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A scoping review on interventions to improve adherence to reporting guidelines in health research

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A scoping review on interventions to improve adherence to reporting guidelines in health research

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Keywords

Scoping review, knowledge synthesis, reporting guidelines, completeness of reporting, quality of reporting, adherence

Abstract

Objectives: The goal of this study is to identify, analyse and classify interventions to improve adherence to reporting guidelines in order to obtain a wide picture of how the

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problem of enhancing the completeness of reporting of biomedical literature has been tackled so far.

Design: Scoping review.

Search strategy: We searched the MEDLINE, EMBASE, and Cochrane Library databases and conducted a grey literature search for (i) studies evaluating interventions to improve adherence to reporting guidelines in health research and (ii) other types of references describing interventions that have been performed or suggested but never evaluated. The characteristics and effect of the evaluated interventions were analysed. Moreover, we explored the rationale of the interventions identified and determined the existing gaps in research on the evaluation of interventions to improve adherence to reporting guidelines.

Results: 109 references containing 31 interventions (11 evaluated) were included. These were grouped into five categories: (1) training, (2) improved understanding, (3) encouraging adherence, (4) monitoring adherence and providing feedback, and (5) collaboration among authors and experts. Only 4 of the interventions found had been evaluated by randomised trials. Research gaps identified included the evaluation of interventions (i) on training and improved understanding of reporting guidelines, (ii) at early stages of research, and (iii) after the process of author revision of the manuscript.

Conclusions: This scoping review identifies a wide range of strategies to improve adherence to reporting guidelines that can be taken by different stakeholders. Future randomised trials should evaluate further interventions and address the research gaps identified. This review is part of a larger project whose next goals are (i) to capture editors' perceptions on the barriers and facilitators of some interventions identified in this review, (ii) to explore new interventions, and (iii) to evaluate one of these interventions in collaboration with BMJ Open.

Strengths and limitations

- We considered wide range of reporting guidelines as well as their extensions.

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- Merging the evidence found in the published and grey literature allows us to provide a broad picture of how the problem of enhancing adherence to reporting guidelines has been tackled so far and could be faced in the future.
- The screening and data extraction were performed in duplicate.
- We could have missed evidence of possible interventions that may not be present in the published or grey literature but are instead used in practice and continue to be used.

Background

Approximately 85% of all biomedical research today is estimated to be wasted, due, in part, to incomplete or inaccurate reporting (1). The past two decades have given rise to a number of changes in an effort to help authors and the broader scientific community properly report research methods and findings, which would allow them to contribute to the broader goal of combating waste in biomedical research. The most prominent of these changes has been the inception of reporting guidelines for different study types, data, and clinical areas (2).

The vast majority of reporting guidelines have not yet been assessed as to whether they help improve the reporting of research (3), but some, such as the Consolidated Standards of Reporting Trials (CONSORT) for the reporting of randomised controlled trials (RCTs) (4), have been shown to enhance the completeness of reporting (5,6).

Dozens of systematic reviews have explored the extent of adherence to some reporting guidelines in certain areas of health research (7–10). Saaman et al. (11) went one step further and performed a systematic review of systematic reviews assessing adherence to reporting guidelines. As they considered a broad range of clinical areas and study designs, their results provided a global picture of adherence to reporting guidelines in health research. Although some studies reported acceptable overall levels of completeness of reporting and found that it had improved since the introduction of certain reporting guidelines such as CONSORT, the authors of most of the reviews (43 of 50, 86%) concluded that more improvement is needed or that adherence to reporting guidelines was inadequate, poor, medium or suboptimal. Therefore, it is

warranted to explore and develop strategies to improve the current levels of adherence to reporting guidelines.

In recent years, several initiatives aiming to improve adherence to reporting guidelines have been proposed, some of which have already been evaluated. For example, the effect of journal endorsement of reporting guidelines (3,5,6) and the implementation of writing aid tools for authors such as the CONSORT-based web tool (COBWEB) (12) have been assessed. While some of these strategies have not been shown to have a benefit (3), others report better but still suboptimal levels of reporting (5,6) or even clear benefits (12,13).

As mentioned, several reviews have analysed the quality of reporting in different clinical areas and for different study types (7–10). However, no scoping review has been performed that provides a global picture of different strategies aiming to improve adherence to reporting guidelines. Given the low levels of completeness of reporting in health research that have been observed (11), along with the imperative need to take further actions for mitigating this problem, we considered that performing such a scoping review was warranted.

In addition to analysing the implementation and effect of interventions that have already been evaluated, we aimed to gather other possible strategies that could be implemented and evaluated in the future.

For clarification, some relevant terms used throughout the scoping are defined in Box 1, which is based on Stevens et al. (3).

Box 1: relevant definitions in the context of this scoping review

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Adherence: Action(s) taken by authors to ensure that a research report is compliant with the items recommended by the appropriate/relevant reporting guideline.

Endorsement: Action(s) taken by journals to indicate their support for the use of one or more reporting guideline(s) by authors submitting research reports for consideration.

Implementation: Action(s) taken by journals to ensure that authors adhere to an endorsed reporting guideline and that therefore published papers are completely reported.

Complete reporting: Pertains to the state of reporting of a study report and whether it is compliant with all the items recommended by the appropriate/relevant reporting guideline.

Methods

As presented in the published protocol (14), this scoping review follows the methodology manual published by the Joanna Briggs Institute for scoping reviews (15).

Objectives

The scoping review questions are:

1. What interventions to improve adherence to reporting guidelines in health research have been evaluated?
2. What further interventions to improve adherence to reporting guidelines have been performed or suggested but never evaluated?

We aim to analyse and classify the interventions found for both questions in order to obtain a wide picture of how the problem of adhering better to reporting guidelines has been tackled so far and can be tackled in the future.

Eligibility criteria

We included:

1. Studies evaluating interventions aiming to improve adherence to reporting guidelines in health research, irrespective of study design.

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2. Commentaries, editorials, letters, studies, and online sources describing possible interventions to improve adherence to reporting guidelines that have been performed or suggested but never evaluated.

The reporting guidelines considered were those shown on 8 May 2017 on the EQUATOR (Enhancing the QUAlity and Transparency Of Health Research) Network website (16) as "Reporting Guidelines for main study types" (see Supplementary file 1). In addition, we also included QUOROM (Quality of Reporting of Meta-analyses), since it was the precursor of PRISMA.

We considered the following languages: English, Spanish, French, German and Catalan.

Exclusion criteria

We have excluded references that include interventions that do not specifically aim to improve the completeness of reporting, even though these interventions may actually influence completeness. For example, we have excluded clinical trial registration even though it may enhance completeness of reporting, because its main goals are to improve clinical trial transparency while also reducing publication and selective reporting biases.

Search strategy and study selection

On 8 May 2017, we searched PubMed, EMBASE, and Cochrane Library databases for articles published between 1 January 1996 and 31 March 2017, in accordance with our scheduled search (14). The detailed search terms for PubMed can be found in Supplementary file 2.

The retrieved studies were exported into Mendeley and duplicates were removed. One reviewer (DB) first screened the titles and abstracts for eligibility. Each of the other two reviewers (JJK and EC) was randomly assigned 50% of the references and screened the titles and abstracts independently of the first reviewer. The reviewers classified the references into one of the following groups:

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A) Evaluated: Includes references describing interventions to improve adherence to reporting guidelines that have been empirically assessed.
B) Non-evaluated: Includes references describing interventions to improve adherence to reporting guidelines that have been performed or suggested but never evaluated.
C) Unclear: Includes references (i) containing vague statements such as "Authors, editors, and journals have to adhere better to reporting guidelines to improve the quality of reporting" or "greater efforts have to be made by authors to check that their research is compliant with [the relevant reporting guideline]", or (ii) not having the abstract available.
D) Excluded: Includes references (i) not describing interventions to improve adherence to any of the reporting guidelines considered and (ii) describing but not evaluating certain interventions that have already been classified as evaluated.

Disagreements were solved by discussion among the reviewers.

Second, one reviewer (DB) examined the full-text of all group A and B references to confirm the previous classification, then all group C references to reclassify them either as group A, B, or D. Re-classification was verified by the initial reviewer (JJK or EC). Finally, one reviewer (DB) ensured literature saturation by searching the reference lists of included studies, the lists of articles citing them according to PubMed, and the individual studies included in two relevant systematic reviews (3,6).

In addition, we performed a grey literature search, which included: the websites of networks and organizations promoting the use of reporting guidelines (i.e., EQUATOR Network and National Library of Medicine Research Reporting Guidelines and Initiatives); work groups of medical journal editors (i.e., International Committee of Medical Journal Editors (ICMJE) and World Association of Medical Editors (WAME)); biomedical journal publishers (i.e., BMJ Publishing Group and BioMed Central); funding agencies (i.e., National Institute of Health (NIH) and European Research Council); online platforms of post-publication peer review (i.e., PubPeer and ScienceOpen); and

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the abstract books of the past editions of the International Congress on Peer Review and Biomedical Publication.

Data extraction

A data extraction form was developed to collect the information necessary for data synthesis. In order to better capture some further relevant aspects of the included references, the original data extraction form proposed in the protocol was updated. Two reviewers (DB, JJK) independently performed a pilot data extraction on a random sample of 5 articles and subsequently refined the form.

Extracted data included:

1. Publication characteristics: title, year of publication, author, author's affiliation country, and field of study.
2. Characteristics of the intervention:
    a. Classification as evaluated or non-evaluated.
    b. Research stage: education, grant writing, protocol writing, manuscript writing, submission, journal peer review, author revision, copy-editing, and post-publication.
    c. Rationale of the intervention, which refers to the deduced reasons why the intervention is evaluated or proposed.
    d. For evaluated interventions: details of the intervention, study design (e.g. RCT, before-after, etc.), reporting guidelines considered and format (checklist, bullet points and/or examples), period of intervention, number of journals and articles involved, effect size of the intervention on adherence to reporting guidelines and measure used to assess this effect.
3. Relevant conclusions.

Two reviewers (DB, JJK) independently performed data extraction for all studies except for the individual studies of the two systematic reviews evaluating journal endorsement of reporting guidelines (3,6), since none of these studies described

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further interventions and their results had already been reported in these reviews. Discrepancies between reviewers were discussed and solved by consensus.

Data synthesis

Following data extraction, interventions to improve adherence to reporting guidelines were categorised as follows:

1. Training: mentoring of different stakeholders on the practical use of reporting guidelines.
2. Improved understanding: in-depth focus on the content and requirements of reporting guidelines.
3. Encouraging adherence: suggestions and tools to facilitate compliance.
4. Monitoring adherence and providing feedback: checking the level of compliance and indicating incorrect or missing items.
5. Collaboration among authors and experts: interaction and cooperation on methodology and reporting.

One reviewer (DB) performed the initial categorization, which was verified and refined by the other two reviewers (JJK and EC).

Furthermore, we determined the existing gaps in research on the evaluation of interventions to improve adherence to reporting guidelines. More specifically, we identified which categories of interventions and which research stages have not been addressed so far in studies evaluating interventions.

Patients and public involvement

No patients or public were involved in the study.

Results

The database search yielded 1399 citations after deduplication (see Figure 1). Screening of titles and abstracts resulted in a first classification, after which 435 papers were included for full text review. We also reviewed the full text of 24 additional references found through forward citation searching. Furthermore, a grey literature

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search yielded 7 additional references. Finally, 109 references were included. 90 of them (86 observational and 4 randomised studies) described 11 evaluated interventions and the other 19 (12 research studies, 2 editorials, 2 blogs, 1 commentary, 1 essay, and 1 perspective) described 20 non-evaluated interventions.

Among all included references, we identified 31 interventions to improve adherence to reporting guidelines. Some of these interventions appeared in more than one reference and some of the references contained more than one intervention. From those 31 interventions, 4 were categorised as "Training" (1,17-21), 2 as "Improved understanding" (22,23), 15 as "Encouraging adherence" (11,12,20,24,25,27,29-114), 8 as "Monitoring adherence and providing feedback" (13,115-117,119,121,122,125), and 2 as "Collaboration among authors and experts" (25,84,126-128). Figure 2 displays all those interventions according to their categorization and the research stage where they can be performed. Evaluated interventions are highlighted in bold. Supplementary file 3 provides further details of the implementation of the evaluated interventions.

Research gaps identified (see Figure 3) included the evaluation of interventions (i) on training and improved understanding of reporting guidelines, and (ii) at early stages of research (education, grant writing or protocol writing), and (iii) after the process of author revision of the manuscript (copyediting or post-publication peer review).

Hereafter, we present a brief description of the interventions found for each category. For the sake of clarity, the rationale of those interventions is shown in Table 1.

Training

In a first step, health profession schools could incorporate reporting guidelines into curricula that address research methodology and publication standards (17–21). In line with this, students could develop protocols for coursework and research using reporting guidelines such as SPIRIT (randomised trials) and PRISMA-P (systematic reviews), and educators may encourage adherence to those guidelines and grade the protocols using them (20). For their part, funders may consider supporting author training on reporting guidelines (1). Finally, journals or publishers may consider

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investing resources in training editors and reviewers on the content and use of reporting guidelines (1,21).

Improved understanding

Reporting guideline developers might consider translating them to new languages that have not been addressed yet (22). Also, further databases of examples of good reporting for different reporting guidelines that are accessible to authors can be developed, as has been done for CONSORT (23).

Encouraging adherence

First, international scientific associations may play an important role in disseminating and popularizing reporting guidelines to large audiences (24). For their part, funders might require authors to use reporting guidelines as a template for grant application proposals (20). Later on, research ethics boards may require that protocols submitted for ethical approval clearly state which reporting guidelines the study will be using based on the study design, and that reporting guideline checklists are part of the application for ethics approval (11). Funders could also encourage adherence to reporting guidelines by asking for reporting guideline checklists as part of the authors' report (20,25).

One initiative to support author to adhere to reporting guidelines at the writing stage of the manuscript has been COBWEB, a writing aid tool that aims to help authors adequately combine the different extensions of the CONSORT statement (12). This tool divided the CONSORT items into bullet points showing the key elements that need to be reported together with examples of adequate reporting. The impact of COBWEB was evaluated through a randomised trial that showed a large effect of this tool, with a mean improvement in CONSORT scores of 2.1 on a 0–10 scale for the intervention group as compared to the control group (12). A second option to support authors at manuscript writing might be to follow a more structured approach including new subheadings, boxes and tables with key information for different kinds of study designs. For example, ClinicalTrials.gov requires a structured approach to register a study or to report its results (26). This has been shown to be effective: some results

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posted on clinicaltrials.gov, especially harms, are more complete than those in corresponding journal articles reporting the same trials (27). In line with this, the American Journal of Orthodontics and Dentofacial Orthopedics (AJO-DO) updated the traditional RCT format and made readily available a sample article including comments and instructions (28). Finally, another option to help authors avoid omissions when writing the manuscript could be that they mark up the text and show where each item of the relevant checklist is addressed (29).

At manuscript submission stage, different editorial actions have been taken to improve adherence to reporting guidelines. The most popular is what has traditionally been defined as journal endorsement of reporting guidelines, which is usually defined as one or more of the three following interventions: (a) journal editorial statement endorsing certain reporting guidelines; (b) requirement or recommendation in journal's 'Instructions to Authors' to follow certain reporting guidelines when preparing their manuscript; or (c) requirement for authors to submit the appropriate reporting guideline checklist together with their manuscript indicating page numbers corresponding to each item (6). Dozens of observational studies have explored the possible effect of journal endorsement of different reporting guidelines in different clinical areas (30–109). A recent systematic review focused on CONSORT evaluations showed relative but suboptimal improvements in the completeness of reporting in journals by following the aforementioned policies (6), while another systematic review considering 9 other guidelines showed no improvements (3).

Journals might also consider other strategies to enhance adherence to reporting guidelines at submission. A first option could be to develop shorter, core versions of reporting guidelines containing key items (110). Second, they might introduce publication officers in order to provide guidance to authors on preparing manuscripts for submission (111). Third, they may ask authors to populate the relevant checklist with text from their report and not accept a submission unless this is provided (112).

