, Dowling, & Doherty, 2010; Scheel, Schijen, & Lakens, 2021).

The most accurate estimates of the percentage of performed studies in the file drawer come from inception cohort studies where studies are – typically retroactively – followed from the moment they are started (Song et al., 2010). For example, Dickersin and colleagues observed that from all studies approved by two institutional review boards serving the school of medicine and the school of health at the John Hopkins University 81% and 66% were published, respectively (Dickersin et al., 1992). In the only inception cohort study in the social sciences we know of, Franco, Malhotra, and Simonovits (2014) found that out of 249 experiments 106 were published in a scientific journal or as a book chapter (45%), 29% of studies were written up but remained unpublished at the time of the study, and 20% (primarily non-significant results) were unpublished and not written up.

One way to make all studies that have been performed known to peers is to require researchers to (pre)register their study in a publicly accessible database (Dickersin & Rennie, 2012). Registries often require researchers to update a registered study with the results. An example of such a study registry is ClinicalTrials.gov. The requirement to register certain types of studies does not exist in psychology. However, since 2013 the Open Science Framework (OSF) has provided a free study registry for any scientific domain (Spies, 2013). The OSF offers researchers the possibility to voluntarily register their study by specifying their hypotheses, methods, and statistical analysis plan.

One interesting aspect of registrations on the OSF is the fact that every registration after June 8 2015 (if not withdrawn)

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will be made public after an embargo period of four years¹. This policy means that the OSF provides a public record of all studies that were registered on the platform up to four years ago. It is therefore possible to use the database of registered studies for an inception cohort study that quantifies how many studies are performed, but never publicly shared.

The current study

In this project we aimed to answer four main research questions. First, we were interested in estimating the number of registered studies on the OSF that were performed but remained unpublished after four years. Although registered studies are only a subset of all studies researchers perform, in the results section we estimate that our findings apply to 9,544 research studies registered on the OSF up to November 2017.

Second, we were interested in whether a registry with the policy to make registration public after an embargo facilitates identifying unpublished studies. By comparing the publication status of registrations manually made public by researchers with registrations automatically opened by the OSF after four years we can answer two questions. How often do researchers voluntarily share information about their study, even when the study remains unpublished? And how often do we learn about performed but unpublished studies because of the OSF policy to automatically make registrations public after four years? Answers to these questions can provide insights into the benefits of a platform that makes registrations public after a certain time (e.g., OSF), compared to platforms that permanently keep registrations private (e.g., AsPredicted.org).

Our third question concerns the possibility to correctly identify whether a registered study is publicly shared, or not. For a registry to notify the scientific community about the presence of unpublished studies, the information in the registry needs to be complete enough to match the registration to a published study, or to conclude the registered study remains unpublished. As far as we know, this is the first investigation that retrieves registrations from the OSF to attempt to identify whether the associated study has been publicly shared or not.

Finally, while it is useful to quantify how many registered studies remain unpublished after four years, it is equally important to understand why studies remain unpublished. The fourth aim of our study was to contact researchers of registrations of studies that were not published and ask why their study remains unpublished.

Method

Data sources: As registrations become public after four years, we downloaded all information that can be retrieved through the application programming interface (API) of the OSF for 17,729 registrations that were created before November 18, 2017 (four years before the start of this study). Registrations are part of at least one associated project page on the OSF. Sometimes researchers still work on projects four years after a registration, and we saw continued activity in some registrations in our sample. The final classification was based on whether the projects were public in April 2022. For 8008 registrations (45.17%) the associated project was public, while for the remaining 9721 registrations (54.83%) the associated project was private. We randomly sampled registrations from both these groups. During data analysis we made sure that we did not include the same study twice (even though a single study can have multiple registrations, for example because an analysis subcomponent and a hypothesis subcomponent each get a separate ID in the OSF database). Our sampling strategy increased the probability that studies with multiple registrations were included in the study.

