

Are reproducible methods the next phase of open science, and can funders create the change?

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Abstract

Open science contains many facets including open access, open data and open software. A further facet, open methods, are far less frequently used or discussed. However, open methods support reproducibility, reusability and research integrity, particularly within 'wet-lab' sciences where pre-registration may not accurately describe the final methods.

Within Parkinson's Disease research, the funder Aligning Science Across Parkinson's (ASAP), has a strict requirement to share methods. This analysis compares the presence of Protocols.io links or methods journal citations between ASAP and other similar funders. Protocols.io links were found to be associated with ASAP funding, but were also associated with NIH funding. Methods Journal citations were also associated with NIH funding. The study concludes that funder requirements and culture can have a strong influence on the open research behaviour of its researchers, but that it may not need to be explicit.

Keywords

Open science monitoring, open methods, reproducibility, Parkinson's Disease, research funder policies

Introduction

Open science, or open research, is an umbrella term covering several different practices. Elements included in open science are designed to make scientific research more accessible, reusable and trustworthy. These practices cover topics such as open access, open data, open software, pre-prints, pre-registration and open methods. Some of which are much more widely accepted and implemented than others (Leite et al. 2024).

Open access, arguably the first facet of open science, has been a formal practice from as early as 2002 (Suber 2002) when the Budapest open access declaration and guidelines were launched (Till 2003). However, it can be argued that in reality digital open access has been around since the earliest days of the internet (Wren 2005). The uptake of open access started slowly, with plenty of resistance (Cairns 2007). However, by 2012 it was predicted that between 2020 and 2025 the world would reach a point where 90% of articles were available through some form of open access (Lewis 2012). We are still very far from that. Analyses have shown that in 2022 the UK had 29% closed access articles, and that globally the percentage of closed access articles was at 41% (Brayman et al. 2024). Since then open access rates have not been seen to improve; the Curtin Open Knowledge Initiative (COKI) dashboard (Diprose et al. 2023) places the UK closed access rate in 2025 at 33%.

Changing behaviour in open research practices have been shown to be challenging across the board, despite many different approaches to the problem (Woods and Pinfield 2022). Some open research proponents believe that the way to foster change is through bottom up initiatives, and that has seen success in areas such as preprints (Armeni et al. 2021). Others believe that to completely change the way research works requires external drivers with rewards and sanctions (Pinfield et al. 2014). Over a decade ago, researchers suggested that the way to encourage open access was for funders to make it a requirement (Harnad 2011). However, studies have shown that funder policies do not necessarily encourage open research on their own (Couture et al. 2018; Khoo and Lay 2018; Scaffidi et al. 2021). Despite this, examples of large-scale policy changes which have had an effect on open access can be identified. For example, a change in the open access requirements in the UK Research Excellence Framework 2021 correlated with a strong increase in green open access, where authors deposit into an institutional or subject repository rather than pay a fee to a publisher (Huang et al. 2020).

Despite the failure to reach the levels of open access predicted by Lewis (2021), open access has become a standard within biomedical scientific publishing. Sharing data has also become an expected way of conducting science, although ensuring data is FAIR (findable, accessible, interoperable and reproducible), whilst also ensuring it complies with regulations to protect patient data, has presented challenges (Kirsch et al. 2026). Other areas of open science are lagging behind, and open protocols and methods are rarely mentioned.

Alongside increasing access to information, many medical fields have also been wrestling with how to ensure that the research in published articles is reliable and reproducible. A 2007 study (Sena et al. 2007) analysing Parkinson's disease, multiple sclerosis and stroke journal articles showed that they frequently have only limited reporting of critical methodological details. Reproducibility studies show that small differences in methodologies, cohort selection, processing and analysis can all impact the final conclusions of a research study (Germani et al. 2025; Soto Linan et al. 2025).