Finally, editors may suggest that peer reviewers use reporting guidelines (113). In addition, by asking peer reviewers questions about whether the author has followed reporting guidelines, this might be an indirect way to encourage them (114).

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Monitoring adherence and providing feedback

Having recognised that journal endorsement without implementation does not guarantee adherence to reporting guidelines, some journals have opted for implementing reporting guidelines at peer review. First, an associate editor may assess manuscripts for adherence to the relevant reporting guideline and ask authors to make changes accordingly (115). This process may be repeated until the associate editor thinks that the manuscript can move to the next step of the review process, leading to an editorial decision. This intervention was evaluated at the AJO-DO and showed satisfactory results: 33 of 37 items reached perfect compliance (115). Second, peer reviewers could also assess the manuscripts against the appropriate checklist (116). While the observed effect of this intervention was slightly positive, it was smaller than hypothesized. In fact, investigators pointed out that authors tended to comply better with suggestions coming from standard reviews rather than from reviews against reporting guidelines, implying that it might be difficult to adhere to high methodological standards at late stages of research if these standards are not considered earlier in the research process. Third, journals could also ask trained editorial assistants to check manuscripts against reporting guidelines (117) or to implement automatic peer review tools such as Statreviewer (118), software that automatically checks adherence to reporting guidelines and evaluates the appropriate use and reporting of statistical tests (119). Currently, its performance is being assessed through a pilot trial in collaboration with four BioMed Central Journals (119). In any of those cases, emails could be sent to authors asking them to revise the manuscript according to guidelines (13). To do this, the EQUATOR Network has provided standard letters that can be used a) after checks by an editor or a single peer reviewer, b) after full peer review, or c) alongside acceptance (120). Furthermore, at the time of author revision of the manuscript, Hopewell et al. found no significant effect when incorporating WebCONSORT, a web-based tool that generates a unique list of items customised to the trial design, to the revision process of journals that endorsed CONSORT but had no active policy for implementing it (121). Finally, in a late stage of the publication process, copyediting of the manuscript could also ensure that all items are covered (122).

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Once the paper is published, the scientific community could use online platforms of post-publication peer review such as PubPeer (123) or ScienceOpen (124) to evaluate the adherence to reporting guidelines of published articles and to provide feedback to authors (125).

Collaboration among authors and experts

Authors may benefit from collaboration with experts at different stages of research. On the one hand, the involvement of statisticians (or epidemiologists or other quantitative methodologists) in the design, conduct or reporting of the study might contribute to properly reporting key areas such as sample size calculation, randomization, blinding, and appropriate statistical analysis (126). While one study did not find a statistically significant positive relationship between CONSORT scores and statistician involvement (127), others did (84,126,128). On the other hand, it has been hypothesized that the involvement of medical writers during the manuscript writing stage of research could improve the completeness of reporting (25).

Discussion

In this scoping review, we identified 31 interventions to improve adherence to reporting guidelines. We have also determined the gaps in research on the evaluation of this type of interventions. By considering a wide range of reporting guidelines as well as their extensions and merging the evidence found in the published and grey literature, this review provides a broad picture of how the problem of enhancing adherence to reporting guidelines has been tackled so far and could be faced in the future.

This study reveals that it is primarily journals that have made most of the efforts to improve adherence to reporting guidelines in health research – although they can certainly do more. Typically, their strategies range from making available editorial statements that endorse certain reporting guidelines, recommending or requiring authors to follow reporting guidelines in the “Instructions to authors”, and requiring authors to submit a reporting guideline checklist together with the manuscript, with page numbers indicated for each item. However, these strategies have been shown

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not to have the desired effect (3,6,129). Recent research has called for more active and enforced journal policies throughout the editorial process, such as requiring the use of structured approaches with new subheads adapted to different kinds of study designs (27), which was also found to be beneficial in a new study outside of our search period (130); providing guidance on manuscript preparation (111); making sure the peer review process involves editorial assistants who have specific training on reporting issues (117); and implementing automatic peer review tools (119). Journals will vary in their ability to make some of these strategies effective, depending on factors such as their resources, their guidelines to peer reviewers and the dedication of their editors – many editors and editorial staff work part-time and have limited amount of time.

Moreover, editors' education and performance should be improved. A recent study pointed out that more than a third (39%) of the manuscripts classified as randomised trials by the editorial staff were not actually randomised trials (121,131). Consequently, it seems difficult to improve author and peer reviewer adherence to reporting guidelines if journal gatekeepers are not properly trained in methodological and reporting issues.

Apart from journals, editors and peer reviewers, other key stakeholders such as medical schools, research funders, universities and other research institutions should also take responsibility regarding this issue. This scoping review provides some strategies to follow. However, as the problem is complex and the possible interventions are varied, enhancing the completeness of reporting most likely depends not so much on any isolated action but on a set of strategies by several different stakeholders. These could be enacted at different stages of research, from education to article post-publication.

For interventions aiming to improve adherence to reporting guidelines, we should require the same level of evidence that we require for interventions to improve health. For this reason, it is striking that we found only 4 published randomised trials that evaluated interventions to improve adherence to reporting guidelines (12,113,116,121). Among these trials, statistically significant effect of the intervention was only observed for the use of the writing aid tool for authors COBWEB (12). While

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performing an additional review against reporting guidelines showed slightly positive but not significant effect (116), suggesting the use of reporting guidelines to peer reviewers (113) or implementing at the process of author revision of the manuscript the web-based tool WebCONSORT showed no benefit (121). The rest of the evaluations of interventions found (86 of 90) were observational studies, whose results are subject to the influence of confounding factors (6). For example, evaluations of the effect of journal endorsement may be influenced by whether different journals are actively checking that authors adhere to the requirements or recommendations they provide to authors at submission (6). For all these reasons, future randomised trials should be performed to evaluate further interventions to improve adherence to reporting guidelines. Moreover, these trials might consider addressing some of the research gaps identified in this review, such as improving adherence to reporting guidelines at the grant application or protocol writing stages.

A few of the interventions found in this review were shown to enhance adherence to reporting guidelines. However, it is noteworthy there is no evidence that some successful interventions (12,27,115) have been implemented more widely later. For this reason, more resources and efforts are needed to further implement these interventions in other settings, evaluate the effect, and share the results with the scientific community. In any case, it is important to keep in mind that contemporary publication culture may harm the potential improvements in reporting quality. This could result from the fact that most scientists feel that the primary evaluation tool of their research is the quantity of their scientific output rather than its quality (132); and such attitudes may undermine the potential effect of any intervention to improve adherence to reporting guidelines.

Our scoping review has some limitations. First, we did not formally assess the methodological quality of the studies that evaluated interventions. Second, restricting to certain databases or not having standard search terms for the databases searched may have excluded relevant publications. Third, it is possible that we could have missed evidence of possible interventions that may have never been reflected in the published or grey literature but are instead used in practice and continue to be used.

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For example, journals might be applying specific editorial strategies that are not publicly available on their websites or in the published literature.

Conclusion

This review is part of a larger project whose next goals are (i) to capture editors' perceptions on the barriers and facilitators of some promising interventions identified in this review, (ii) to explore new possible interventions, and (iii) to evaluate one of these interventions in collaboration with BMJ Open.

Improving adherence to reporting guidelines is one of the key issues in order to enhance complete and accurate reporting and therefore reduce waste in research. For example, a decrease in waste of research from 85% to 70% would double the output of valuable research and innovation.

Different stakeholders – such as research funders, ethics boards, and journals – should identify, implement and evaluate further interventions to improve adherence to reporting guidelines.

List of abbreviations

AJO-DO: American Journal of Orthodontics and Dentofacial Orthopedics; CONSORT: CONsolidated Standards Of Reporting Trials; COBWEB: CONSORT-based web tool; EQUATOR: Enhancing the QUAlity and Transparency Of Health Research; RCT: Randomised Controlled Trial; RG: Reporting Guideline; SPIRIT: Standard Protocol Items: Recommendations for Interventional Trials; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

Declarations

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Author contributions: All authors contributed to conceptualizing and designing the study. DB, EC, and JJK independently performed screening. DB and JJK independently performed data extraction. DB performed initial data synthesis and EC, IB, DM, DGA, and JJK refined it. DB drafted the manuscript. EC, IB, DM, DGA, and JJK made major revisions. All authors read and approved the final version of the manuscript.

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Figures, tables and supplementary files

Figure 1: PRISMA flow diagram

Figure 2: Typology of interventions to improve adherence to RGs according to type of intervention and research stage. **Legend:** Evaluated interventions are shown in bold.

Figure 3: Gaps in research on the evaluation of interventions to improve adherence to reporting guidelines. **Legend:** Each circle represents one intervention. Variables displayed: 1) Circle size: Number of studies evaluating each intervention (bigger = more studies); 2) Circle colour: Study design of those studies (blue for RCTs and green for observational studies) and 3) Circle fill: Kind of RG implementation (plain for checklist and stripes for bullet points and examples). Research gaps are highlighted in red.

Table 1: Rationale of the interventions identified.

Supplementary file 1: Description of the acronyms and full names of the reporting guidelines shown in the EQUATOR website as “Reporting Guidelines for main study types” on 8 May 2017.

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Supplementary file 2: Search terms for PubMed (from January 1, 1996, to March 31, 2017) via PubMed.

Supplementary file 3: implementation details of the evaluated interventions.

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Group	Intervention	Rationale
Training	Introduction of RGs & journalology into graduate curricula (17-21)	To introduce good research reporting habits early in young researchers' scientific careers.
	Student's development of protocols for coursework and research using RGs (20)	
	Funder's support of author training on RGs (1)	Authors, editors, and peer reviewers have insufficient training in issues related to reporting.
	Training for peer reviewers and editors on RGs by journals (1,21)	
Improved understanding	Translation of RGs to further languages (22)	Language barriers may affect the proper use of RGs.
	Development of expanded database of examples for each RG (23)	Authors need more examples of good reporting to properly understand certain items.
Encouraging adherence	Dissemination of RGs by scientific associations (24)	A large number of researchers are not aware of the existence of RGs.
	Author use of RGs as a template for grant application proposals (20)	Using RGs in early stages may facilitate completeness of reporting of published research.
	Required checklist for ethics approval application (11)	
	Funder's requirement of checklists in author's report (20,25)	

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	Author use of the writing aid tool COBWEB (12)	A) Authors need help to successfully adhere to RGs at the writing stage and B) Dividing RG items into bullet points and providing examples might help.
	Author use of a structured approach for reporting research (27)	A) To help authors avoid omissions, B) to aid reviewers and editors in appraising articles and C) to allow more efficient data extraction during the systematic review process.
	Author markup of the manuscript to indicate where each RG item is addressed (29)	
	Editorial statement endorsing certain RGs (30-109)	Authors read editorial statements and follow “Instructions to authors”.
	Recommendation or requirement to follow RGs in the "Instructions to authors“ (30-109)	
	Requirement to submit a RG checklist together with the manuscript indicating page numbers corresponding to each item (30-109)	Authors may not consider editorial statements or recommendations in “Instructions to authors” to be important. Compulsory submission of checklists or text mark-up may encourage authors to be more compliant with RGs.
	Requirement to populate and submit a RG checklist with text from the manuscript (112)	

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	Journal development of core versions of RGs containing key items (110)	Focusing on the most important items could be more effective than considering the whole checklist.
	Guidance to authors on manuscript preparation by publication officers (111)	Trained journal officers may enhance authors' compliance with RGs during manuscript preparation.
	Suggestion for peer reviewers to use RGs (113)	Peer reviewers often do not detect reporting flaws. Therefore, they may need to follow a more systematic approach and use RGs.
	Editor's questions to peer reviewers about whether the authors have followed RGs (114)	
Monitoring adherence and providing feedback	Completeness of reporting check by editors (115)	Requiring checklists at submission does not guarantee adherence. Editors and peer reviewers have to check whether submitted papers are compliant with RGs. It is extremely unlikely that the average clinical peer reviewer has the methodological expertise to check a paper against RGs.
	Peer review against RGs (116)	
	Internal peer review against RGs by a trained editorial assistant (117)	
	Implementation of the automatic tool Statreviewer (119)	
	Email to authors to revise the manuscript according to RGs (13)	It might be more effective to ask authors for adherence to RGs during the revision process

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	Implementation of the tool WebCONSORT (121)	because they will do anything to get their paper published. Copy-editing and post-publication offer alternate time points to improve adherence to RGs.
	Completeness of reporting check at copy-editing (122)	
	Post- publication peer review (125)	
Collaboration among authors and experts	Statistician involvement (84,126-128)	Professionals with specific knowledge of RGs might help authors when designing, conducting or reporting their research.
	Medical writer involvement (25)	

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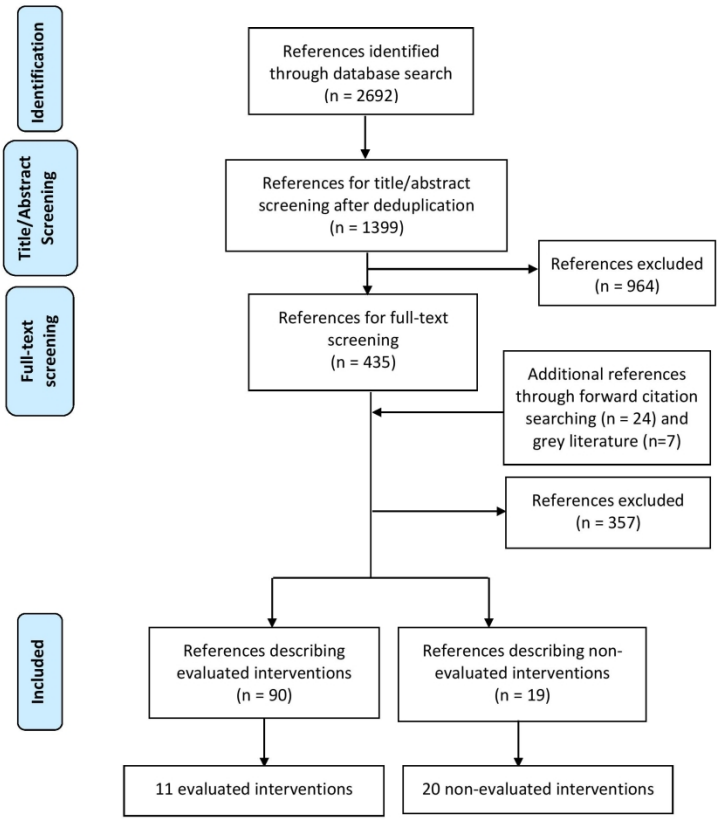

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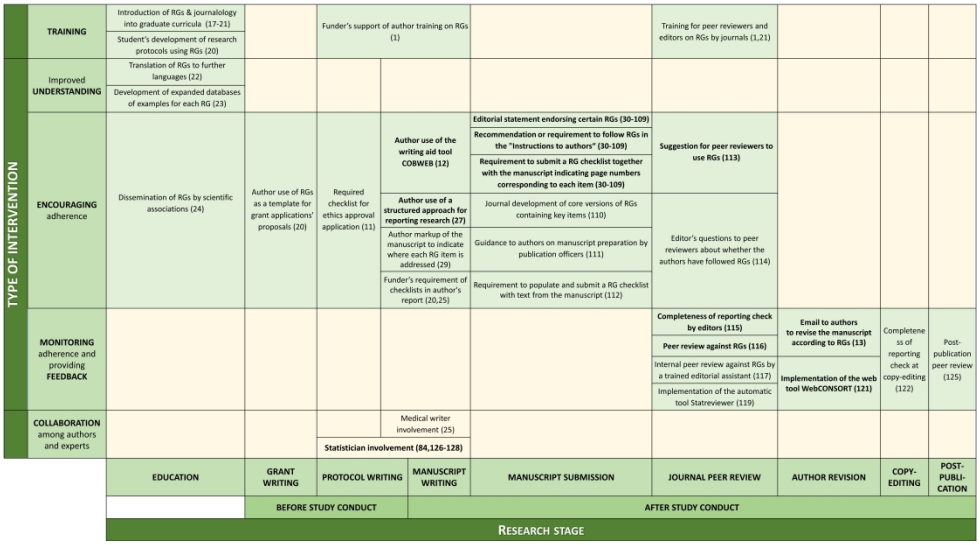