Classifying Registrations: We aimed to examine at least 300 registrations (150 for which the registration was made public by the researchers, and 150 for which the registration was made public automatically after four years). The OSF API does not provide information about how a project has been made public. To circumvent this limitation, we relied on a proxy indicator to classify projects as opened by the user, or opened automatically when the embargo was lifted. We classified OSF registrations as made public by the researcher when any of the associated OSF project pages was public, and classified the project as made public automatically by the OSF after four years when the associated project page was not made public. Our reasoning is that when only the registration is public, but the underlying project remains closed, the registration is most likely opened automatically, as there are not that many use-cases where a researcher would open the registration, but not the associated project. This is not a perfect proxy, as it is possible for users to make a registration public, but to keep the associated OSF project hidden (for example, because they mistakenly believe they made the entire project public when making the registration public). When the registration and underlying project are public, we assume the registration is opened by the researchers. This assumption is more likely to hold, as only users can make underlying project pages public.

Classifying Publication Status: Studies can be available in

¹see <https://web.archive.org/web/20230519110220/https://groups.google.com/g/openscienceframework/c/3ZaZYKV8WD4/m/JCN4OB31skQJ>

different degrees, ranging from never being analysed (for example because the researcher who collected the data no longer works in science) to presented at a conference, to being published in a peer reviewed journal (Lishner, 2021). We considered a study ‘published’ if the study was communicated in any form that allows other researchers to learn about the results. In the remainder of this article the term ‘published’ is used when we classified studies as publicly shared because they appeared in the peer reviewed literature, but also when they were shared as a preprint, a PhD thesis in a stable repository, or a poster or conference paper that described the study in sufficient detail to include it in a meta-analysis (see the online supplementary material for more detail). We did not include bachelor or master theses because even though these can eventually be published (as this article demonstrates) they primarily have an educational goal and we do not consider the file drawer problem equally applicable to this category of studies. Our definition of ‘published’ is broader than in previous inception cohort studies (e.g., Dickersin et al. (1992); Franco et al. (2014)). We believe the rise of preprints and stable repositories warrants a broader definition of what it means to publish the results of a study, especially because preprints provide a possible outlet for studies that a researcher might decide not to submit to a scientific journal.

Results

Inclusion criteria: In total 315 randomly chosen registrations from manually and automatically opened registrations were examined to see whether they met the selection criteria of our study. Of these, the associated project was public for 164 registrations and the associated project was closed for 151 registrations. Registrations needed to be actual research studies, as we are interested in estimating how many studies remain unpublished when researchers had the goal to publish. We therefore coded and excluded registrations that were (1) withdrawn (e.g., all content is removed because an error was made in the registration, but the meta-data continues to exist), (2) performed for practice purposes (e.g. student assignments or trial registrations), (3) used to generate a stable DOI for supplementary materials at the end of a project, and studies that are unlikely to end up in the file drawer such as (4) Registered Reports, (Allen & Mehler, 2019; Chambers & Tzavella, 2022; Scheel et al., 2021), and (5) multi-lab projects (i.e., the Reproducibility Project: Psychology).

The number of included and excluded registrations in the sample is summarized in Table 1. We originally included 176 registrations. After excluding 7 registrations based on email responses for being student projects, performed without the goal of publishing the data, or part of a multi-lab project, our final sample size consists of 169 registrations. Of these, 88 registrations were categorized as manually opened and 81

registrations were categorized as automatically opened. An overview of how often registrations were excluded for each of the 5 inclusion criteria is provided in Table 2.

Identifying Publications Corresponding to Registrations: We attempted to find a publication (e.g., a journal article, preprint, thesis, or scientific poster) associated with each registration included in the analysis. Ideally, it is possible to find a publication associated with a registration without the help of the researchers who performed the study. In practice, due to the often limited information included in a registration on the OSF, information provided by the researchers improved our ability to classify registrations as publicly shared or not. If a publication could be found that provided a direct link to the OSF registration we could be certain that we found the publication corresponding to the registration. In many cases, especially when registrations on the OSF contained little information, and publications did not link to a registration on the OSF, there was some uncertainty about whether a paper corresponded to a registration. Furthermore, if no publication could be found, there always remained the possibility that we failed to find it. Based on an extensive search (for details, see the online supplement) we classified 68 out of the 169 registrations as published, 71 registrations as unpublished, and for 30 registrations we were uncertain about whether the registration was published. We remained uncertain when, for example, there was very little information in the preregistration, and the information that was available seemed related to a paper without a link to an OSF registration.