Knowing the exact steps a researcher carried out during their experiment is a key factor in ensuring that the research is reproducible. In some fields, such as psychology, pre-registration of methods has become a standard practice (Klonsky 2025). However, even when followed and completed to a high standard, these documents do not always give the level of detail needed to accurately reproduce a biological or chemical

experiment. Even with pre-registration, authors find themselves writing long prose-based methods sections, often difficult to follow, containing vague descriptions or assuming prior knowledge (Giraldo et al. 2018).

Methods-focused journals have provided venues for sharing specific stepwise protocols which can help move science forward even before results are known (Lacy and Spiegel 2017). These, however, only tend to be used for substantially new methods, rather than for explaining exactly what a researcher did to acquire their data or conclusions. Although open stepwise methods were initially suggested over a decade ago (Teytelman et al. 2016), and platforms such as Protocols.io and Open Science Framework (OSF) have facilitated the posting of these, they have not taken off in the same way as open access or open data has. Perhaps this is because whilst open access is simply making openly available the journal articles that would have been written anyway, providing a stepwise protocol requires additional work, and unlike open data it is very rarely required by funders or publishers.

Aim

Even where open methods are required or encouraged through policies, it is often difficult to identify whether this has occurred due to limited monitoring (Anderberg et al. 2026). The adoption of open access shows that funders can have an influence on the uptake of open research policies. This observational study analyses Parkinson's disease research funder policies alongside the uptake of open methods in articles funded by them, identifying any relationship between the two. Given its observational nature, the aim is to assess correlation, not causation.

Policy Literature Review

Many of the organisations which fund research into Parkinson's have open research policies which require research outputs funded by their grants to be shared openly. Over the last two decades policies across all research funders have been strengthening their requirements. Open Access policies were usually the first to be added, with these gradually expanding to require data sharing and to encourage preprints. It is still very rare to see policies which expand further on these requirements.

The strongest exception to this is Aligning Science Across Parkinson's (ASAP), a relatively new funder. ASAP has made reproducible and open methodologies a core part of their open research requirements, as important as data sharing.

1. "Share research outputs. Data, code, and protocols generated as part of an ASAP-funded study must be deposited in a community-recognized repository by the time of publication, with information to facilitate reuse and a license that allows for reuse. Key lab materials generated as part of an ASAP-funded study must be registered by the time of publication." (ASAP 2025)
2. "Identify research inputs. Data, software, protocols, and key lab materials used in a study—but which were not generated as part of an ASAP-funded study—must be unambiguously identified in the study's publication." (ASAP 2025)

Further details are given in the ASAP Open Science Policy Handbook requiring that authors create stepwise protocols, using a platform such as Protocols.io, for all methods providing they have not already published in a stepwise format in a journal such as STAR Protocols or Nature Methods (Thibault 2024). These clear and explicit guidelines from a funder, in the absence of almost any other encouragement to create open protocols, provides an opportunity to explore whether top-down mandates from funders do in fact have the power to change researcher's behaviour in the open science domain.

Methods

Open Methods

A step-wise protocol for the identification of articles and recording of data can be found at <https://www.protocols.io/view/parkinsons-step-wise-methods-amp-protocols-dataset-hebrb3am7> (Montague-Hellen 2026a).

Identification of relevant articles

PubMed was searched for articles related to Parkinson Disease using the following search terms: "Parkinson Disease"[MeSH Terms] AND ((excludepreprints[Filter]) AND (english[Filter]) AND (2023:2025[pdat])) NOT Review[ptyp]. 9630 papers were retrieved.

Articles were checked against the PMCID file to identify articles with full text in PubMed Central (National Centre for Biotechnology Information 2026)). Only those articles with PMCIDs were included in the collection. Of these papers, those that could be found with full text in the PubMed OA collection were retained. XML files were retrieved for these articles.