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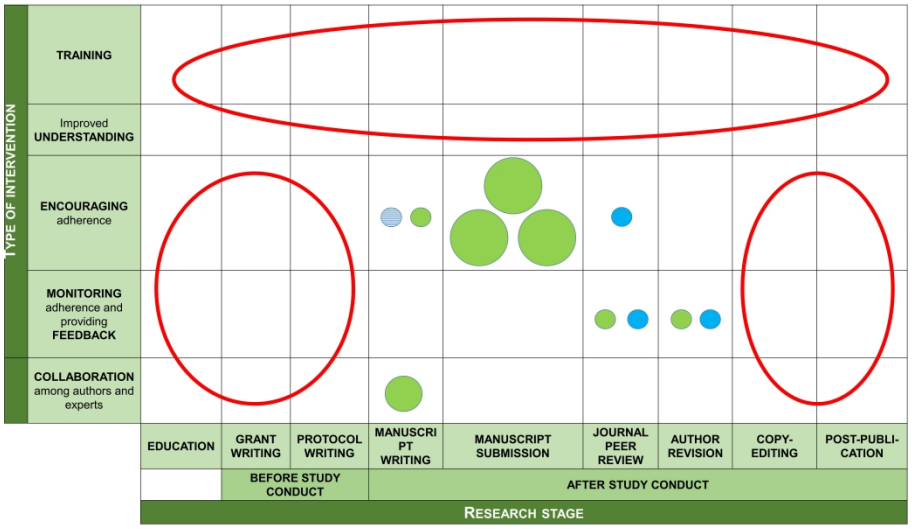

670x379mm (300 x 300 DPI)

Acronym	Full name
CONSORT	Consolidated Standards of Reporting Trials
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SRQR	Standards for Reporting Qualitative Research
COREQ	Consolidated criteria for Reporting Qualitative research
STARD	Standard Protocol Items: Recommendations for Interventional Trials
TRIPOD	Transparent Reporting of a multivariable prediction model for Individual Prognosis or Diagnosis
SQUIRE	Standards for Quality Improvement Reporting Excellence
CHEERS	Consolidated Health Economic Evaluation Reporting Standards
SPIRIT	Standard Protocol Items: Recommendations for Interventional Trials
PRISMA-P	Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols
CARE	Case Report
AGREE	Appraisal of Guidelines, Research and Evaluation
ARRIVE	Animal Research: Reporting In Vivo Experiments
RIGHT	Reporting Tool for Practice Guidelines in Health Care

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Steps	Search terms
S1	impact* [tw]
S2	improv* [tw]
S3	enhanc* [tw]
S4	boost* [tw]
S5	increas* [tw]
S6	influenc* [tw]
S7	effect [tw]
S8	S1 **OR** S2 **OR** S3 **OR** S4 **OR** S5 **OR** S6 **OR** S7
S9	compliance [tw]
S10	adherence [tw]
S11	completeness [tw]
S12	quality of reporting [tw]
S13	reporting quality [tw]
S14	S9 **OR** S10 **OR** S11 **OR** S12 **OR** S 13
S15	Consolidated [tw] Standards [tw] Reporting [tw] Trials [tw] **OR** CONSORT[tw]
S16	Strengthening [tw] Reporting [tw] Observational [tw] Studies [tw] Epidemiology[tw] **OR** STROBE[tw]
S17	Preferred [tw] Reporting [tw] Items [tw] Systematic [tw] reviews [tw] Meta-Analyses [tw] **OR** PRISMA[tw]
S18	Standards [tw] Reporting [tw] Qualitative Research[tw] **OR** SRQR[tw]
S19	Consolidated [tw] Criteria [tw] Reporting [tw] Qualitative [tw] Research[tw] **OR** COREQ[tw]
S20	Standard [tw] Protocol [tw] Items [tw] Recommendations [tw] Interventional [tw] Trials[tw] **OR** STARD[tw]
S21	Transparent [tw] Reporting [tw] multivariable [tw] prediction [tw] model [tw] Individual [tw] Prognosis [tw] Diagnosis[tw] **OR** TRIPOD[tw]
S22	Standards [tw] QUality [tw] Improvement [tw] Reporting [tw] Excellence[tw] **OR** SQUIRE[tw]
S23	Consolidated [tw] Health [tw] Economic [tw] Evaluation [tw] Reporting [tw] Standards[tw] **OR** CHEERS[tw]
S24	Standard [tw] Protocol [tw] Items [tw] Recommendations [tw] Interventional [tw] Trials[tw] **OR** SPIRIT[tw]
S25	Preferred [tw] Reporting [tw] Items [tw] Systematic [tw] Review [tw] Meta-Analysis [tw] Protocols[tw] **OR** PRISMA-P[tw]
S26	Quality [tw] Reporting [tw] Meta-analyses[tw] **OR** QUOROM[tw]
S27	Case [tw] Report [tw] **AND** CARE[tw]
S28	Appraisal [tw] Guidelines [tw] Research [tw] Evaluation[tw] **AND** AGREE[tw]
S29	Animal [tw] Research [tw] Reporting [tw] Vivo [tw] Experiments[tw] **AND** ARRIVE[tw]
S30	Reporting [tw] Tool [tw] Practice [tw] Guidelines [tw] Health [tw] Care[tw] **AND** RIGHT[tw]
S31	S15 **OR** S16 **OR** S17 **OR** S18 **OR** S19 **OR** S20 **OR** S21 **OR** S22 **OR** S23 **OR** S24 **OR** S25 **OR** S26 **OR** S27 **OR** S28 **OR** S29 **OR** S30
S32	S8 **AND** S14 **AND** S31
S33	S32 **AND** "1996/01/01"[PDAT] : "2017/03/31"[PDAT]

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Type of intervention	Intervention	Number of studies and study design	Details of the intervention	RGs implemented	Format of RG implementation	Measure of adherence to RGs	Effect on adherence to RGs
Encouraged adherence	Implementation of the writing aid tool COBWEB (12)	1 RCT	Participants have to write the six domains of the methods section of the manuscript for the protocol they receive. They have access to COBWEB tool for a random three of the six domains.	CONSORT & CONSORT extension for non-pharmacological interventions	Bullet points and examples (6 items)	Mean global score for completeness of reporting (scale 0–10, items weighted).	Significant: increase of 2.1 (95% CI 1.5-2.7)
	Author use of a structured approach for reporting research (27)	1 Observational study (cross-sectional evaluation)	Results are posted in a standard tabular format without discussions or conclusions.	CONSORT	Checklist (4 items)	Percentage compliance of each RG item	Significant: all 4 items studied improved significantly
	Journal endorsement (3 interventions, see “Details of the intervention”) (30-109)	80 observational studies (57 cross sectional evaluations of endorsing vs non-endorsing journals, 9 before and after evaluations of endorsing journals before and after endorsement, 14 both kind of evaluations)	A) Editorial statement endorsing certain RGs, B) Recommendation or requirement to follow RGs in the "Instructions to authors", and C) Requirement to submit a RG checklist together with the manuscript indicating page numbers corresponding to each item.	CONSORT (46 of 80) CONSORT extensions (9 of 80) QUOROM (3 of 80) PRISMA (4 of 80) PRISMA extensions (1 of 80) STARD (11 of 80)	Checklist (all items)	Relative proportions of studies adequately reporting any of the item & percentage compliance of each RG item	Significant for CONSORT: 25 items improved, five significantly Not significant for other RGs**

				STROBE (4 of 80) ARRIVE (1 of 80) CONSORT, STROBE and PRISMA (11 of 80)			
	Suggestion for peer reviewers to use RGs (113)	1 RCT	Peer reviewers are sent a standard letter encouraging them to use different reporting guidelines. Reviewers are not asked to report whether they used the reporting guideline in reviewing the manuscript.	CONSORT, QUOROM, STARD	Checklist (all items)	Modified version of Manuscript Quality Assessment Instrument (scale 36-180)	Not significant: increase of 0.9 (95% CI -0.3 to +2.1)
Monitoring adherence and providing feedback	Completeness of reporting check by the editors (115)	1 Observational Study (Before and after evaluation)	Initial submissions are vetted by the editor-in-chief. If the submission is considered appropriate, manuscripts are assessed by the associate editor for CONSORT adherence. Authors are asked to make changes accordingly until associate editor deems appropriate that they move to the next step of the review process leading to an editorial decision.	CONSORT	Checklist (all items)	Percentage compliance of each RG item	Significant: Before – compliance ranged from 0% to 100% (Median 40%) / After – perfect compliance in 33 out of 37 items

	Additional review against RGs (116)	1 RCT	A senior statistician does an additional review of all papers and provides authors suggestions on how to follow reporting guideline checklists.	STROBE, CONSORT, STARD	Checklist (all items)	Modified version of Manuscript Quality Assessment Instrument (scale 1 to 9)	Not significant: increase of 0.25 (95% CI -0.05 to +0.54)
	Active implementation of RG by editors (2 interventions, see "Details of the intervention") (13)	1 Observational study (Interrupted time series evaluation)	A) Email is sent to authors to revise the abstract according to the guidelines at the revision stage and B) Changes are made by the assistant editors of these journals towards the end of the editorial process.	CONSORT extension for abstracts	Checklist (9 of 17 items)	Monthly mean number of items reported	Significant: increase 1.50 items
	Implementation of the web-based tool WebCONSORT (121)	1 RCT	Journal editor includes a link to WebCONSORT in the revision letter to authors. Authors are directed to an automatically generated list of items and a flow diagram customised to their specific trial design.	CONSORT & some CONSORT extensions	Checklist (10 of 25 items)	Percentage of possible items reported for each article	Not significant: increase of 0.04 (95% CI –0.02 to +0.10)
Collaboration among authors and experts	Statistician involvement (84,126-128)	4 Observational studies (cross sectional evaluations)	Statisticians (or epidemiologists or other quantitative methodologists) are involved in the design, conduct or reporting of the study	CONSORT	Checklist (all items)	Percentage of possible items reported for each article	Significant in three studies (84,126,128), not significant in one (127)

*According to the systematic review by Turner et al. (6) **According to the systematic review by Stevens et al. (3)

BMJ Open

A scoping review on interventions to improve adherence to reporting guidelines in health research

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Keywords:	Scoping review, Quality of reporting, Completeness of reporting, Reporting guidelines, Knowledge synthesis, Adherence

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A scoping review on interventions to improve adherence to reporting guidelines in health research

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Keywords

Scoping review, knowledge synthesis, reporting guidelines, completeness of reporting, quality of reporting, adherence

Abstract

Objectives: The goal of this study is to identify, analyse and classify interventions to improve adherence to reporting guidelines in order to obtain a wide picture of how the

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problem of enhancing the completeness of reporting of biomedical literature has been tackled so far.

Design: Scoping review.

Search strategy: We searched the MEDLINE, EMBASE, and Cochrane Library databases and conducted a grey literature search for (i) studies evaluating interventions to improve adherence to reporting guidelines in health research and (ii) other types of references describing interventions that have been performed or suggested but never evaluated. The characteristics and effect of the evaluated interventions were analysed. Moreover, we explored the rationale of the interventions identified and determined the existing gaps in research on the evaluation of interventions to improve adherence to reporting guidelines.

Results: 109 references containing 31 interventions (11 evaluated) were included. These were grouped into five categories: (1) training on the use of reporting guidelines, (2) improving understanding, (3) encouraging adherence, (4) checking adherence and providing feedback, and (5) involvement of experts. Research gaps identified included the evaluation of interventions (i) on training on the use of reporting guidelines and improving understanding of these, (ii) at early stages of research, and (iii) after the final acceptance of the manuscript.

Conclusions: This scoping review identifies a wide range of strategies to improve adherence to reporting guidelines that can be taken by different stakeholders. Future randomised trials should consider evaluating some of the interventions that have not been assessed yet, therefore addressing the research gaps identified.

Strengths and limitations

- We considered wide range of reporting guidelines as well as their extensions.
- Merging the evidence found in the published and grey literature allowed us to provide a broad picture of how the problem of enhancing adherence to reporting guidelines has been tackled so far and could be faced in the future.
- The screening and data extraction were performed in duplicate.

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- We could have missed evidence of possible interventions that may not be present in the published or grey literature but are instead used in practice and continue to be used.

Background

Approximately 85% of all biomedical research today is estimated to be wasted, due, in part, to incomplete or inaccurate reporting (1). The past two decades have given rise to a number of changes in an effort to help authors and the broader scientific community properly report research methods and findings, which would allow them to contribute to the broader goal of combating waste in biomedical research. The most prominent of these changes has been the inception of reporting guidelines for different study types, data, and clinical areas (2).

The vast majority of reporting guidelines have not yet been assessed as to whether they help improve the reporting of research (3), but some, such as the Consolidated Standards of Reporting Trials (CONSORT) for the reporting of randomised controlled trials (RCTs) (4), have been shown to enhance the completeness of reporting (5,6).

Dozens of systematic reviews have explored the extent of adherence to some reporting guidelines in certain areas of health research (7–10). Saaman et al. (11) went one step further and performed a systematic review of systematic reviews assessing adherence to reporting guidelines. As they considered a broad range of clinical areas and study designs, their results provided a global picture of adherence to reporting guidelines in health research. Although some studies reported acceptable overall levels of completeness of reporting and found that it had improved since the introduction of certain reporting guidelines such as CONSORT, the authors of most of the reviews (43 of 50, 86%) concluded that more improvement is needed or that adherence to reporting guidelines was inadequate, poor, medium or suboptimal. Therefore, it is warranted to explore and develop strategies to improve the current levels of adherence to reporting guidelines.

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In recent years, several initiatives aiming to improve adherence to reporting guidelines have been proposed, some of which have already been evaluated. For example, the effect of journal endorsement of reporting guidelines (3,5,6) and the implementation of writing aid tools for authors such as the CONSORT-based web tool (COBWEB) (12) have been assessed. While some of these strategies have not been shown to have a benefit (3), others report better but still suboptimal levels of reporting (5,6) or even clear benefits (12,13).

As mentioned, several reviews have analysed the quality of reporting in different clinical areas and for different study types (7–10). However, no scoping review has been performed that provides a global picture of different strategies aiming to improve adherence to reporting guidelines. Given the low levels of completeness of reporting in health research that have been observed (11), along with the imperative need to take further actions for mitigating this problem, we considered that performing such a scoping review was warranted.

In addition to analysing the implementation and effect of interventions that have already been evaluated, we aimed to gather other possible strategies that could be implemented and evaluated in the future.

For clarification, some relevant terms used throughout the scoping are defined in Box 1, which is based on Stevens et al. (3).

Box 1: relevant definitions in the context of this scoping review

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Adherence: Action(s) taken by authors to ensure that a research report is compliant with the items recommended by the appropriate/relevant reporting guideline. These can take place before or after the first version of the manuscript is published.

Endorsement: Action(s) taken by journals to indicate their support for the use of one or more reporting guideline(s) by authors submitting research reports for consideration.

Implementation: Action(s) taken by journals to ensure that authors adhere to an endorsed reporting guideline and that therefore published papers are completely reported.

Complete reporting: Pertains to the state of reporting of a study report and whether it is compliant with all the items recommended by the appropriate/relevant reporting guideline.

Methods

As presented in the published protocol (14), this scoping review follows the methodology manual published by the Joanna Briggs Institute for scoping reviews (15).

Objectives

The scoping review questions are:

1. What interventions to improve adherence to reporting guidelines in health research have been evaluated?
2. What further interventions to improve adherence to reporting guidelines have been performed or suggested but never evaluated?