For all registrations where we were uncertain about whether a publication corresponded to the registration, we attempted to retrieve contact information of researchers involved, and contacted the researchers. We also contacted researchers associated with all registrations classified after an extensive search as unpublished, to check if the registration was indeed unpublished, and if so, ask the researchers why the study remained unpublished. We contacted 109 researchers, 29 researchers with registrations associated with public OSF projects and 80 researchers with registrations associated with closed OSF projects, of which 24 (82.76%) and 53 (66.25%) replied to our email with additional information to update our classification. We sent one email for a registration classified as published because we found a thesis in a repository to check if a paper had been published (and received one response), for one registration we did not have to email the researcher because we could retrieve the required information from a paper in which they explicitly discussed their file-drawer (van Elk, 2021), 77 emails for registrations we believed remained unpublished (and received 51 responses), and 31 emails because we were uncertain if they were published or not (and received 25 responses). Two additional researchers replied to our email, but did not give consent to

Table 1
Studies included in the analysis before and after e-mailing researchers.

	Included Before Emails	Included After Emails
Manually Opened (n = 164)	90 (54.88%)	88 (53.66%)
Automatically Opened (n = 151)	86 (56.95%)	81 (53.64%)

Table 2
Reasons studies were excluded from the analysis.

	Manually Opened	Automatically Opened
Withdrawn	1	5
No Research Study	21	50
No Unique Study	13	5
No Registration	27	20
Registered Report	13	3
Replication Project	12	1

Note. The sum is greater than the total number of excluded registrations because an individual registration can be excluded for multiple reasons.

use their replies in our data analysis, and we therefore did not change the classification of these two registrations.

After updating our classification based on email responses, the publication rate in group 1 increased by 6% (meaning that we failed to identify some publications corresponding to registrations) while the publication rate in group 2 decreased by 1%. Sometimes a publication we found in the literature did not belong to the registration. If the study associated with the registration was published in another source than the one we identified, the classification remained the same, but we still counted this registration as a mismatch because we failed to identify the correct article without the help of the researchers. In total, 48 of the 76 responses match with publications we found. For the 50 registrations we classified as unpublished, responses to the follow-up emails indicated that 36 (72%) were unpublished, while for 14 (28%) we failed to identify the published paper based on the information in the registration. Most of the mismatches occurred when we were uncertain about whether a paper we found included the registered study because there was no link to the registration on the OSF and only some terminology in the registration and article overlapped. For the 25 registrations where we were uncertain if the study was published, 11 (44%) of registrations matched a paper we found. Of the 14 (28%) cases in this group that were a mismatch, 2 were indeed published but we failed to find the correct paper, and the remaining 12 were actually not published. In one special case the paper we found was indeed a match, but we decided to change the final classification to unpublished as the registration belonged to two studies and only one of the registered studies

was published. Altogether, these results indicate that without contacting the researchers it is often difficult to determine whether a registration is published based exclusively on the information researchers provide in their registration on the OSF.

Due to non-response to our emails there is remaining uncertainty about the number of registrations in our sample that were eventually published. The 26 non-responses related to registrations where we could not find a publication might contain some publications that we missed, and the 6 non-responses related to registrations where we remained uncertain similarly contain some published and some unpublished studies. Researchers might be more likely to reply when their registration is actually published, or non-response might be unaffected by the publication status of their registration. Under the latter assumption, we can use the observed percentages of published studies in both categories to predict that responses from researchers would have told us that 19.45 out of 26 of the registration in the unpublished classification and 3.03 out of 6 of the registration in the uncertain classification are actually published.

After incorporating responses from researchers, and extrapolating these responses to the registrations where we did not receive a response, we predict that out of a total of 169 included registrations, 103.52 registered studies are published (61.25%, 95% CI [53.74; 68.27]). Our sample intentionally contained an almost equal number of manually opened and automatically opened registrations. As can be seen in Table 3 manually opened registrations were much more likely to be published than automatically opened registrations, but also

Table 3

Estimated number of published and unpublished studies registered on the OSF before November 2017.

Group	Registrations	% Included	Included	% Published	Published	Not Published
Manually Opened	8008	0.55	4,395	0.86	3,775	619
Automatically Opened	9042	0.57	5,150	0.34	1,775	3,375
Total	17050		9,544		5,550	3,994

somewhat less frequent in the total population of registrations. Multiplying our publication estimates by the estimated number registrations on the OSF before November 2017 that can be classified as an actual research study we find that 5550 registrations are published, and 3994 remain unpublished. Therefore, in the total population of all registrations on the OSF from before November 2017 we estimated that 58.15%, of registrations are published as an article, preprint, thesis, or poster after at least four years.