A Python script was created to search each XML file for the occurrence of a specified list of funders (Montague-Hellen 2026b). The list was compiled through internet searches for Parkinson's funders and concentrated on research from the UK, Europe, USA, Australia and Canada. The list consisted of: Aligning Science Across Parkinson's (ASAP), American Parkinson Disease Association (APDA), Brain Canada / Canada Brain Research Fund, CIHR (Canadian Institutes of Health Research), Cure Parkinson's, Horizon Europe (European Commission), JPND (EU Joint Programme Neurodegenerative Disease Research), The Michael J. Fox Foundation (MJFF), NHMRC (National Health and Medical Research Council, Australia), NIH / NINDS (US National Institutes of Health), NIHR (National Institute for Health and Care Research), Parkinson Canada, Parkinson's Foundation, Parkinson's UK, Shake It Up Australia Foundation, UKRI Medical Research Council (MRC), Wellcome.

1557 papers were found to include an acknowledgment to one or more of these funders and was included in the final corpus (Figure 1).

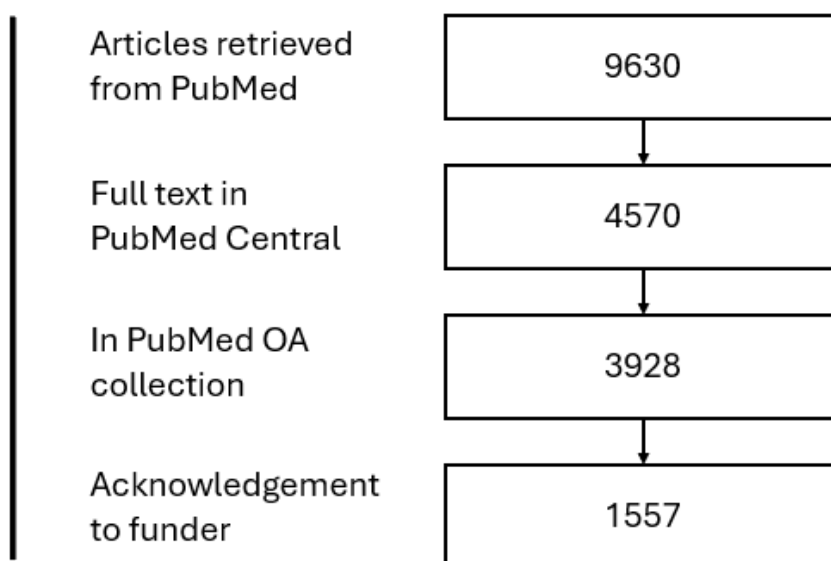


Figure 1: Flow chart showing the number of articles included after each of the data collection steps.

Identification of links or citations to Protocols.io or methods journals

For each paper, a script was run (Montague-Hellen 2026b) searching the XML for mentions of Protocols.io and for references from a methods journal. Protocols.io was used for this analysis because the platform is specifically for methods and the format encourages the researcher to use a step-wise method similar to that provided in methods journals. General data and file sharing platforms such as Zenodo or OSF were not searched because of the difficulty of identifying methods shared through these platforms, and because, while open, methods shared through these platforms do not necessarily use stepwise methods preventing easy reproducibility. The methods journals searched for were: Nature Protocols, STAR Protocols, The Journal of Visualised Methods (JOVE), Cold Spring Harbour Protocols, Bio-protocols, Current Protocols in [x] and Methods in [x]. The positive results of this script were checked manually.

Descriptive statistics and graphs showing the percentages of papers with protocols or open methods citations or mentions, were created using R version 4.5.2. An R script was run to determine whether the occurrence of a Protocols.io link or a methods paper reference was significantly associated with each funder. Fisher tests were run with Benjamini-Hochberg correction for multiple testing (Ferreira and Zwinderman 2006), significance was set at 0.05.

Logistic regression was carried out to determine whether the presence of a certain funding acknowledgment predicted the presence of a Protocols.io or methods journal citation or mention. Funders were coded as non-mutually-exclusive binary indicators (an article could acknowledge more than one funder). All funder indicators were entered simultaneously into a single multivariable logistic regression model, so that each funder's estimated association is adjusted for co-occurring funder acknowledgments in the same article.