We aimed to analyse and classify the interventions found for both questions in order to obtain a wide picture of how the problem of adhering better to reporting guidelines has been tackled so far and can be tackled in the future.

Eligibility criteria

We included:

1. Studies evaluating interventions aiming to improve adherence to reporting guidelines in health research, irrespective of study design.

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2. Commentaries, editorials, letters, studies, and online sources describing possible interventions to improve adherence to reporting guidelines that have been performed or suggested but never evaluated.

The reporting guidelines considered were those shown on 8 May 2017 on the EQUATOR (Enhancing the QUAlity and Transparency Of Health Research) Network website (16) as "Reporting Guidelines for main study types". In addition, we included QUOROM (Quality of Reporting of Meta-analyses), since it was the precursor of PRISMA. Supplementary file 1 shows all reporting guidelines considered.

We considered the following languages: English, Spanish, French, German and Catalan.

Exclusion criteria

We have excluded references that include interventions that do not specifically aim to improve the completeness of reporting, even though these interventions may actually influence completeness. For example, we have excluded clinical trial registration even though it may enhance completeness of reporting, because its main goals are to improve clinical trial transparency while also reducing publication and selective reporting biases.

Search strategy and study selection

On 8 May 2017, we searched PubMed, EMBASE, and Cochrane Library databases for articles published between 1 January 1996 and 31 March 2017, in accordance with our scheduled search (14). The detailed search terms for PubMed can be found in the protocol.

The retrieved studies were exported into Mendeley and duplicates were automatically removed using it. One reviewer (DB) first screened the titles and abstracts for eligibility. Each of the other two reviewers (JJK and EC) was randomly assigned 50% of the references and screened the titles and abstracts independently of the first reviewer. The reviewers classified the references into one of the following groups:

A) Evaluated: Includes references describing interventions to improve adherence to reporting guidelines that have been empirically assessed.

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B) Non-evaluated: Includes references describing interventions to improve adherence to reporting guidelines that have been performed or suggested but never evaluated.

C) Unclear: Includes references (i) containing vague statements such as "Authors, editors, and journals have to adhere better to reporting guidelines to improve the quality of reporting" or "greater efforts have to be made by authors to check that their research is compliant with [the relevant reporting guideline]", or (ii) not having the abstract available.

D) Excluded: Includes references (i) not describing interventions to improve adherence to any of the reporting guidelines considered and (ii) describing but not evaluating certain interventions that have already been classified as evaluated.

Disagreements were solved by discussion among the reviewers.

Second, one reviewer (DB) examined the full-text of all group A and B references to confirm the previous classification, then all group C references to reclassify them either as group A, B, or D. Re-classification was verified by the initial reviewer (JJK or EC). Finally, one reviewer (DB) ensured literature saturation by searching the reference lists of included studies, the lists of articles citing them according to PubMed, and the individual studies included in two relevant systematic reviews (3,6).

In addition, we performed a grey literature search, which included: the websites of networks and organizations promoting the use of reporting guidelines (i.e., EQUATOR Network and National Library of Medicine Research Reporting Guidelines and Initiatives); work groups of medical journal editors (i.e., International Committee of Medical Journal Editors (ICMJE) and World Association of Medical Editors (WAME)); biomedical journal publishers (i.e., BMJ Publishing Group and BioMed Central); funding agencies (i.e., National Institute of Health (NIH) and European Research Council); online platforms of post-publication peer review (i.e., PubPeer and ScienceOpen); and the abstract books of the past editions of the International Congress on Peer Review and Biomedical Publication.

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Some of the included references were described in studies co-authored by some of the authors this scoping review. These references underwent the same process of screening, data extraction, and data synthesis as the others.

Data extraction

A data extraction form was developed to collect the information necessary for data synthesis. Two reviewers (DB, JJK) independently performed a pilot data extraction on a random sample of 5 articles and subsequently refined the form.

Extracted data included:

1. Publication characteristics: title, year of publication, author, author's affiliation country, and field of study.
2. Characteristics of the intervention:
    a. Classification as evaluated or non-evaluated.
    b. Research stage: education, grant writing, protocol writing, manuscript writing, submission, journal peer review, copy-editing, and post-publication.
    c. Rationale of the intervention, which refers to the deduced reasons why the intervention is evaluated or proposed.
    d. For evaluated interventions: details of the intervention, study design (e.g. RCT, before-after, etc.), reporting guidelines considered and format (checklist, bullet points and/or examples), period of intervention, number of journals and articles involved, effect size of the intervention on adherence to reporting guidelines and measure used to assess this effect.
3. Relevant conclusions.

Two reviewers (DB, JJK) independently performed data extraction for all studies except for the individual studies of the two systematic reviews evaluating journal endorsement of reporting guidelines (3,6), since none of these studies described further interventions and their results had already been reported in these reviews. Discrepancies between reviewers were discussed and solved by consensus.

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Data synthesis

Following data extraction, interventions to improve adherence to reporting guidelines were categorised as follows:

1. Training on the practical use of reporting guidelines: mentoring of different stakeholders on the practical use of reporting guidelines.
2. Enhancing accessibility and understanding: dissemination of reporting guidelines and the improvement of authors' understanding of their content.
3. Encouraging adherence: suggestions and tools to facilitate compliance.
4. Checking adherence and providing feedback: checking the level of compliance and indicating incorrect or missing items.
5. Involvement of experts: interaction and cooperation on methodology and reporting.

One reviewer (DB) performed the initial categorization, which was verified and refined by the other two reviewers (JJK and EC).

Furthermore, we determined the existing gaps in research on the evaluation of interventions to improve adherence to reporting guidelines. More specifically, we identified which categories of interventions and which research stages have not been addressed so far in studies evaluating interventions.

Deviations from the protocol

In order to better capture the most relevant aspects of the included studies, the original data extraction form proposed in the protocol was modified. We removed the health care area of the studies included, refined the research stages considered, and included more details on the implementation of the evaluated interventions.

Patients and public involvement

No patients or public were involved in the study.

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Results

The database search yielded 1399 citations after deduplication (see Figure 1). Screening of titles and abstracts resulted in a first classification, after which 435 papers were included for full text review. We also reviewed the full text of 24 additional references found through forward citation searching. Furthermore, a grey literature search yielded 7 additional references. Finally, 109 references were included. Some of these interventions appeared in more than one reference and some of the references contained more than one intervention. 90 of these references (86 observational and 4 randomised studies) described 11 evaluated interventions and the other 19 (12 research studies, 2 editorials, 2 blogs, 1 commentary, 1 essay, and 1 perspective) described 20 non-evaluated interventions. Figure 2 displays these 31 interventions according to their categorization and the research stage where they can be performed. Moreover, Table 1 shows all interventions in a tabular format together with their rationale.

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Group	Intervention	Rationale
Training on the practical use of RGs	Introduction of RGs & journalology into graduate curricula (18-22)	To introduce good research reporting habits early in young researchers' scientific careers.
	Student's development of protocols for coursework and research using RGs (21)	
	Funder's support of author training on RGs (23)	Authors, editors, and peer reviewers have insufficient training in issues related to reporting.
	Training for peer reviewers and editors on RGs by journals (22,23)	
Enhancing accessibility and understanding	Dissemination of RGs by scientific associations (24)	A large number of researchers are not aware of the existence of RGs.
	Translation of RGs to further languages (25)	Language barriers may affect the proper use of RGs.
	Development of expanded database of examples for each RG (26)	Authors need more examples of good reporting to properly understand certain items.
Encouraging adherence	Author use of RGs as a template for grant application proposals (21)	Using RGs in early stages may facilitate completeness of reporting of published research.
	Required checklist for ethics approval application (11)	
	Funder's requirement of checklists in author's report (21,108)	
	Author use of the writing aid tool COBWEB (12)	A) Authors need help to successfully adhere to RGs at the writing stage and B) Dividing RG items into bullet points and providing examples might help.
	Author use of a structured approach for reporting research (47,112)	A) To help authors avoid omissions, B) to aid reviewers and editors in appraising articles and C) to allow more efficient data extraction during the systematic review process.
	Author markup of the manuscript to indicate where each RG item is addressed (109)	
	Editorial statement endorsing certain RGs (27–46,48–106,113)	Authors read editorial statements and follow "Instructions to authors".
	Recommendation or requirement to follow RGs in the "Instructions to	

	authors“ (27–46,48–106,113)	
	Requirement to submit a RG checklist together with the manuscript indicating page numbers corresponding to each item (27–46,48–106,113)	Authors may not consider editorial statements or recommendations in “Instructions to authors” to be important. Compulsory submission of checklists or text mark-up may encourage authors to be more compliant with RGs.
	Requirement to populate and submit a RG checklist with text from the manuscript (114)	
	Journal development of core versions of RGs containing key items (110)	Focusing on the most important items could be more effective than considering the whole checklist.
	Guidance to authors on manuscript preparation by publication officers (111)	Trained journal officers may enhance authors’ compliance with RGs during manuscript preparation.
	Suggestion for peer reviewers to use RGs (107)	Peer reviewers often do not detect reporting flaws. Therefore, they may need to follow a more systematic approach and use RGs.
	Editor’s questions to peer reviewers about whether the authors have followed RGs (115)	
Checking adherence and providing feedback	Completeness of reporting check by editors (117)	Requiring checklists at submission does not guarantee adherence. Editors and peer reviewers have to check whether submitted papers are compliant with RGs.
	Peer review against RGs (118)	
	Internal peer review against RGs by a trained editorial assistant (120)	It is extremely unlikely that the average clinical peer reviewer has the methodological expertise to check a paper against RGs.
	Implementation of the automatic tool Statreviewer (121)	
	Email to authors to revise the manuscript according to RGs (13)	It might be more effective to ask authors for adherence to RGs during the revision process because they will do anything to get their paper published.
	Implementation of the tool WebCONSORT (119)	
	Completeness of reporting check at copy-editing (122)	Copy-editing and post-publication offer alternate time points to improve adherence to RGs.
	Post- publication peer review (123)	
Involvement of	Statistician involvement (78,128-130)	Professionals with specific knowledge of RGs

experts	Medical writer involvement (108)	might help authors when designing, conducting or reporting their research.

Among the 11 evaluated interventions identified, we found a variety of measures used to assess their effect on adherence to reporting guidelines, including:

- Score for completeness of reporting for each paper, either assigning different or equal weights to RG items, on a 0-10 scale.
- Percentage of items reported for each paper.
- Percentage of compliance per RG item.
- Score for the Manuscript Quality Assessment Instrument (17) for each paper.

Due to the heterogeneity of these measures and for the sake of clarity, we prefer to omit the information on the exact effect sizes in the main body of the manuscript and show it in Supplementary file 2, together with the implementation details of the evaluated interventions. In this way, these effects can be understood in an appropriate context.

Research gaps identified (see Figure 3) included the evaluation of interventions (i) on training on the use of reporting guidelines and improving understanding of these, and (ii) at early stages of research (education, grant writing or protocol writing), and (iii) after the final acceptance of the manuscript (copyediting or post-publication peer review).

Hereafter, we describe the interventions found for each category (Table 1 and Supplementary file 2 summarise these interventions).

Training on the practical use of reporting guidelines

Four non-evaluated interventions related to educating different stakeholders on the practical use of reporting guidelines were found (18-23).

In a first step, health profession schools could incorporate reporting guidelines into curricula that address research methodology and publication standards (18–22). In line with this, students could develop protocols for coursework and research using reporting guidelines such as SPIRIT (randomised trials) and PRISMA-P (systematic reviews), and

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educators may encourage adherence to those guidelines and grade the protocols using them (21). For their part, funders may consider supporting author training on reporting guidelines (23). Finally, journals or publishers may consider investing resources in training editors and reviewers on the content and use of reporting guidelines (22,23).

Enhancing accessibility and understanding

We identified three non-evaluated interventions focused on increasing the awareness of the existence of reporting guidelines, as well as the authors' understanding of content of these (24-26).

First, international scientific associations may play an important role in disseminating and popularizing reporting guidelines to large audiences (24). Second, reporting guideline developers might consider translating them to new languages that have not been addressed yet (25). Finally, further databases of examples of good reporting for different reporting guidelines that are accessible to authors can be developed, as has been done for CONSORT (26).

Encouraging adherence

Fourteen interventions found were associated with different strategies to facilitate compliance with reporting guidelines (11,12,21,27–115). Six of these were evaluated (47)(12,27–46,48–107,113).

Funders might require authors to use reporting guidelines as a template for grant application proposals (21). Later on, research ethics boards may require that protocols submitted for ethical approval clearly state which reporting guidelines the study will be using based on the study design, and that reporting guideline checklists are part of the application for ethics approval (11). Funders could also encourage adherence to reporting guidelines by asking for reporting guideline checklists as part of the authors' report (21,108).

One initiative to support authors adhering to reporting guidelines at the writing stage of the manuscript has been COBWEB, a writing aid tool that aims to help authors adequately combine the different extensions of the CONSORT statement (12). This tool divided the CONSORT items into bullet points showing the key elements that need to be

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reported together with examples of adequate reporting. The impact of COBWEB was evaluated in a randomised trial that showed a large effect of this intervention (12) (see Supplementary file 2 for more details about this and other evaluated interventions). A second option to support authors at manuscript writing is that they follow a more structured approach. For example, ClinicalTrials.gov requires authors to report key information in a tabular format when registering a study or making available its results (116). This has been shown to be effective: some results posted on this platform, especially harms, are more complete than those in corresponding journal articles reporting the same trials (47). Another possibility to improve the structure of manuscripts is to include new subheadings corresponding to different reporting guideline items within the traditional IMRaD format (Introduction, Methods, Results, and Discussion), as the American Journal of Orthodontics and Dentofacial Orthopedics (AJO-DO) proposed (112). Finally, authors may also avoid omissions when writing the manuscript if mark up the text and highlight where each item of the relevant checklist is addressed (109).

At manuscript submission stage, different editorial actions have been taken to improve adherence to reporting guidelines. The most popular is what has traditionally been defined as journal endorsement of reporting guidelines, which is usually defined as one or more of the three following interventions: (a) journal editorial statement endorsing certain reporting guidelines; (b) requirement or recommendation in journal's 'Instructions to Authors' to follow certain reporting guidelines when preparing their manuscript; or (c) requirement for authors to submit the appropriate reporting guideline checklist together with their manuscript indicating page numbers corresponding to each item (6). Dozens of observational studies have explored the possible effect of journal endorsement of different reporting guidelines in different clinical areas (27–46,48–106,113). A recent systematic review focused on CONSORT evaluations showed relative but suboptimal improvements in the completeness of reporting in journals by following the aforementioned policies (6), while another systematic review considering 9 other guidelines showed no improvements (3).

Journals might also consider other strategies to enhance adherence to reporting guidelines at submission. A first option could be to develop shorter, core versions of

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reporting guidelines containing key items, which could be provided to authors as part of the submission process (110). Second, they might introduce publication officers in order to provide guidance to authors on preparing manuscripts for submission (111). Third, editors may ask authors to populate the relevant checklist with text from their manuscript and not accept a submission unless this is provided (114).

Finally, editors may suggest that peer reviewers use reporting guidelines (107). In addition, by asking peer reviewers questions about whether the author has followed reporting guidelines, this might be an indirect way to encourage them (115).

Checking adherence and providing feedback

Eight interventions were related to monitoring level of compliance with reporting guidelines of the manuscripts and providing instructions to authors on how to improve the reporting of missing or incorrect items (13,117–123). Four of them were evaluated (13,117–119).