Evaluating the Effect of Automatically Making Registries Public

We see that 85.91%, 95% CI [77.13; 91.68] of all registrations that based on our proxy were classified as manually opened by the researchers have been published. In the remaining 14.09% of these registrations researchers have voluntarily chosen to make the registration public, even though the study was not published. This shows that a platform that enables researchers to make their registration public will make studies that would otherwise remain in the file-drawer known to the research community. We estimate that 34.47%, 95% CI [25.04; 45.31] of automatically opened registrations is published. Consequently, 65.53% of these registrations would not be known to the research community were it not for the fact that the OSF automatically opens registrations after four years. In other words, automatically opening registrations increases our awareness of all studies that have been performed, above and beyond enabling researchers to create public registrations that they can voluntarily make public.

Why do studies remained unpublished?

When registrations were classified as unpublished, or when we were uncertain about whether a registration was published, we reached out to the researchers to ask them whether their registration was published or not, and if not, why it remained unpublished. We also asked why they made the corresponding OSF project public or why they kept it private, and if the researchers were aware that the OSF would automatically make their registration public after four years. This study was approved by the ERB at Eindhoven University of Technology under proposal number 1674.

There can be many reasons why a researcher does not publish a performed study. We classified the responses given by researchers into 5 categories (see Table 4, for a more detailed overview, see the online supplement). Researchers indicated that their motivation to not publish was based on (1) logistical issues, such as a lack of time, or a new job on a different research topic or outside of academia (45%), (2) the results of the study, such as null or unclear results and failed replications (25%), (3) the review process, such as that the paper was rejected, or that reviewers thought it would be better to leave this study out (20%), (4) problems with the study design, such as not reaching the intended sample size, or a statistical artifact (5%), and (5) the goal of the study, which was not publishing the results because the project was educational or intended to be shared with stakeholders (4%).

According to the responses we received, logistical issues are the biggest cause of unpublished studies in our sample. Researchers leave academia and fail to complete a project before their contract ends, move on to a new position with a different research focus, or experience a lack of time to complete this specific project given other responsibilities. In some of these cases researchers did intend to come back to this project, and we observed continuing activity in projects registered more than four years ago, including publications that appeared in the literature.

When asked why researchers made their OSF project page open, most researchers (18 out of 23) mentioned a motivation to practice open science. Out of 43 responses more diverse reasons were given for keeping the OSF project closed, such as that there was no relevant information stored in the project (15 times), researchers forgot to open it (11 times), were waiting until a project was published (6 times), or experienced technical issues (4 times). For more details, see the online supplement. Finally, we were interested in how many researchers who registered on the OSF before 2017 - many of which should be considered early adopters - were aware of the OSF policy to automatically open all registrations after four years. Although not all of the email respondents answered this question, 24 of the researchers indicated they were aware of this policy, and 14 were not aware of this policy.

Table 4
Summary of main reasons researchers self-reported to not publish registered studies.

	Manually Opened	Automatically Opened	Total
Logistical Issues	7	18	25
Results	3	11	14
Peer Review	6	5	11
Study Design	1	2	3
Not Goal to Publish	0	2	2

Note. Only the first or main reason was coded whenever respondents gave multiple reasons.

Discussion

Our examination of 169 registrations led to an estimated publication rate of 58.15%, for all registrations on the Open Science framework that were created before November 18, 2017. Extrapolating from our sample, we estimate that of the 9544 registered research studies on the OSF that met our inclusion criteria, 3994 remain unpublished. Our study provides an important datapoint to understand how many studies are performed, but never shared. The possibility that around 41.85% of research studies registered on the OSF (excluding multi-lab studies and Registered Reports) are not shared should make scientists reflect on the efficiency of scientific research. Although not all unreported studies necessarily reflect research waste, and science will never be perfectly efficient, our results suggest scientists might need to seriously engage with the question how internal inefficiency can be reduced (Bernal, 1939; Chalmers & Glasziou, 2009), wherever this waste is avoidable.