Further regressions were carried out to identify whether there were any publishers which predicted the presence of a Protocols.io, or methods journal citation or mention. To reduce the impact of separation on the analysis any funder with 10 or fewer articles, or without any links or citations to methods was collapsed into a 'small publisher' group. This left 13 separate publishers and a combined smaller publisher.

All R scripts can be found in the associated GitHub repository

<https://github.com/AlfAWolf140/OpenMethodsbyFunder/>.

Results

Of the 1557 articles included in the corpus 579 (38.3%) referenced or linked to a stepwise methodology. The majority of these (569; 36.5%) articles referenced a methods journal, and 53 (3.4%) had a link to Protocols.io, a step-wise open methods platform, either through a formal reference or via a DOI link in the methods section.

14 funders out of the initial 17 included in the analysis were found to fund articles in the corpus, although some had only a relatively small number (Table 1). Whilst ASAP-funded articles had a similar share of papers with methods references to many of the other funders, articles with links to Protocols.io were found more frequently (Figure 2). ASAP was the only funder where this was the case, in all other cases traditional methods journal references were more likely to be included in articles than Protocols.io links were. APDA, ASAP and NIH/NINDS all had over 20% of their articles with methods links, although the number of articles acknowledging APDA funding was low (18) and so it should be considered that this might be an artifact.

