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Reproducible research practices are underused in systematic reviews of biomedical interventions

Matthew J. Page[a,*], Douglas G. Altman[b], Larissa Shamseer[c,d], Joanne E. McKenzie[a], Nadera Ahmadzai[e], Dianna Wolfe[e], Fatemeh Yazdi[e], Ferrán Catalá-López[e,f], Andrea C. Tricco[g,h], David Moher[c,d]

[a]*School of Public Health and Preventive Medicine, Monash University, 553 St Kilda Road, Melbourne, Victoria 3004, Australia*
[b]*UK EQUATOR Centre, Centre for Statistics in Medicine, NDORMS, University of Oxford, Windmill Road, Oxford OX3 7LD, UK*
[c]*Centre for Journalology, Clinical Epidemiology Program, Ottawa Hospital Research Institute, 501 Smyth Road, Ottawa, Ontario K1H 8L6, Canada*
[d]*School of Epidemiology, Public Health and Preventive Medicine, Faculty of Medicine, University of Ottawa, 451 Smyth Road, Ottawa, Ontario K1H 8M5, Canada*
[e]*Knowledge Synthesis Group, Clinical Epidemiology Program, Ottawa Hospital Research Institute, 451 Smyth Road, Ottawa, Ontario K1H 8M5, Canada*
[f]*Department of Medicine, University of Valencia/INCLIVA Health Research Institute and CIBERSAM, Valencia 46010, Spain*
[g]*Knowledge Translation Program, Li Ka Shing Knowledge Institute, St Michael's Hospital, Toronto, 30 Bond Street, Ontario M5B 1W8, Canada*
[h]*Epidemiology Division, Dalla Lana School of Public Health, University of Toronto, 155 College Street, Toronto, Ontario M5T 3M7, Canada*

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Abstract

Objectives: To evaluate how often reproducible research practices, which allow others to recreate the findings of studies, given the original data, are used in systematic reviews (SRs) of biomedical research.

Study Design and Setting: We evaluated a random sample of SRs indexed in MEDLINE during February 2014, which focused on a therapeutic intervention and reported at least one meta-analysis. Data on reproducible research practices in each SR were extracted using a 26-item form by one author, with a 20% random sample extracted in duplicate. We explored whether the use of reproducible research practices was associated with an SR being a Cochrane review, as well as with the reported use of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.

Results: We evaluated 110 SRs of therapeutic interventions, 78 (71%) of which were non-Cochrane SRs. Across the SRs, there were 2,139 meta-analytic effects (including subgroup meta-analytic effects and sensitivity analyses), 1,551 (73%) of which were reported in sufficient detail to recreate them. Systematic reviewers reported the data needed to recreate all meta-analytic effects in 72 (65%) SRs only. This percentage was higher in Cochrane than in non-Cochrane SRs (30/32 [94%] vs. 42/78 [54%]; risk ratio 1.74, 95% confidence interval 1.39−2.18). Systematic reviewers who reported imputing, algebraically manipulating, or obtaining some data from the study author/sponsor infrequently stated which specific data were handled in this way. Only 33 (30%) SRs mentioned access to data sets and statistical code used to perform analyses.

Conclusion: Reproducible research practices are underused in SRs of biomedical interventions. Adoption of such practices facilitates identification of errors and allows the SR data to be reanalyzed.

Keywords: Reproducibility; Reporting; Systematic reviews; Methodology; Quality; Data sharing

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Conflicts of interest: The authors have read the journal's policy and the authors of this article have the following competing interests: A.C.T. is an associate editor for *Journal of Clinical Epidemiology* but had no involvement in the peer review process or decision for publication. M.J.P. and J.E.M. are affiliates of Cochrane Australia. M.J.P. is a co-convenor of the Cochrane Bias Methods Group. J.E.M. is a co-convenor of the Cochrane Statistical Methods Group. A.C.T. is an author of two of the systematic reviews included in this study but was not involved in eligibility assessment or data collection. D.G.A. is a senior investigator of National Institute for Health Research.

Data availability: The study protocol, data-collection form, and the raw data and statistical analysis code for this study are available on the Open Science Framework: https://osf.io/523bq/.