The main reason researchers give when asked why their studies remain unpublished are logistical issues related to a lack of time, or responsible researchers moving on to a new job. Better time-management, designing projects from the outset in a way that they can be completed by other team members, or making unfinished projects available to potential collaborators could mitigate these issues. The fact that for 25% of unpublished studies researchers indicated that the reason that the study remained unpublished is due to the results (e.g., null results or failed replications) is concerning, and considered unacceptable by the general public (Bottesini, Rhemtulla, & Vazire, 2022; Pickett & Roche, 2017). It is possible that the absence of these studies contributes to publication bias in the scientific literature. Researchers can prevent the results of a study from influencing the probability that their study will be published by submitting their registration as a Registered Report (Chambers & Tzavella, 2022; Nosek & Lakens, 2014). If researchers do not report failed replications it is impossible to correct false positive claims in the scientific literature (Schmidt, 2009), and if null-results remain

unreported effect size estimates in meta-analyses will be inflated (Egger, Davey Smith, Schneider, & Minder, 1997).

Our estimate has remaining uncertainty as some registrations for which authors did not respond to our email might be classified incorrectly. Furthermore, the estimate is specific to the context of our study, which were all registrations on the OSF created before November 18, 2017. Users of the OSF in these years are early adopters interested in open science practices, and the likelihood they share a study might differ from researchers who do not use the OSF. Our estimate might not generalize to non-registered studies. The estimate might also change over time (e.g., more studies might have remained unpublished during the COVID pandemic). In short, the exact percentage of studies that remain unpublished will be different in other contexts.

At the same time, the factors that cause researchers not to publish results (e.g., a lack of time, responsible researchers leaving academia, null results, rejections during peer review) play a role in many (if not all) scientific contexts. In fields where most studies are submitted as a Registered Report, researchers work in larger teams where one team member takes over the work of a colleague who leaves academia, and all studies are designed to have a high probability to yield informative results, there might be less reason to be concerned about the number of unpublished studies. Our study demonstrates that the percentage of unpublished studies can be high. The question how many studies remain unpublished deserves attention across scientific contexts where similar factors preventing the publication of studies play a role. Empirically examining the size of the file drawer can determine if there is room for improvement.

Recommendations for Registries. We found that the OSF is not only used to (pre)register a study, but also to create a stable archive after a study has been completed. To be able to distinguish these uses of registries, it might be useful to create separate categories of registrations (e.g., distinguishing ‘preregistration’ from ‘data archiving’). Allowing users to distinguish educational projects from research projects might

also be useful. It would be useful for meta-scientific research if the API that allows researchers to access data from the registry made it possible to retrieve whether a registration was made public manually or automatically by the OSF. Lastly, the OSF currently displays registrations of separate components of the same project as unique registrations. It would be clearer if one could identify when registrations of components are part of the registration of the overarching project.

Recommendations for Registry Users. Researchers should be aware that the OSF only makes the registration public, but not the main project page. This means that, for example, in the “OSF-Standard Pre-Data Collection Registration” the only information that becomes visible is the answer to the question “Has data collection begun for this project?”, the answer to the question “Have you looked at the data?”, and the text in the field “Other comments”. Some users wrote in this field “See the preregistration document specifying the logic, hypotheses, and analyses” but that files is not made accessible. If researchers want to use registrations to inform peers about a study they have performed, they will need to provide all relevant information in the “Other comments” field. It is recommended to follow a comprehensive preregistration template to increase the quality of the preregistration (Akker et al., 2023) and to create machine-readable analysis code that describes when statistical hypotheses are corroborated or falsified (Lakens & DeBruine, 2021). Finally, it would be useful if researchers include contact information such that peers can reach out to them with inquiries about the study that was performed. Adding an ORCID ID (for example to your OSF profile) and an email address (while realizing that researchers do not stay at the same institution indefinitely) is good practice.

Conclusion

A substantial amount of data that researchers collect is never publicly shared. Every system will have some inefficiencies, and researchers will differ in their views about when a file drawer is too large (Dickersin et al., 1992). What is perhaps most surprising is that researchers rarely talk about how many studies they have collected that could have value for peers, and yet linger in their file drawer. Researchers might feel uneasy to honestly discuss this topic because unpublished studies are strongly associated with bias. More transparency about unpublished studies would allow our field to improve the way we work and increase the efficiency of psychological science.

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