Some journals have opted for implementing reporting guidelines at peer review. First, an associate editor may assess manuscripts for adherence to the relevant reporting guideline and ask authors to make changes accordingly (117). This process may be repeated until the associate editor thinks that the manuscript can move to the next step of the review process, leading to an editorial decision. This intervention was evaluated at the AJO-DO and showed satisfactory results: 33 of 37 items reached perfect compliance (117). Second, peer reviewers could also assess the manuscripts against the appropriate checklist (118). While the observed effect of this intervention was slightly positive, it was smaller than hypothesized. In fact, investigators pointed out that authors tended to comply better with suggestions coming from standard reviews rather than from reviews against reporting guidelines, implying that it might be difficult to adhere to high methodological standards at late stages of research if these standards are not considered earlier in the research process. Third, journals could also ask trained editorial assistants to check manuscripts against reporting guidelines (120) or to implement automatic peer review tools such as Statreviewer (124), software that automatically checks adherence to reporting guidelines and evaluates the appropriate use and reporting of statistical tests (121). Currently, its performance is being assessed through

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a pilot trial in collaboration with four BioMed Central Journals (121). In any of those cases, emails could be sent to authors asking them to revise the manuscript according to guidelines (13). To do this, the EQUATOR Network has provided standard letters that can be used a) after checks by an editor or a single peer reviewer, b) after full peer review, or c) alongside acceptance (125). Furthermore, at the time of author revision of the manuscript, Hopewell et al. found no significant effect when incorporating WebCONSORT, a web-based tool that generates a unique list of items customised to the trial design, to the revision process of journals that endorsed CONSORT but had no active policy for implementing it (119). Finally, in a late stage of the publication process, copyediting of the manuscript could also ensure that all items are covered (122).

Once the paper is published, the scientific community could use online platforms of post-publication peer review such as PubPeer (126) or ScienceOpen (127) to evaluate the adherence to reporting guidelines of published articles and to provide feedback to authors (123).

Involvement of experts

Two interventions identified implied interaction and cooperation between authors and experts on methodology and reporting at different stages of research (78,108,128–130). One of them was evaluated (78,128–130).

On the one hand, statisticians (or epidemiologists or other quantitative methodologists) may get involved in the design, conduct or reporting of the study might contribute to properly reporting key areas such as sample size calculation, randomization, blinding, and appropriate statistical analysis (129). While three studies found a statistically significant positive relationship between CONSORT scores and statistician involvement (78,129,130), another one did not (128). On the other hand, it has been hypothesized that the involvement of medical writers during the manuscript writing stage of research could improve the completeness of reporting (108).

Interventions described in papers co-authored by authors of this scoping review

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25 (of 109) included references describing 21 (of 31) included interventions were co-authored by at least one of the authors of this scoping review (12,13,63,67,74,76,80,104,107,111,114,115,20,117–120,123,21–23,26,47,54,55).

Discussion

In this scoping review, we identified 31 interventions to improve adherence to reporting guidelines. We have also determined the gaps in research on the evaluation of this type of interventions. By considering a wide range of reporting guidelines as well as their extensions and merging the evidence found in the published and grey literature, this review provides a broad picture of how the problem of enhancing adherence to reporting guidelines has been tackled so far and could be faced in the future.

This study reveals that it is primarily journals that have made most of the efforts to improve adherence to reporting guidelines in health research – although they can certainly do more. Typically, their strategies range from making available editorial statements that endorse certain reporting guidelines, recommending or requiring authors to follow reporting guidelines in the "Instructions to authors", and requiring authors to submit a reporting guideline checklist together with the manuscript, with page numbers indicated for each item. However, these strategies have been shown not to have the desired effect (3,6,131). Recent research has called for more active and enforced journal policies throughout the editorial process, such as requiring the use of structured approaches with new subheadings adapted to different kinds of study designs (112), which was also found to be beneficial in a new study outside of our search period (132); providing guidance on manuscript preparation (111); making sure the peer review process involves editorial assistants who have specific training on reporting issues (120); and implementing automatic peer review tools (121). Journals will vary in their ability to make some of these strategies effective, depending on factors such as their resources, their guidelines to peer reviewers and the dedication of their editors – many editors and editorial staff work part-time and have limited amount of time.

Moreover, editors' education and performance should be improved. A recent study pointed out that more than a third (39%) of the manuscripts classified as randomised

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trials by the editorial staff were not actually randomised trials (119,133). Consequently, it seems difficult to improve author and peer reviewer adherence to reporting guidelines if journal gatekeepers are not properly trained in methodological and reporting issues.

Apart from journals, editors and peer reviewers, other key stakeholders such as medical schools, research funders, universities and other research institutions should also take responsibility regarding this issue. This scoping review provides some strategies to follow. However, as the problem is complex and the possible interventions are varied, enhancing the completeness of reporting most likely depends not so much on any isolated action but on a set of strategies by several different stakeholders. These could be enacted at different stages of research, from education to article post-publication.

For interventions aiming to improve adherence to reporting guidelines, we should require the same level of evidence that we require for interventions to improve health. For this reason, it is striking that we found only 4 published randomised trials that evaluated interventions to improve adherence to reporting guidelines (12,107,118,119). Among these trials, statistically significant effect of the intervention was only observed for the use of the writing aid tool for authors COBWEB (12). While performing an additional review against reporting guidelines showed slightly positive but not significant effect (118), suggesting the use of reporting guidelines to peer reviewers (107) or implementing at the process of author revision of the manuscript the web-based tool WebCONSORT showed no benefit (119). The rest of the evaluations of interventions found (86 of 90) were observational studies, whose results are subject to the influence of confounding factors (6). For example, evaluations of the effect of journal endorsement may be influenced by whether different journals are actively checking that authors adhere to the requirements or recommendations they provide to authors at submission (6). For all these reasons, future randomised trials should be performed to evaluate further interventions to improve adherence to reporting guidelines. Moreover, these trials might consider addressing some of the research gaps identified in this review, such as improving adherence to reporting guidelines at the grant application or protocol writing stages.

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A few of the interventions found in this review were shown to enhance adherence to reporting guidelines. However, it is noteworthy there is no evidence that some successful interventions (12,117) have been implemented more widely later. For this reason, more resources and efforts are needed to further implement these interventions in other settings, evaluate the effect, and share the results with the scientific community. In any case, it is important to keep in mind that contemporary publication culture may harm the potential improvements in reporting quality. This could result from the fact that most scientists feel that the primary evaluation tool of their research is the quantity of their scientific output rather than its quality (134); and such attitudes may undermine the potential effect of any intervention to improve adherence to reporting guidelines.

Our scoping review has some limitations. First, we did not formally assess the methodological quality of the studies that evaluated interventions. Second, restricting to certain databases or not having standard search terms for the databases searched may have excluded relevant publications. Third, it is possible that we could have missed evidence of possible interventions that may have never been reflected in the published or grey literature but are instead used in practice and continue to be used. For example, journals might be applying specific editorial strategies that are not publicly available on their websites or in the published literature.

This review is part of a larger project whose next goals are (i) to capture editors' perceptions on the barriers and facilitators of some promising interventions identified in this review, (ii) to explore new possible interventions, and (iii) to evaluate one of these interventions in collaboration with BMJ Open.

Conclusion

Improving adherence to reporting guidelines is one of the key issues in order to enhance complete and accurate reporting and therefore reduce waste in research.

Different stakeholders – such as research funders, ethics boards, and journals – should consider implementing and evaluating some of the interventions identified in this study.

For peer review only

List of abbreviations

AJO-DO: American Journal of Orthodontics and Dentofacial Orthopedics; CONSORT: CONsolidated Standards Of Reporting Trials; COBWEB: CONSORT-based web tool; EQUATOR: Enhancing the QUAlity and Transparency Of Health Research; RCT: Randomised Controlled Trial; RG: Reporting Guideline; SPIRIT: Standard Protocol Items: Recommendations for Interventional Trials; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

Declarations

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Competing interests: DA and DM are Directors of the UK and Canadian EQUATOR Centres, respectively. IB is deputy director of French EQUATOR Centre.

Author contributions: All authors contributed to conceptualizing and designing the study. DB, EC, and JJK independently performed screening. DB and JJK independently performed data extraction. DB performed initial data synthesis and EC, IB, DM, DGA, and JJK refined it. DB drafted the manuscript. EC, IB, DM, DGA, and JJK made major revisions. Due to the strong involvement of JJK and EC at several different stages of the study, all authors agreed to consider them joint senior authors of the scoping review, although EC was the only senior author of the protocol. All authors read and approved the final manuscript, which was completed in April 2018. DGA passed away in June 2018 and therefore could not approve the revised manuscript (November 2018).

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Figures, tables and supplementary files

Figure 1: PRISMA flow diagram.

Figure 2: Typology of interventions to improve adherence to RGs according to type of intervention and research stage. **Legend:** Evaluated interventions are shown in bold.

Figure 3: Gaps in research on the evaluation of interventions to improve adherence to reporting guidelines. **Legend:** Each circle represents one intervention. Variables displayed: 1) Circle size: Number of studies evaluating each intervention (bigger = more studies); 2) Circle colour: Study design of those studies (blue for RCTs and green for observational studies) and 3) Circle fill: Kind

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of RG implementation (plain for checklist and stripes for bullet points and examples). Research gaps are highlighted in red.

Table 1: Rationale of the interventions identified.

Supplementary file 1: Description of the acronyms and full names of all reporting guidelines considered.

Supplementary file 2: implementation details of the evaluated interventions.

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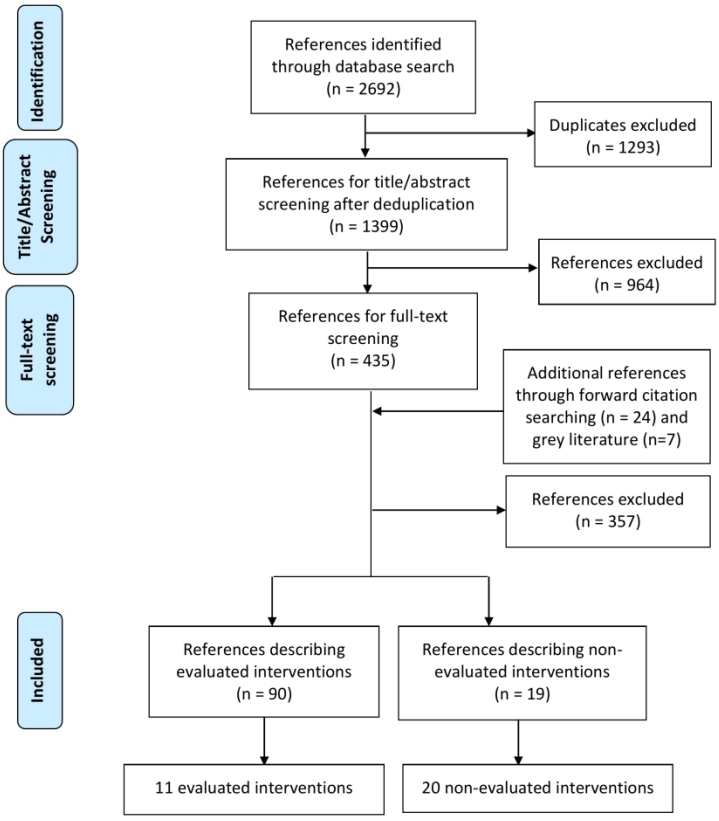

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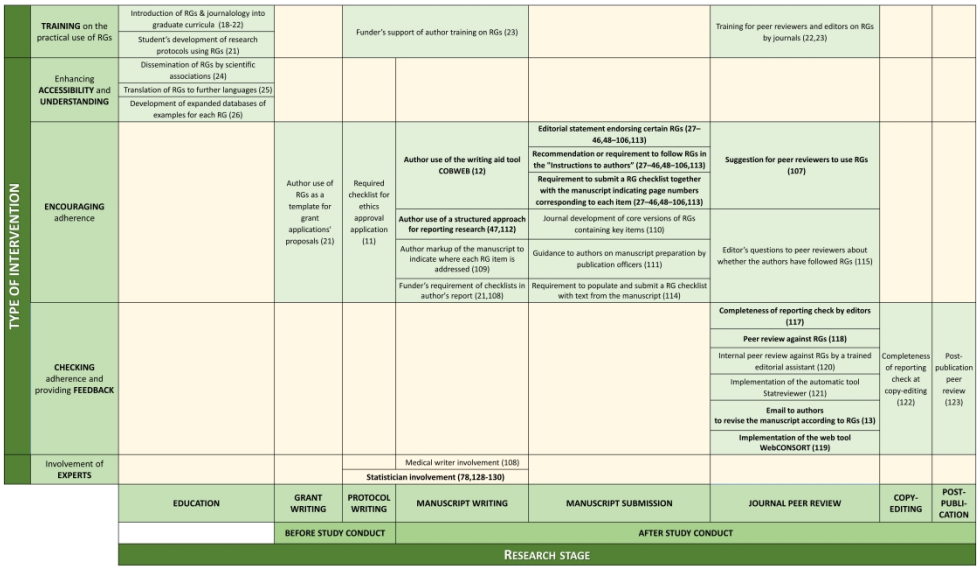

Typology of interventions to improve adherence to RGs according to type of intervention and research stage.
Legend: Evaluated interventions are shown in bold.

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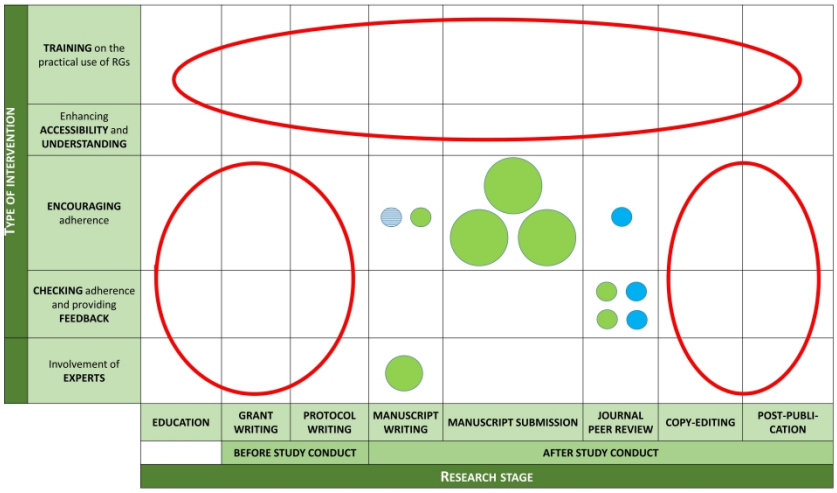

Gaps in research on the evaluation of interventions to improve adherence to reporting guidelines. Legend: Each circle represents one intervention. Variables displayed: 1) Circle size: Number of studies evaluating each intervention (bigger = more studies); 2) Circle colour: Study design of those studies (blue for RCTs and green for observational studies) and 3) Circle fill: Kind of RG implementation (plain for checklist and stripes for bullet points and examples). Research gaps are highlighted in red.