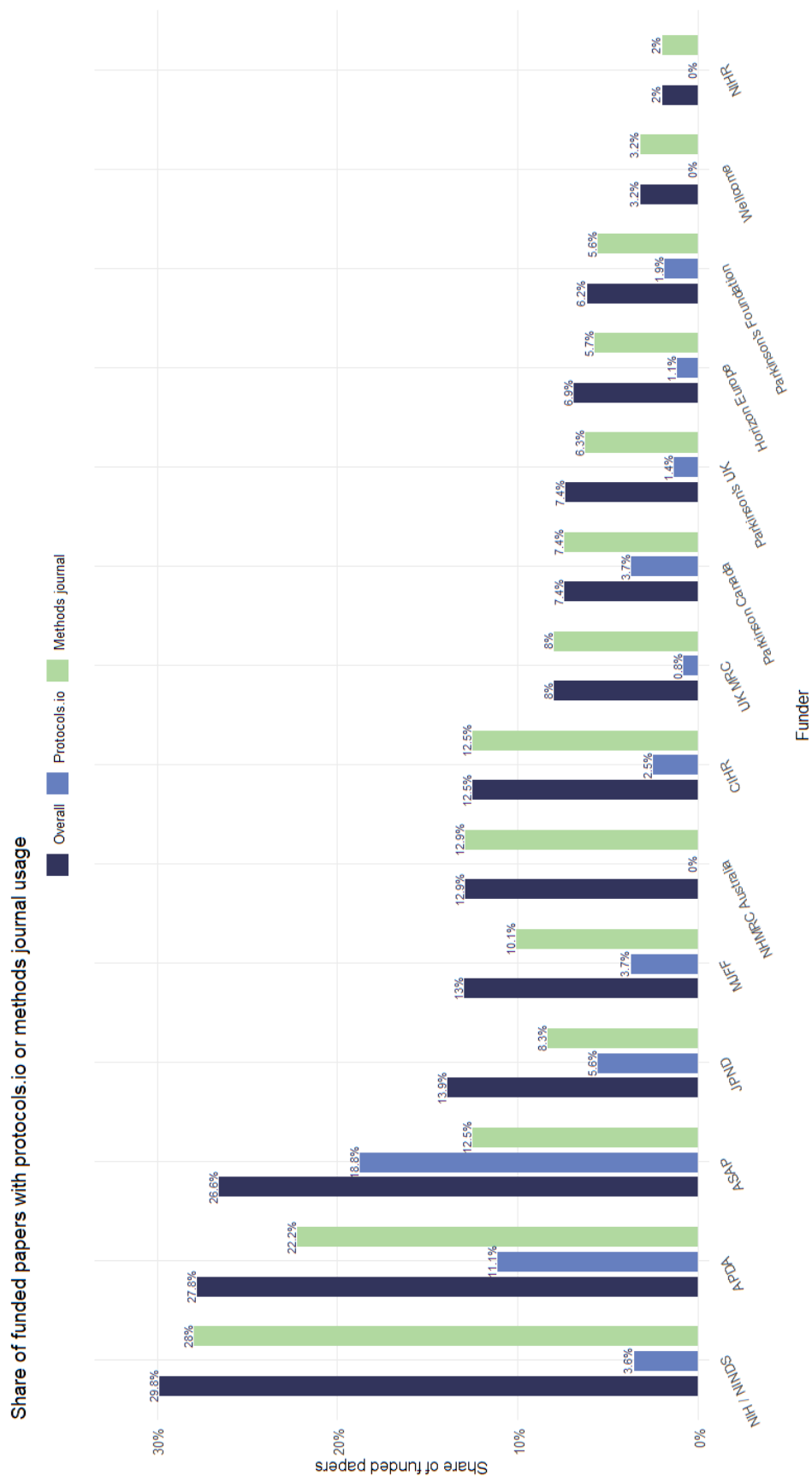


Figure 2: Percentage of papers funded by each research funder which included links or citations to methods journals or to Protocols.io. (Montague-Hellen 2026c)

Funder	N	Protocols.io	Methods Journal	Overall
NIH	898	3.6	28	29.8
APDA	18	11.1	22.2	27.8
ASAP	64	18.8	12.5	26.6
JPND	36	5.6	8.3	13.9
MJFF	347	3.7	10.1	13.0
NHMRC Australia	31	0	12.9	12.9
CIHR	40	2.5	12.5	12.5
UK MRC	125	0.8	8.0	8.0
Parkinson Canada	27	3.7	7.4	7.4
Parkinson's UK	367	1.4	6.3	7.4
Horizon Europe	87	1.1	5.7	6.9
Parkinson's Foundation	162	1.9	5.6	6.2
Wellcome	93	0	3.2	3.2
NIHR	100	0	2	2

Table 1: Percentage of articles acknowledging a specific funder which contain a link or citation to any stepwise protocol, or to a stepwise protocol created by the author.

Fisher's tests (with multiple testing correction) only showed significant positive associations between stepwise methods and either NIH or ASAP funded papers. NIH funded papers had a very high and statistically significant association with references to methods journals (odds ratio 3.31; Fisher BH-adjusted $p = 3.42 \times 10^{-33}$). Associations with Protocols.io were found in the ASAP funded group (odds ratio 21.51; Fisher BH-adjusted $p = 3.25 \times 10^{-10}$) and to a lesser extent in the group of NIH funded articles (odds ratio 5.29; Fisher BH-adjusted $p = 5.03 \times 10^{-8}$) and MJFF funded articles (odds ratio 3.44; Fisher BH-adjusted $p = 2.03 \times 10^{-3}$).

Logistic Regression

The regression model confirmed that articles with an ASAP funding acknowledgement (OR 32.1, 95% CI 9.72–118.41, $p = 4.16 \times 10^{-8}$) strongly predicted the presence of Protocols.io links within the manuscript. NIH funding also predicted the presence of Protocols.io links, although less strongly (OR 4.458, 95% CI 2.48–8.13, $p = 7.13 \times 10^{-7}$). The NIH/NINDS funding acknowledgement also strongly predicted the presence of references to methods journals (OR 3.61 95% CI 2.98–4.38, $p = 6.63 \times 10^{-39}$).