* Corresponding author. Tel.: +61 3 9903 0248.
E-mail address: matthew.page@monash.edu (M.J. Page).

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What is new?

Key findings

- Systematic reviewers reported the data needed to recreate all meta-analytic effect estimates in the systematic review (SR), including subgroup meta-analytic effects and sensitivity analyses, in only 65% of SRs. This percentage was higher in Cochrane than in non-Cochrane SRs (94% vs. 54%).
- Systematic reviewers who reported imputing, algebraically manipulating, or obtaining some data from the study author/sponsor infrequently stated which specific data were handled in this way.
- Only 30% of SRs mentioned access to data sets and statistical code used to perform analyses.

What this adds to what was known?

- To our knowledge, no study has quantified how often systematic reviewers report the data needed to recreate all meta-analytic effect estimates in an SR (including subgroup meta-analytic effects and sensitivity analyses) nor investigated whether completeness of reporting varies by type of outcome (i.e., primary or other). In addition, no study has investigated how often other reproducible research practices, such as the sharing of data sets and statistical analysis code, are used in SRs.

What is the implication and what should change now?

- Strategies are needed to facilitate the provision of detailed descriptions of data gathered and data used for analysis, transparent reporting of the analysis method and results, and sharing of data sets and statistical analysis code so that others can recreate the findings or perform secondary analyses.

1. Introduction

Biomedical researchers are increasingly encouraged to use reproducible research practices, which allow others to recreate the findings of studies, given the original data [1−3]. Such practices include providing a detailed description of the data collected and used for analysis, along with descriptive metadata, clearly reporting the analysis methods and results, and sharing the data set and statistical code used to perform analyses [1,4]. There are many benefits of performing such practices in the context of systematic reviews (SRs) of studies. For example, users can check for possible data-entry errors when summary statistics for each included study are reported in sufficient detail. Transparent reporting of meta-analyses also makes it possible for others to reanalyze published meta-analyses using different inclusion criteria or statistical methods or to perform additional analyses that address secondary research questions [5]. For example, readers may reanalyze a published meta-analysis by restricting it to the subset of studies conducted in the setting where they work. In addition, sharing of data sets and statistical analysis code allows other researchers to cumulatively add new data that are published, thus keeping meta-analytic effect estimates up-to-date [6,7].

The limited data on use of reproducible research practices in SRs come from studies that have recorded how well SRs adhere to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. The PRISMA statement includes an item recommending that for all outcomes considered, systematic reviewers report, for each study, ‘‘simple summary data for each intervention group and effect estimates and confidence intervals’’ [8]. However, not all studies evaluating PRISMA adherence have provided data on adherence to this item, opting to present a total score summed across all PRISMA items instead [9]. Furthermore, many studies that have identified low adherence to this item have assessed SRs in a single clinical specialty (e.g., [10−14]), which limits generalizability of the findings. To our knowledge, no study has quantified how often systematic reviewers report the data needed to recreate all meta-analytic effect estimates in an SR (including subgroup meta-analytic effects and sensitivity analyses) nor investigated whether completeness of reporting varies by type of outcome (i.e., primary or other).

Efforts to increase transparent reporting of SR articles have existed for many years (e.g., the PRISMA statement was disseminated in top medical journals in 2009); however, little attention has been given to the sharing of data collected as part of SRs [15]. For example, since 2015, the *BMJ* encourages authors of all research articles to link their articles to the raw data from their studies but requires data sharing on request as a minimum for clinical trials only [16]. No study has investigated how often sharing of data sets and statistical analysis code is done by authors of SRs.

We investigated how often research practices that facilitate reproducibility of analyses were used in a cross-sectional sample of SRs of therapeutic interventions. We also explored whether the use of such reproducible research practices was associated with whether an SR was a Cochrane review and with the systematic reviewers' reported use of the PRISMA statement.

2. Methods

We conducted this project in accordance with a study protocol, which is available on the Open Science Framework (RRID:SCR_003238): https://osf.io/523bq/. This study was conducted concurrently with another project