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Acronym	Full name
CONSORT	Consolidated Standards of Reporting Trials
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SRQR	Standards for Reporting Qualitative Research
COREQ	Consolidated criteria for Reporting Qualitative research
STARD	Standard Protocol Items: Recommendations for Interventional Trials
TRIPOD	Transparent Reporting of a multivariable prediction model for Individual Prognosis or Diagnosis
SQUIRE	Standards for Quality Improvement Reporting Excellence
CHEERS	Consolidated Health Economic Evaluation Reporting Standards
SPIRIT	Standard Protocol Items: Recommendations for Interventional Trials
PRISMA-P	Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols
CARE	Case Report
AGREE	Appraisal of Guidelines, Research and Evaluation
ARRIVE	Animal Research: Reporting In Vivo Experiments
RIGHT	Reporting Tool for Practice Guidelines in Health Care
QUOROM	Quality of Reporting of Meta-analyses

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Type of intervention	Intervention	Number of studies and study design	Details of the intervention	RGs implemented	Format of RG implementation	Measure of adherence to RGs	Effect on adherence to RGs*
Encouraging adherence	Implementation of the writing aid tool COBWEB (12)	1 RCT	Participants have to write the six domains of the methods section of the manuscript for the protocol they receive. They have access to COBWEB tool for a random three of the six domains.	CONSORT & CONSORT extension for non-pharmacological interventions	Bullet points and examples (6 items)	Mean score for completeness of reporting (scale 0–10, items weighted)	Difference of 2.1 (95% CI 1.5-2.7)
	Author use of a structured approach for reporting research (47)	1 Observational study (cross-sectional evaluation)	Results are posted in a standard tabular format without discussions or conclusions.	CONSORT	Checklist (4 items)	Percentage compliance of each RG item	Difference of 0.16, 0.10, 0.18 and 0.36 for each of the 4 items considered
	Journal endorsement (3 interventions, see "Details of the intervention") (27–46,48–106,113)	80 observational studies (57 cross sectional evaluations of endorsing vs non-endorsing journals, 9 before and after evaluations of endorsing journals before and after endorsement, 14 both kind of evaluations)	A) Editorial statement endorsing certain RGs, B) Recommendation or requirement to follow RGs in the "Instructions to authors", and C) Requirement to submit a RG checklist together with the manuscript indicating page numbers corresponding to each item.	CONSORT (46 of 80) CONSORT extensions (9 of 80) QUOROM (3 of 80) PRISMA (4 of 80) PRISMA extensions (1 of 80) STARD (11 of 80) STROBE (4 of 80) ARRIVE (1 of 80) CONSORT, STROBE and PRISMA (11 of 80)	Checklist (all items)	For CONSORT: percentage of compliance for each item** For other RGs: Mean summed score for completeness of reporting	For CONSORT: 25 items improved (see details for each item on figure 2 on Turner et al. (6)) For CONSORT extension for harms: Difference of 0.04 (99% CI –1.50 to 1.58)

							For PRISMA: Difference of 0.53 (99% CI 0.02 to 1.03) For STARD: Difference of 0.52 (99% CI –0.11 to 1.16) For STRICTA: Difference of 1.42 (99% CI –0.04 to 2.88) For STROBE: Difference of 1.55 (99% CI –3.19 to 6.29)
	Suggestion for peer reviewers to use RGs (107)	1 RCT	Peer reviewers are sent a standard letter encouraging them to use different reporting guidelines. Reviewers are not asked to report whether they used the reporting guideline in reviewing the manuscript.	CONSORT, QUOROM, STARD	Checklist (all items)	Modified version of Manuscript Quality Assessment Instrument (scale 36-180)	Difference of 0.9 (95% CI -0.3 to +2.1)
Checking adherence and providing feedback	Completeness of reporting check by the editors (117)	1 Observational Study (Before and after evaluation)	Initial submissions are vetted by the editor-in-chief. If the submission is considered appropriate, manuscripts are assessed by the associate editor for CONSORT	CONSORT	Checklist (all items)	Percentage of compliance of each RG item	Before – compliance ranges from 0% to 100% (Median 40%)

			adherence. Authors are asked to make changes accordingly until associate editor deems appropriate that they move to the next step of the review process leading to an editorial decision.				After – perfect compliance in 33 out of 37 items
	Additional review against RGs (118)	1 RCT	A senior statistician does an additional review of all papers and provides authors suggestions on how to follow reporting guideline checklists.	STROBE, CONSORT, STARD	Checklist (all items)	Modified version of Manuscript Quality Assessment Instrument (scale 1 to 9)	Difference of 0.25 (95% CI -0.05 to +0.54)
	Active implementation of RG by editors (2 interventions, see "Details of the intervention") (13)	1 Observational study (Interrupted time series evaluation)	A) Email is sent to authors to revise the abstract according to the guidelines at the revision stage and B) Changes are made by the assistant editors of these journals towards the end of the editorial process.	CONSORT extension for abstracts	Checklist (9 of 17 items)	Monthly mean number of items reported (scale 0 to 9)	Difference of 1.5 items
	Implementation of the web-based tool WebCONSORT (119)	1 RCT	Journal editor includes a link to WebCONSORT in the revision letter to authors. Authors are directed to an automatically generated list of items and a flow diagram customised to their specific trial design.	CONSORT & some CONSORT extensions	Checklist (10 of 25 items)	Percentage of items reported for each article	Difference of 0.04 (95% CI −0.02 to +0.10)

Involvement of experts	Statistician involvement (78,128-130)	4 Observational studies (cross sectional evaluations)	Statisticians (or epidemiologists or other quantitative methodologists) are involved in the design, conduct or reporting of the study	CONSORT	Checklist (all items)	Mean score for completeness of reporting (scale 0-10, items not weighted)	In Diaz-Ordaz (78): No global effect provided (see effects for individual items in Table 2 of the paper) In Pandis et al. (128): Difference of 0.93 In Péron et al. (129): No difference in medians In Kloukos et al. (130): 0.27

*Difference between adherence to RGs in intervention and non-intervention group. We did not report the CI of the effect size when authors did not report it in the original papers.

**As the 80 individual studies that belong to this category used different measures of adherence to reporting guidelines, we report here the measures used in the two systematic reviews that summarized the pooled results of most of these studies (3,6).

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PRISMA-ScR Checklist*

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable) background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	1,2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	3,4 ("Background")
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	5 ("Objectives")
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	5 ("Methods")
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	5,6 ("Eligibility Criteria", "Exclusion Criteria")
Information sources	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	6 ("Search Strategy and Study Selection")
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	6 ("Search Strategy and Study Selection")
Study selection	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	6,7 ("Search Strategy and Study

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PRISMA-ScR Checklist*

			Selection")
Data collection process	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	8 ("Data Extraction")
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	8 ("Data Extraction")
Risk of bias in individual studies	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	N/A
Summary measures	13	Not applicable for scoping reviews.	N/A
Synthesis of results	14	Describe the methods of handling and summarizing the data that were charted.	9 ("Data Synthesis)

Section/topic	#	Checklist item 10	Reported on page #
Risk of bias across studies	15	Not applicable for scoping reviews.	N/A
Additional analyses	16	Not applicable for scoping reviews.	N/A
RESULTS			
Study selection	17	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Figure 1
Study characteristics	18	For each source of evidence, present characteristics for which data were charted and provide the citations.	10 ("Results)
Risk of bias within studies	19	If done, present data on critical appraisal of included sources of evidence (see item 12).	N/A
Results of individual studies	20	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	10 ("Results")
Synthesis of results	21	Summarize and/or present the charting results as they relate to the review questions and objectives.	10-15 ("Results")

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PRISMA-ScR Checklist*

Risk of bias across studies	22	Not applicable for scoping reviews.	
Additional analysis	23	Not applicable for scoping reviews.	
DISCUSSION			
Summary of evidence	24	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	15 ("Discussion)
Limitations	25	Discuss the limitations of the scoping review process.	17 ("Discussion")
Conclusions	26	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	15-17 ("Discussion)
FUNDING			
Funding	27	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	18 ("Declarations – Funding")

*Original source: http://annals.org/aim/fullarticle/2700389/prisma-extension-scoping-reviews-prisma-scr-checklist-explanation

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A scoping review on interventions to improve adherence to reporting guidelines in health research

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Keywords

Scoping review, knowledge synthesis, reporting guidelines, completeness of reporting, quality of reporting, adherence

Abstract

Objectives: The goal of this study is to identify, analyse and classify interventions to improve adherence to reporting guidelines in order to obtain a wide picture of how the

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problem of enhancing the completeness of reporting of biomedical literature has been tackled so far.

Design: Scoping review.

Search strategy: We searched the MEDLINE, EMBASE, and Cochrane Library databases and conducted a grey literature search for (i) studies evaluating interventions to improve adherence to reporting guidelines in health research and (ii) other types of references describing interventions that have been performed or suggested but never evaluated. The characteristics and effect of the evaluated interventions were analysed. Moreover, we explored the rationale of the interventions identified and determined the existing gaps in research on the evaluation of interventions to improve adherence to reporting guidelines.

Results: 109 references containing 31 interventions (11 evaluated) were included. These were grouped into five categories: (1) training on the use of reporting guidelines, (2) improving understanding, (3) encouraging adherence, (4) checking adherence and providing feedback, and (5) involvement of experts. Additionally, we identified lack of evaluated interventions (i) on training on the use of reporting guidelines and improving their understanding, (ii) at early stages of research, and (iii) after the final acceptance of the manuscript.

Conclusions: This scoping review identified a wide range of strategies to improve adherence to reporting guidelines that can be taken by different stakeholders. Additional research is needed to assess the effectiveness of many of these interventions.

Strengths and limitations

- We considered wide range of reporting guidelines as well as their extensions.
- Merging the evidence found in the published and grey literature allowed us to provide a broad picture of how the problem of enhancing adherence to reporting guidelines has been tackled so far and could be faced in the future.
- The screening and data extraction were performed in duplicate.

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- We could have missed evidence of possible interventions that may not be present in the published or grey literature but are instead used in practice and continue to be used.

Background

Approximately 85% of all biomedical research today is estimated to be wasted, due, in part, to incomplete or inaccurate reporting (1). The past two decades have given rise to a number of changes in an effort to help authors and the broader scientific community properly report research methods and findings, which would allow them to contribute to the broader goal of combating waste in biomedical research. The most prominent of these changes has been the inception of reporting guidelines for different study types, data, and clinical areas (2).

The vast majority of reporting guidelines have not yet been assessed as to whether they help improve the reporting of research (3), but some, such as the Consolidated Standards of Reporting Trials (CONSORT) for the reporting of randomised controlled trials (RCTs) (4), have been shown to enhance the completeness of reporting (5,6).

Dozens of systematic reviews have explored the extent of adherence to some reporting guidelines in certain areas of health research (7–10). Saaman et al. (11) went one step further and performed a systematic review of systematic reviews assessing adherence to reporting guidelines. As they considered a broad range of clinical areas and study designs, their results provided a global picture of adherence to reporting guidelines in health research. Although some studies reported acceptable overall levels of completeness of reporting and found that it had improved since the introduction of certain reporting guidelines such as CONSORT, the authors of most of the reviews (43 of 50, 86%) concluded that more improvement is needed or that adherence to reporting guidelines was inadequate, poor, medium or suboptimal. Therefore, it is warranted to explore and develop strategies to improve the current levels of adherence to reporting guidelines.

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In recent years, several initiatives aiming to improve adherence to reporting guidelines have been proposed, some of which have already been evaluated. For example, the effect of journal endorsement of reporting guidelines (3,5,6) and the implementation of writing aid tools for authors such as the CONSORT-based web tool (COBWEB) (12) have been assessed. While some of these strategies have not been shown to have a benefit (3), others report better but still suboptimal levels of reporting (5,6) or even clear benefits (12,13).

As mentioned, several reviews have analysed the quality of reporting in different clinical areas and for different study types (7–10). However, no scoping review has been performed that provides a global picture of different strategies aiming to improve adherence to reporting guidelines. Given the low levels of completeness of reporting in health research that have been observed (11), along with the imperative need to take further actions for mitigating this problem, we considered that performing such a scoping review was warranted.

In addition to analysing the implementation and effect of interventions that have already been evaluated, we aimed to gather other possible strategies that could be implemented and evaluated in the future.

For clarification, some relevant terms used throughout the scoping are defined in Box 1, which is based on Stevens et al. (3).

Box 1: relevant definitions in the context of this scoping review

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Adherence: Action(s) taken by authors to ensure that a research report is compliant with the items recommended by the appropriate/relevant reporting guideline. These can take place before or after the first version of the manuscript is published.

Endorsement: Action(s) taken by journals to indicate their support for the use of one or more reporting guideline(s) by authors submitting research reports for consideration.

Implementation: Action(s) taken by journals to ensure that authors adhere to an endorsed reporting guideline and that therefore published papers are completely reported.

Complete reporting: Pertains to the state of reporting of a study report and whether it is compliant with all the items recommended by the appropriate/relevant reporting guideline.

Methods

As presented in the published protocol (14), this scoping review follows the methodology manual published by the Joanna Briggs Institute for scoping reviews (15).

Objectives

The scoping review questions are:

1. What interventions to improve adherence to reporting guidelines in health research have been evaluated?
2. What further interventions to improve adherence to reporting guidelines have been performed or suggested but never evaluated?

We aimed to analyse and classify the interventions found for both questions in order to obtain a wide picture of how the problem of adhering better to reporting guidelines has been tackled so far and can be tackled in the future.

Eligibility criteria

We included:

1. Studies evaluating interventions aiming to improve adherence to reporting guidelines in health research, irrespective of study design.

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2. Commentaries, editorials, letters, studies, and online sources describing possible interventions to improve adherence to reporting guidelines that have been performed or suggested but never evaluated.

The reporting guidelines considered were those shown on 8 May 2017 on the EQUATOR (Enhancing the QUAlity and Transparency Of Health Research) Network website (16) as "Reporting Guidelines for main study types". In addition, we included QUOROM (Quality of Reporting of Meta-analyses), since it was the precursor of PRISMA. Supplementary file 1 shows all reporting guidelines considered.

We considered the following languages: English, Spanish, French, German and Catalan.

Exclusion criteria

We have excluded references that include interventions that do not specifically aim to improve the completeness of reporting, even though these interventions may actually influence completeness. For example, we have excluded clinical trial registration even though it may enhance completeness of reporting, because its main goals are to improve clinical trial transparency while also reducing publication and selective reporting biases.

Search strategy and study selection

On 8 May 2017, we searched PubMed, EMBASE, and Cochrane Library databases for articles published between 1 January 1996 and 31 March 2017, in accordance with our scheduled search (14). The detailed search terms for PubMed can be found in the protocol.

The retrieved studies were exported into Mendeley and duplicates were automatically removed using it. One reviewer (DB) first screened the titles and abstracts for eligibility. Each of the other two reviewers (JJK and EC) was randomly assigned 50% of the references and screened the titles and abstracts independently of the first reviewer. The reviewers classified the references into one of the following groups:

A) Evaluated: Includes references describing interventions to improve adherence to reporting guidelines that have been empirically assessed.

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B) Non-evaluated: Includes references describing interventions to improve adherence to reporting guidelines that have been performed or suggested but never evaluated.

C) Unclear: Includes references (i) containing vague statements such as “Authors, editors, and journals have to adhere better to reporting guidelines to improve the quality of reporting” or “greater efforts have to be made by authors to check that their research is compliant with [the relevant reporting guideline]”, or (ii) not having the abstract available.

D) Excluded: Includes references (i) not describing interventions to improve adherence to any of the reporting guidelines considered and (ii) describing but not evaluating certain interventions that have already been classified as evaluated.

Disagreements were solved by discussion among the reviewers.

Second, one reviewer (DB) examined the full-text of all group A and B references to confirm the previous classification, then all group C references to reclassify them either as group A, B, or D. Re-classification was verified by the initial reviewer (JJK or EC). Finally, one reviewer (DB) ensured literature saturation by searching the reference lists of included studies, the lists of articles citing them according to PubMed, and the individual studies included in two relevant systematic reviews (3,6).

In addition, we performed a grey literature search, which included: the websites of networks and organizations promoting the use of reporting guidelines (i.e., EQUATOR Network and National Library of Medicine Research Reporting Guidelines and Initiatives); work groups of medical journal editors (i.e., International Committee of Medical Journal Editors (ICMJE) and World Association of Medical Editors (WAME)); biomedical journal publishers (i.e., BMJ Publishing Group and BioMed Central); funding agencies (i.e., National Institute of Health (NIH) and European Research Council); online platforms of post-publication peer review (i.e., PubPeer and ScienceOpen); and the abstract books of the past editions of the International Congress on Peer Review and Biomedical Publication.

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Some of the included references were described in studies co-authored by some of the authors this scoping review. These references underwent the same process of screening, data extraction, and data synthesis as the others.

Data extraction

A data extraction form was developed to collect the information necessary for data synthesis. Two reviewers (DB, JJK) independently performed a pilot data extraction on a random sample of 5 articles and subsequently refined the form.