Although there is overlap between funders, this was assessed using the VIF score, a measure of how well the predictor's result can be explained by the other predictors (Roustaei 2024). VIFs for all funder predictors were below 5, indicating the model can estimate funder-specific associations without problematic collinearity. ASAP and MJFF showed the highest VIFs among the funder set (2–3), consistent with the administrative overlap between these two funders, but remained well within acceptable range.

In publisher adjusted logistic regression models, no publisher predicted a higher or lower presence of Protocols.io links. Adjustment for publisher only slightly altered the association between specific funders and Protocols.io mentions. Acknowledgement of ASAP funding remained strongly associated with Protocols.io use (OR 48.09, 95% CI 12.16–222.22, $p = 1.41 \times 10^{-7}$) and NIH funding maintained its moderate predictive power (OR 4.20, 95% CI 2.27–7.88, $p = 5.54 \times 10^{-6}$).

When adjusted for publisher, the NIH positive association stayed strong (OR 3.44, 95% CI 2.82–4.19, $p = 1.41 \times 10^{-34}$). No association was found between publisher and the presence of references to methods journals.

Citation and linking behaviour

The mean number of times a methods paper was cited was 1.65 and the mean number of links to a Protocols.io article was 1.2. The median for both groups was 1. Due to the high tail of papers and protocols which were only mentioned once, the difference between multiply cited articles is obscured. Although no Protocols.io article was linked to more than 5 times in the corpus, 2 outlier methods journal articles were cited more than 25 times (Jackson-Lewis and Przedborski 2007; Volpicelli-Daley et al. 2014). Both of these articles are extremely highly cited overall and appear to be standard methods within Parkinson's research.

Of the articles with methods journal citations, the mean number of these citations per article was 1.4. Of the articles with Protocols.io links or citations, the mean number per article was 5.2. Where Protocols.io was used to show detailed methods, a paper frequently described every method in the article this way. This did not happen with journal articles where only one or two methods were cited.

Self-citations and citations to papers which had no overlap of authors show very different patterns between Protocols.io links and citations, and those for methods journals (Figure 3). Of those papers which have links to Protocols.io, 92% of the papers had links to the authors' own protocols. The methods journal citations show the opposite pattern with 89% of papers including non-self-citations and only a small number of self-citations.

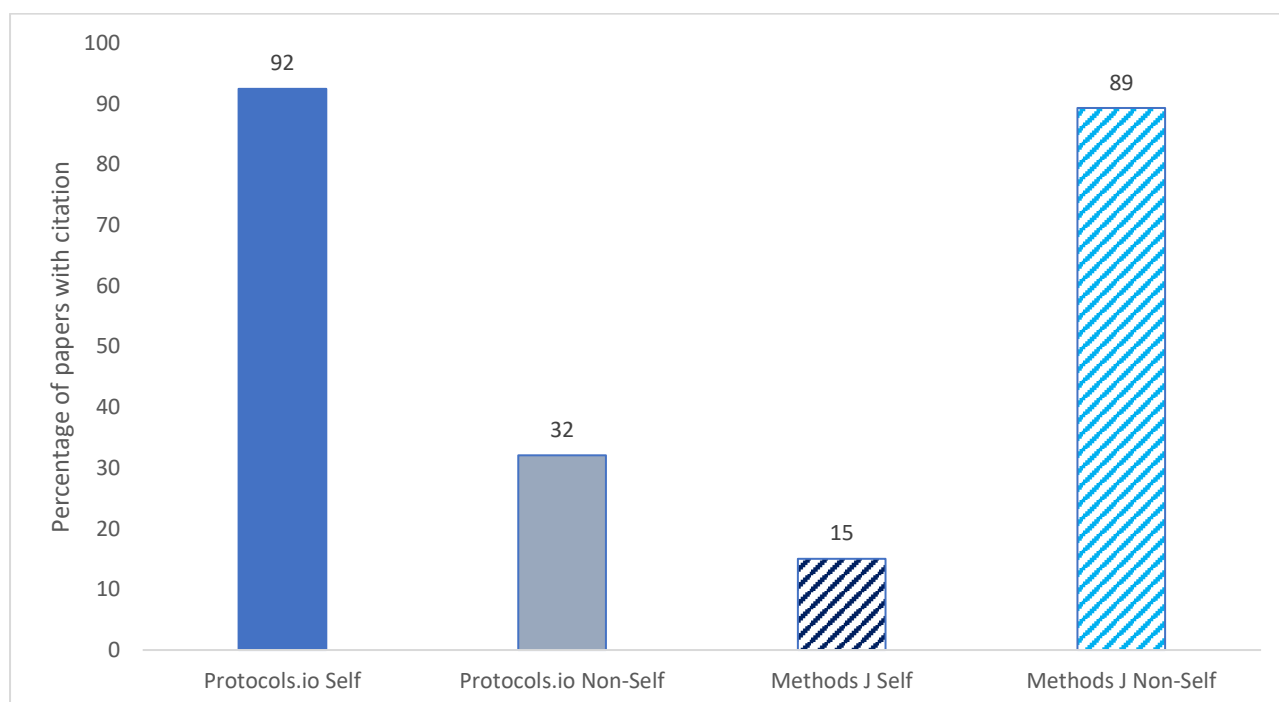


Figure 3: Bar chart showing the percentage of papers with self-citing and non-self-citing references and links out of the papers with a Protocols.io or Methods Journal citation or link.

Discussion

Sharing of step-wise protocols, either through open platforms such as Protocols.io or through traditional journals such as Nature Protocols, was not found to be particularly commonplace within Parkinson's research. Whilst approximately 1/3 of articles contained a link to a methods journal, the numbers of papers linking to Protocols.io methods was only 3.4%. Despite Protocols.io launching over 10 years ago, it has failed to achieve a strong place within this discipline. This may be related to the traditional kudos that is achieved

through publishing in peer reviewed journals instead of an open access platform. The differences in citation behaviour may also have an impact.

Where Protocols.io methods were provided, these were frequently included as links in the text rather than formally cited. This was particularly the case for self-cited protocols, which were the majority. It is possible that the discouragement of self-citing within academic practice discourages researchers from citing their own protocols. However, this behaviour could also be related to a similar effect seen with datasets where, although authors report that they directly cite datasets (Gregory et al. 2023), other studies have shown that data is frequently linked via URLs, or just the name of the dataset, rather than formal mention in a reference list which are kept for literature (Zhao et al. 2018). Regardless of the reason, the lack of citation of external protocols means that researchers are unlikely to be receiving kudos from these outputs in the form of traditional metrics, whereas this is still likely to be happening with methods journal articles.

Articles from two funders were found to be strongly and positively associated with shared step-wise methods. ASAP funding was associated with the use of the Protocols.io platform, whilst NIH funding was mostly associated with methods journals, although these articles were also more likely to have Protocols.io links than articles from the other funders. ASAP open research policies explicitly state that methods need to be open and they encourage the use of Protocols.io (ASAP 2025). This aligns with previously identified hypotheses that researchers are more likely to conform to funder policies where those policies also include clear instructions (Montague-Hellen and Montague-Hellen 2023). The higher levels of both references to methods journals and Protocols.io links found in NIH funded articles is harder to explain. NIH has no explicit policy requiring this behaviour; however, it does have strong requirements around rigour, transparency and reproducibility which may prompt researchers to seek out ways to make their methods as reproducible as possible.

Many papers are funded by more than one organisation, and this has not been explicitly dealt with in this analysis. In particular, most papers funded by ASAP also acknowledge MJFF as the administrator of this grant. However, there are many MJFF articles which do not acknowledge ASAP, and it is clear from the results presented here that the behaviour is being driven by ASAP and not MJFF. However, the interplay between funding organisations on researcher open research, or stepwise methods creation, behaviour would be a useful topic for future investigations.