Extracted data included:

1. Publication characteristics: title, year of publication, author, author's affiliation country, and field of study.
2. Characteristics of the intervention:
    a. Classification as evaluated or non-evaluated.
    b. Research stage: education, grant writing, protocol writing, manuscript writing, submission, journal peer review, copy-editing, and post-publication.
    c. Rationale of the intervention, which refers to the deduced reasons why the intervention is evaluated or proposed.
    d. For evaluated interventions: details of the intervention, study design (e.g. RCT, before-after, etc.), reporting guidelines considered and format (checklist, bullet points and/or examples), period of intervention, number of journals and articles involved, effect size of the intervention on adherence to reporting guidelines and measure used to assess this effect.
3. Relevant conclusions.

Two reviewers (DB, JJK) independently performed data extraction for all studies except for the individual studies of the two systematic reviews evaluating journal endorsement of reporting guidelines (3,6), since none of these studies described further interventions and their results had already been reported in these reviews. Discrepancies between reviewers were discussed and solved by consensus.

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Data synthesis

Following data extraction, interventions to improve adherence to reporting guidelines were categorised as follows:

1. Training on the practical use of reporting guidelines: mentoring of different stakeholders on the practical use of reporting guidelines.
2. Enhancing accessibility and understanding: dissemination of reporting guidelines and the improvement of authors' understanding of their content.
3. Encouraging adherence: suggestions and tools to facilitate compliance.
4. Checking adherence and providing feedback: checking the level of compliance and indicating incorrect or missing items.
5. Involvement of experts: interaction and cooperation on methodology and reporting.

One reviewer (DB) performed the initial categorization, which was verified and refined by the other two reviewers (JJK and EC).

Furthermore, we determined the existing gaps in research on the evaluation of interventions to improve adherence to reporting guidelines. More specifically, we identified which categories of interventions and which research stages have not been addressed so far in studies evaluating interventions.

We did not perform a meta-analysis of the observational studies assessing journal endorsement of reporting guidelines that were not included in the two systematic reviews previously mentioned (3,6). We considered that, for the purpose of this scoping review, these systematic reviews provided a reliable picture of the impact of this editorial intervention.

Deviations from the protocol

In order to better capture the most relevant aspects of the included studies, the original data extraction form proposed in the protocol was modified. We removed the health care area of the studies included, refined the research stages considered, and included more details on the implementation of the evaluated interventions.

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Patients and public involvement

No patients or public were involved in the study.

Results

The database search yielded 1399 citations after deduplication (see Figure 1). Screening of titles and abstracts resulted in a first classification, after which 435 papers were included for full text review. We also reviewed the full text of 24 additional references found through forward citation searching. Furthermore, a grey literature search yielded 7 additional references. Finally, 109 references were included. Some of these interventions appeared in more than one reference and some of the references contained more than one intervention. 90 of these references (86 observational and 4 randomised studies) described 11 evaluated interventions and the other 19 (12 research studies, 2 editorials, 2 blogs, 1 commentary, 1 essay, and 1 perspective) described 20 non-evaluated interventions. Figure 2 displays these 31 interventions according to their categorization and the research stage where they can be performed. Moreover, Table 1 shows all interventions in a tabular format together with their rationale. All interventions reported in this section were found in the literature and do not necessarily correspond to the personal ideas of the scoping review authors.

Among the 11 evaluated interventions identified, we found a variety of measures used to assess their effect on adherence to reporting guidelines, including:

- Score for completeness of reporting for each paper, either assigning different or equal weights to RG items, on a 0-10 scale.
- Percentage of items reported for each paper.
- Percentage of compliance per RG item.
- Score for the Manuscript Quality Assessment Instrument (17) for each paper.

Due to the heterogeneity of these measures and for the sake of clarity, we prefer to omit the information on the exact effect sizes in the main body of the manuscript and show it in Supplementary file 2, together with the implementation details of the

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evaluated interventions. In this way, these effects can be understood in an appropriate context.

Research gaps identified (see Figure 3) included the evaluation of interventions (i) on training on the use of reporting guidelines and improving understanding of these, and (ii) at early stages of research (education, grant writing or protocol writing), and (iii) after the final acceptance of the manuscript (copyediting or post-publication peer review).

Hereafter, we describe the interventions found for each category (Table 1 and Supplementary file 2 summarise these interventions).

Training on the practical use of reporting guidelines

Four non-evaluated interventions related to educating different stakeholders on the practical use of reporting guidelines were found (18-23).

In a first step, health profession schools could incorporate reporting guidelines into curricula that address research methodology and publication standards (18–22). In line with this, students could develop protocols for coursework and research using reporting guidelines such as SPIRIT (randomised trials) and PRISMA-P (systematic reviews), and educators may encourage adherence to those guidelines and grade the protocols using them (21). For their part, funders may consider supporting author training on reporting guidelines (23). Finally, journals or publishers may consider investing resources in training editors and reviewers on the content and use of reporting guidelines (22,23).

Enhancing accessibility and understanding

We identified three non-evaluated interventions focused on increasing the awareness of the existence of reporting guidelines, as well as the authors' understanding of content of these (24-26).

First, international scientific associations may play an important role in disseminating and popularizing reporting guidelines to large audiences (24). Second, reporting guideline developers might consider translating them to new languages that have not been addressed yet (25). Finally, further databases of examples of good reporting for

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different reporting guidelines that are accessible to authors can be developed, as has been done for CONSORT (26).

Encouraging adherence

Fourteen interventions found were associated with different strategies to facilitate compliance with reporting guidelines (11,12,21,27–115). Six of these were evaluated (47)(12,27–46,48–107,113).

Funders might require authors to use reporting guidelines as a template for grant application proposals (21). Later on, research ethics boards may require that protocols submitted for ethical approval clearly state which reporting guidelines the study will be using based on the study design, and that reporting guideline checklists are part of the application for ethics approval (11). Funders could also encourage adherence to reporting guidelines by asking for reporting guideline checklists as part of the authors' report (21,108).

One initiative to support authors adhering to reporting guidelines at the writing stage of the manuscript has been COBWEB, a writing aid tool that aims to help authors adequately combine the different extensions of the CONSORT statement (12). This tool divided the CONSORT items into bullet points showing the key elements that need to be reported together with examples of adequate reporting. The impact of COBWEB was evaluated in a randomised trial that showed a large effect of this intervention (12) (see Supplementary file 2 for more details about this and other evaluated interventions). A second option to support authors at manuscript writing is that they follow a more structured approach. For example, ClinicalTrials.gov requires authors to report key information in a tabular format when registering a study or making available its results (116). This has been shown to be effective: some results posted on this platform, especially harms, are more complete than those in corresponding journal articles reporting the same trials (47). Another possibility to improve the structure of manuscripts is to include new subheadings corresponding to different reporting guideline items within the traditional IMRaD format (Introduction, Methods, Results, and Discussion), as the American Journal of Orthodontics and Dentofacial Orthopedics (AJO-DO) proposed (112). Finally, authors may also avoid omissions when writing the

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manuscript if mark up the text and highlight where each item of the relevant checklist is addressed (109).

At manuscript submission stage, different editorial actions have been taken to improve adherence to reporting guidelines. The most popular is what has traditionally been defined as journal endorsement of reporting guidelines, which is usually defined as one or more of the three following interventions: (a) journal editorial statement endorsing certain reporting guidelines; (b) requirement or recommendation in journal's 'Instructions to Authors' to follow certain reporting guidelines when preparing their manuscript; or (c) requirement for authors to submit the appropriate reporting guideline checklist together with their manuscript indicating page numbers corresponding to each item (6). Dozens of observational studies have explored the possible effect of journal endorsement of different reporting guidelines in different clinical areas (27–46,48–106,113). A recent systematic review focused on CONSORT evaluations showed relative but suboptimal improvements in the completeness of reporting in journals by following the aforementioned policies (6), while another systematic review considering 9 other guidelines showed no improvements (3).

Journals might also consider other strategies to enhance adherence to reporting guidelines at submission. A first option could be to develop shorter, core versions of reporting guidelines containing key items, which could be provided to authors as part of the submission process (110). Second, they might introduce publication officers in order to provide guidance to authors on preparing manuscripts for submission (111). Third, editors may ask authors to populate the relevant checklist with text from their manuscript and not accept a submission unless this is provided (114).

Finally, editors may suggest that peer reviewers use reporting guidelines (107). In addition, by asking peer reviewers questions about whether the author has followed reporting guidelines, this might be an indirect way to encourage them (115).

Checking adherence and providing feedback

Eight interventions were related to monitoring level of compliance with reporting guidelines of the manuscripts and providing instructions to authors on how to improve

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the reporting of missing or incorrect items (13,117–123). Four of them were evaluated (13,117–119).

Some journals have opted for implementing reporting guidelines at peer review. First, an associate editor may assess manuscripts for adherence to the relevant reporting guideline and ask authors to make changes accordingly (117). This process may be repeated until the associate editor thinks that the manuscript can move to the next step of the review process, leading to an editorial decision. This intervention was evaluated at the AJO-DO and showed satisfactory results: 33 of 37 items reached perfect compliance (117). Second, peer reviewers could also assess the manuscripts against the appropriate checklist (118). While the observed effect of this intervention was slightly positive, it was smaller than hypothesized. In fact, investigators pointed out that authors tended to comply better with suggestions coming from standard reviews rather than from reviews against reporting guidelines, implying that it might be difficult to adhere to high methodological standards at late stages of research if these standards are not considered earlier in the research process. Third, journals could also ask trained editorial assistants to check manuscripts against reporting guidelines (120) or to implement automatic peer review tools such as Statreviewer (124), software that automatically checks adherence to reporting guidelines and evaluates the appropriate use and reporting of statistical tests (121). Currently, its performance is being assessed through a pilot trial in collaboration with four BioMed Central Journals (121). In any of those cases, emails could be sent to authors asking them to revise the manuscript according to guidelines (13). To do this, the EQUATOR Network has provided standard letters that can be used a) after checks by an editor or a single peer reviewer, b) after full peer review, or c) alongside acceptance (125). Furthermore, at the time of author revision of the manuscript, Hopewell et al. found no significant effect when incorporating WebCONSORT, a web-based tool that generates a unique list of items customised to the trial design, to the revision process of journals that endorsed CONSORT but had no active policy for implementing it (119). Finally, in a late stage of the publication process, copyediting of the manuscript could also ensure that all items are covered (122).

Once the paper is published, the scientific community could use online platforms of post-publication peer review such as PubPeer (126) or ScienceOpen (127) to evaluate

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the adherence to reporting guidelines of published articles and to provide feedback to authors (123).

Involvement of experts

Two interventions identified implied interaction and cooperation between authors and experts on methodology and reporting at different stages of research (78,108,128–130). One of them was evaluated (78,128–130).

On the one hand, statisticians (or epidemiologists or other quantitative methodologists) may get involved in the design, conduct or reporting of the study might contribute to properly reporting key areas such as sample size calculation, randomization, blinding, and appropriate statistical analysis (129). While three studies found a statistically significant positive relationship between CONSORT scores and statistician involvement (78,129,130), another one did not (128). On the other hand, it has been hypothesized that the involvement of medical writers during the manuscript writing stage of research could improve the completeness of reporting (108).

Interventions described in papers co-authored by authors of this scoping review

25 (of 109) included references describing 21 (of 31) included interventions were co-authored by at least one of the authors of this scoping review (12,13,63,67,74,76,80,104,107,111,114,115,20,117–120,123,21–23,26,47,54,55).

Discussion

In this scoping review, we identified 31 interventions to improve adherence to reporting guidelines. We have also determined the gaps in research on the evaluation of this type of interventions. By considering a wide range of reporting guidelines as well as their extensions and merging the evidence found in the published and grey literature, this review provides a broad picture of how the problem of enhancing adherence to reporting guidelines has been tackled so far and could be faced in the future.

This study reveals that most published research aimed at improving adherence to reporting guidelines has been conducted in journals. Typically, journal strategies range

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from making available editorial statements that endorse certain reporting guidelines, recommending or requiring authors to follow reporting guidelines in the "Instructions to authors", and requiring authors to submit a reporting guideline checklist together with the manuscript, with page numbers indicated for each item. However, these strategies have been shown not to have the desired effect (3,6,131). Recent research has called for more active and enforced journal policies throughout the editorial process, such as requiring the use of structured approaches with new subheadings adapted to different kinds of study designs (112), which was also found to be beneficial in a new study outside of our search period (132); providing guidance on manuscript preparation (111); making sure the peer review process involves editorial assistants who have specific training on reporting issues (120); and implementing automatic peer review tools (121). Journals will vary in their ability to make some of these strategies effective, depending on factors such as their resources, their guidelines to peer reviewers and the dedication of their editors – many editors and editorial staff work part-time and have limited amount of time.

Moreover, editors' education and performance should be improved. A recent study pointed out that more than a third (39%) of the manuscripts classified as randomised trials by the editorial staff were not actually randomised trials (119,133). Consequently, it seems difficult to improve author and peer reviewer adherence to reporting guidelines if journal gatekeepers are not properly trained in methodological and reporting issues.

Apart from journals, editors and peer reviewers, other key stakeholders such as medical schools, research funders, universities and other research institutions should also take responsibility regarding this issue. This scoping review provides some strategies to follow. However, as the problem is complex and the possible interventions are varied, enhancing the completeness of reporting most likely depends not so much on any isolated action but on a set of strategies by several different stakeholders. These could be enacted at different stages of research, from education to article post-publication.

For interventions aiming to improve adherence to reporting guidelines, we should require the same level of evidence that we require for interventions to improve health. For this reason, it is striking that we found only 4 published randomised trials that

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evaluated interventions to improve adherence to reporting guidelines (12,107,118,119). Among these trials, statistically significant effect of the intervention was only observed for the use of the writing aid tool for authors COBWEB (12). While performing an additional review against reporting guidelines showed slightly positive but not significant effect (118), suggesting the use of reporting guidelines to peer reviewers (107) or implementing at the process of author revision of the manuscript the web-based tool WebCONSORT showed no benefit (119). The rest of the evaluations of interventions found (86 of 90) were observational studies, whose results are subject to the influence of confounding factors. As already mentioned, the impact of journal endorsement on completeness of reporting was suboptimal (3,6). However, completeness of reporting improved remarkably when reporting guidelines were actively implemented by editors (e.g. if editors perform a completeness of reporting check of the manuscript (117)) and when research results were posted in a tabular format without discussion or conclusions (47). Future randomised trials should consider evaluating these interventions or addressing some of the research gaps identified in this review, such as improving adherence to reporting guidelines at the grant application or protocol writing stages.

A few of the interventions found in this review were shown to enhance adherence to reporting guidelines. However, it is noteworthy there is no evidence that some successful interventions (12,117) have been implemented more widely later. For this reason, more resources and efforts are needed to further implement these interventions in other settings, evaluate the effect, and share the results with the scientific community. In any case, it is important to keep in mind that contemporary publication culture may harm the potential improvements in reporting quality. This could result from the fact that most scientists feel that the primary evaluation tool of their research is the quantity of their scientific output rather than its quality (134); and such attitudes may undermine the potential effect of any intervention to improve adherence to reporting guidelines.

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Our scoping review has some limitations. First, we did not formally assess the methodological quality of the studies that evaluated interventions. Second, restricting to certain databases or not having standard search terms for the databases searched may have excluded relevant publications. Third, it is possible that we could have missed evidence of possible interventions that may have never been reflected in the published or grey literature but are instead used in practice and continue to be used. For example, journals might be applying specific editorial strategies that are not publicly available on their websites or in the published literature.

Conclusion

Improving adherence to reporting guidelines is one of the key issues in order to enhance complete and accurate reporting and therefore reduce waste in research.

Different stakeholders – such as research funders, ethics boards, and journals – should consider implementing and evaluating some of the interventions identified in this study.