Limitations

Not all articles in the analysis will contain methods that are suitable for sharing through methods journals or the Protocols.io platform. Bioinformatics analysis, for example, may be more likely to sharing pipelines through GitHub, however these analyses could still be completely reproducible. Although the analysis may underestimate the number of reproducibly bioinformatics workflows included in the article corpus, methods from this domain are still frequently found within both methods journals and Protocols.io.

The choice of using PubMed deposited articles, whilst ensuring that full text articles were available with a license that allows for text mining, may have introduced bias. Researchers who are more supportive of open science may be more likely to deposit their article into PubMed. NIH researchers are required to deposit all articles with a 0-month embargo, and so this is unlikely to have affected this funder, but for other funders this requirement is not present. It may also have contributed to the low numbers of articles associated with some of the research funders.

The corpus of articles is from a small range of years and so cannot show change over time. Restricting the analysis to articles published since 2023 was to ensure parity of funders given that ASAP has only been

funding articles for a few years. However, this has also meant that for some funders the number of available articles is relatively small. It would be worth repeating the study in the future to confirm these initial findings.

Although the regression analysis compares one funder against all articles not associated with the funder, the overlapping nature of research funding has not been accounted for in this study.

As with any computational search, it is possible that references or Protocols.io mentions were missed. This was mitigated through author spot checking of data, but not every article was checked manually.

Conclusion

The NIH and ASAP funders both promote sharing of stepwise or open methods and protocols in comparison to other Parkinson's funders. However, they have differing strategies to do this. ASAP has detailed and prescriptive policies, but the NIH instead creates a culture where rigour and reproducibility is expected.

Combining the approaches of both of these funders may provide a strategy for funding bodies which would like to promote research integrity and rigour. The strong cultural mandate of the NIH around reproducibility provides an expectation and reason for searching out ways to share methods, however the ASAP policy and guidance provide researchers with a way to do this without having to devote time and energy to identifying routes to compliance.

Stronger encouragement of researchers to formally cite Protocols.io methods when they have been used may help provide a greater incentive to researchers to create these outputs. Current publication metrics still have a strong sway on promotion and hiring criteria in a way that good open research practice has failed to achieve.

Mandates from funders for methods sharing are reasonably new additions to Open Research and further research will be needed in the coming years to identify whether these have managed to impact the field more widely than simply encouraging their researchers to follow the guidelines expected of them. This could be the beginning of a revolution in open methods, or it may simply continue to be a niche box ticking exercise for certain funders.

List of abbreviations

APDA: American Parkinson Disease Association

ASAP: Aligning Science Across Parkinson's

CIHR: Canadian Institutes of Health Research

COKI: Curtin Open Knowledge Initiative

FAIR: Findable, Accessible, Interoperable and Reproducible

JPND: Joint Programme – Neurodegenerative Disease Research

MJFF: Michael J. Fox Foundation

MRC Medical Research Council

NHMRC: National Health and Medical Research Council

NIH: National Institutes of Health

NIHR: National Institute for Health and Care Research

NINDS: National Institute of Neurological Disorders and Stroke

OSF: Open Science Framework

PMCID: PubMed Central Identifier

Data availability statement

The primary data can be obtained at [10.25418/crick.32833820](https://doi.org/10.25418/crick.32833820) and is licensed CC BY.

Code can be obtained at [10.25418/crick.32833856](https://doi.org/10.25418/crick.32833856) or <https://github.com/AlfAWolf140/OpenMethodsbyFunder> and is licensed MIT.

Open methods for creating the data set can be found at DOI: [10.17504/protocols.io.8epv5k5y6v1b/v1](https://doi.org/10.17504/protocols.io.8epv5k5y6v1b/v1)

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Competing Interests

The author declares no competing interests.

Ethical approval

Ethical approval was not required for this study.

AI statement

Claude Sonnet 4.6 was used to assist with writing and debugging R scripts for data analysis. The author reviewed and edited the code as needed and takes full responsibility for the content in this article.

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