List of abbreviations

AJO-DO: American Journal of Orthodontics and Dentofacial Orthopedics; CONSORT: CONsolidated Standards Of Reporting Trials; COBWEB: CONSORT-based web tool; EQUATOR: Enhancing the QUAlity and Transparency Of Health Research; RCT: Randomised Controlled Trial; RG: Reporting Guideline; SPIRIT: Standard Protocol Items: Recommendations for Interventional Trials; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

Declarations

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Competing interests: DA and DM are Directors of the UK and Canadian EQUATOR Centres,

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respectively. IB is deputy director of French EQUATOR Centre.

Author contributions: All authors contributed to conceptualizing and designing the study. DB, EC, and JJK independently performed screening. DB and JJK independently performed data extraction. DB performed initial data synthesis and EC, IB, DM, DGA, and JJK refined it. DB drafted the manuscript. EC, IB, DM, DGA, and JJK made major revisions. Due to the strong involvement of JJK and EC at several different stages of the study, all authors agreed to consider them joint senior authors of the scoping review, although EC was the only senior author of the protocol. All authors read and approved the final manuscript, which was completed in April 2018. DGA passed away in June 2018 and therefore could not approve the revised manuscript (November 2018).

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Group	Intervention	Rationale
Training on the practical use of RGs	Introduction of RGs & journalology into graduate curricula (18-22)	To introduce good research reporting habits early in young researchers' scientific careers.
	Student's development of protocols for coursework and research using RGs (21)	
	Funder's support of author training on RGs (23)	Authors, editors, and peer reviewers have insufficient training in issues related to reporting.
	Training for peer reviewers and editors	

Figures, tables and supplementary files

Figure 1: PRISMA flow diagram.

Figure 2: Typology of interventions to improve adherence to RGs according to type of intervention and research stage. **Legend:** Evaluated interventions are shown in bold.

Figure 3: Gaps in research on the evaluation of interventions to improve adherence to reporting guidelines. **Legend:** Each circle represents one intervention. Variables displayed: 1) Circle size: Number of studies evaluating each intervention (bigger = more studies); 2) Circle colour: Study design of those studies (blue for RCTs and green for observational studies) and 3) Circle fill: Kind of RG implementation (plain for checklist and stripes for bullet points and examples). Research gaps are highlighted in red.

Supplementary file 1: Description of the acronyms and full names of all reporting guidelines considered.

Supplementary file 2: implementation details of the evaluated interventions.

Table 1: Rationale of the interventions identified.

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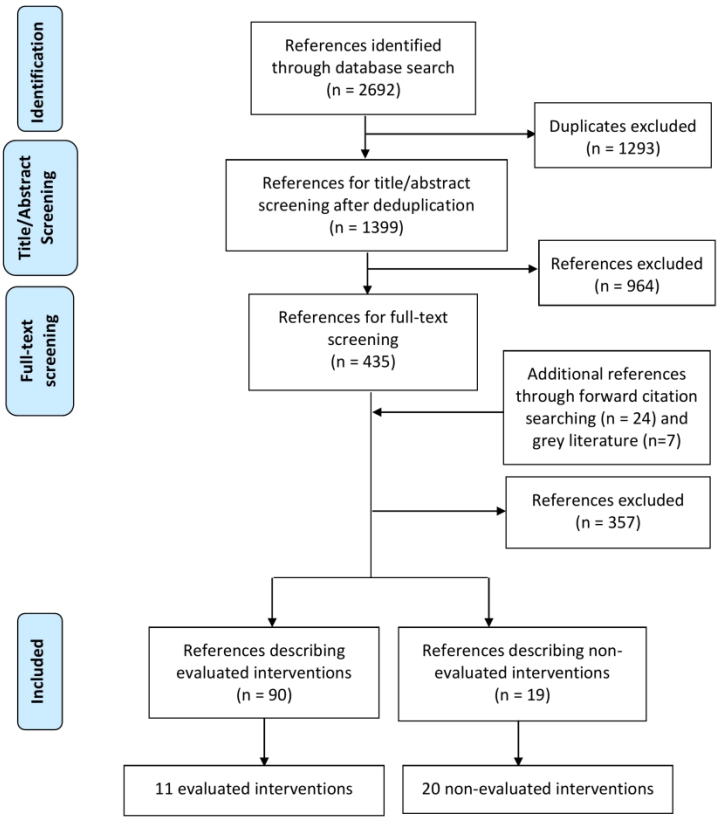
	on RGs by journals (22,23)	
Enhancing accessibility and understanding	Dissemination of RGs by scientific associations (24)	A large number of researchers are not aware of the existence of RGs.
	Translation of RGs to further languages (25)	Language barriers may affect the proper use of RGs.
	Development of expanded database of examples for each RG (26)	Authors need more examples of good reporting to properly understand certain items.
Encouraging adherence	Author use of RGs as a template for grant application proposals (21)	Using RGs in early stages may facilitate completeness of reporting of published research.
	Required checklist for ethics approval application (11)	
	Funder's requirement of checklists in author's report (21,108)	
	Author use of the writing aid tool COBWEB (12)	A) Authors need help to successfully adhere to RGs at the writing stage and B) Dividing RG items into bullet points and providing examples might help.
	Author use of a structured approach for reporting research (47,112)	A) To help authors avoid omissions, B) to aid reviewers and editors in appraising articles and C) to allow more efficient data extraction during the systematic review process.
	Author markup of the manuscript to indicate where each RG item is addressed (109)	
	Editorial statement endorsing certain RGs (27–46,48–106,113)	Authors read editorial statements and follow “Instructions to authors”.
	Recommendation or requirement to follow RGs in the "Instructions to authors“ (27–46,48–106,113)	
	Requirement to submit a RG checklist together with the manuscript indicating page numbers corresponding to each item (27–46,48–106,113)	Authors may not consider editorial statements or recommendations in “Instructions to authors” to be important. Compulsory submission of checklists or text mark-up may encourage authors to be more compliant with RGs.
	Requirement to populate and submit a RG checklist with text from the manuscript (114)	

	Journal development of core versions of RGs containing key items (110)	Focusing on the most important items could be more effective than considering the whole checklist.
	Guidance to authors on manuscript preparation by publication officers (111)	Trained journal officers may enhance authors' compliance with RGs during manuscript preparation.
	Suggestion for peer reviewers to use RGs (107)	Peer reviewers often do not detect reporting flaws. Therefore, they may need to follow a more systematic approach and use RGs.
	Editor's questions to peer reviewers about whether the authors have followed RGs (115)	
Checking adherence and providing feedback	Completeness of reporting check by editors (117)	Requiring checklists at submission does not guarantee adherence. Editors and peer reviewers have to check whether submitted papers are compliant with RGs.
	Peer review against RGs (118)	
	Internal peer review against RGs by a trained editorial assistant (120)	It is extremely unlikely that the average clinical peer reviewer has the methodological expertise to check a paper against RGs.
	Implementation of the automatic tool Statreviewer (121)	
	Email to authors to revise the manuscript according to RGs (13)	It might be more effective to ask authors for adherence to RGs during the revision process because they will do anything to get their paper published.
	Implementation of the tool WebCONSORT (119)	
	Completeness of reporting check at copy-editing (122)	Copy-editing and post-publication offer alternate time points to improve adherence to RGs.
	Post- publication peer review (123)	
Involvement of experts	Statistician involvement (78,128-130)	Professionals with specific knowledge of RGs might help authors when designing, conducting or reporting their research.
	Medical writer involvement (108)	

1127



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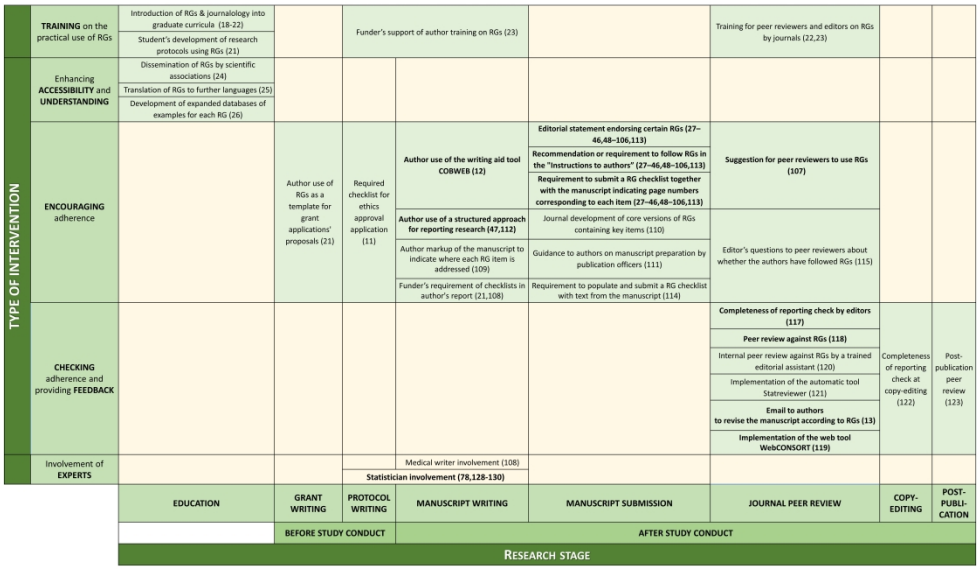

Typology of interventions to improve adherence to RGs according to type of intervention and research stage.
Legend: Evaluated interventions are shown in bold.

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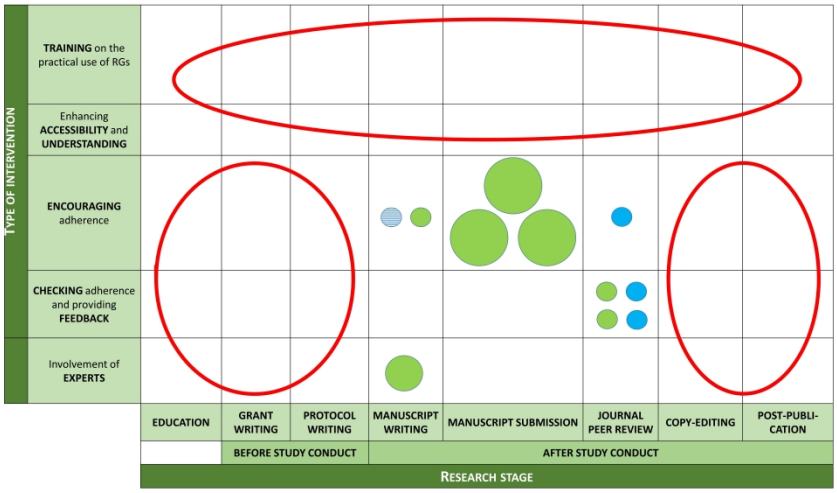

Gaps in research on the evaluation of interventions to improve adherence to reporting guidelines. Legend: Each circle represents one intervention. Variables displayed: 1) Circle size: Number of studies evaluating each intervention (bigger = more studies); 2) Circle colour: Study design of those studies (blue for RCTs and green for observational studies) and 3) Circle fill: Kind of RG implementation (plain for checklist and stripes for bullet points and examples). Research gaps are highlighted in red.

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Acronym	Full name
CONSORT	Consolidated Standards of Reporting Trials
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SRQR	Standards for Reporting Qualitative Research
COREQ	Consolidated criteria for Reporting Qualitative research
STARD	Standard Protocol Items: Recommendations for Interventional Trials
TRIPOD	Transparent Reporting of a multivariable prediction model for Individual Prognosis or Diagnosis
SQUIRE	Standards for Quality Improvement Reporting Excellence
CHEERS	Consolidated Health Economic Evaluation Reporting Standards
SPIRIT	Standard Protocol Items: Recommendations for Interventional Trials
PRISMA-P	Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols
CARE	Case Report
AGREE	Appraisal of Guidelines, Research and Evaluation
ARRIVE	Animal Research: Reporting In Vivo Experiments
RIGHT	Reporting Tool for Practice Guidelines in Health Care
QUOROM	Quality of Reporting of Meta-analyses

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Type of intervention	Intervention	Number of studies and study design	Details of the intervention	RGs implemented	Format of RG implementation	Measure of adherence to RGs	Effect on adherence to RGs*
Encouraging adherence	Implementation of the writing aid tool COBWEB (12)	1 RCT	Participants have to write the six domains of the methods section of the manuscript for the protocol they receive. They have access to COBWEB tool for a random three of the six domains.	CONSORT & CONSORT extension for non-pharmacological interventions	Bullet points and examples (6 items)	Mean score for completeness of reporting (scale 0–10, items weighted)	Difference of 2.1 (95% CI 1.5-2.7)
	Author use of a structured approach for reporting research (47)	1 Observational study (cross-sectional evaluation)	Results are posted in a standard tabular format without discussions or conclusions.	CONSORT	Checklist (4 items)	Percentage compliance of each RG item	Difference of 0.16, 0.10, 0.18 and 0.36 for each of the 4 items considered
	Journal endorsement (3 interventions, see "Details of the intervention") (27–46,48–106,113)	80 observational studies (57 cross sectional evaluations of endorsing vs non-endorsing journals, 9 before and after evaluations of endorsing journals before and after endorsement, 14 both kind of evaluations)	A) Editorial statement endorsing certain RGs, B) Recommendation or requirement to follow RGs in the "Instructions to authors", and C) Requirement to submit a RG checklist together with the manuscript indicating page numbers corresponding to each item.	CONSORT (46 of 80) CONSORT extensions (9 of 80) QUOROM (3 of 80) PRISMA (4 of 80) PRISMA extensions (1 of 80) STARD (11 of 80) STROBE (4 of 80) ARRIVE (1 of 80) CONSORT, STROBE and PRISMA (11 of 80)	Checklist (all items)	For CONSORT: percentage of compliance for each item** For other RGs: Mean summed score for completeness of reporting**	For CONSORT: 25 items improved (see details for each item on figure 2 on Turner et al. (6)) For CONSORT extension for harms: Difference of 0.04 (99% CI –1.50 to 1.58) (see Stevens et al. (3))

						For PRISMA: Difference of 0.53 (99% CI 0.02 to 1.03) (see Stevens et al. (3)) For STARD: Difference of 0.52 (99% CI –0.11 to 1.16) (see Stevens et al. (3)) For STRICTA: Difference of 1.42 (99% CI –0.04 to 2.88) (see Stevens et al. (3)) For STROBE: Difference of 1.55 (99% CI –3.19 to 6.29) (see Stevens et al. (3))
Suggestion for peer reviewers to use RGs (107)	1 RCT	Peer reviewers are sent a standard letter encouraging them to use different reporting guidelines. Reviewers are not asked to report whether they used the reporting guideline in reviewing the manuscript.	CONSORT, QUOROM, STARD	Checklist (all items)	Modified version of Manuscript Quality Assessment Instrument (scale 36-180)	Difference of 0.9 (95% CI -0.3 to +2.1)

Checking adherence and providing feedback	Completeness of reporting check by the editors (117)	1 Observational Study (Before and after evaluation)	Initial submissions are vetted by the editor-in-chief. If the submission is considered appropriate, manuscripts are assessed by the associate editor for CONSORT adherence. Authors are asked to make changes accordingly until associate editor deems appropriate that they move to the next step of the review process leading to an editorial decision.	CONSORT	Checklist (all items)	Percentage of compliance of each RG item	Before – compliance ranges from 0% to 100% (Median 40%) After – perfect compliance in 33 out of 37 items
	Additional review against RGs (118)	1 RCT	A senior statistician does an additional review of all papers and provides authors suggestions on how to follow reporting guideline checklists.	STROBE, CONSORT, STARD	Checklist (all items)	Modified version of Manuscript Quality Assessment Instrument (scale 1 to 9)	Difference of 0.25 (95% CI -0.05 to +0.54)
	Active implementation of RG by editors (2 interventions, see "Details of the intervention") (13)	1 Observational study (Interrupted time series evaluation)	A) Email is sent to authors to revise the abstract according to the guidelines at the revision stage and B) Changes are made by the assistant editors of these journals towards the end of the editorial process.	CONSORT extension for abstracts	Checklist (9 of 17 items)	Monthly mean number of items reported (scale 0 to 9)	Difference of 1.5 items

	Implementation of the web-based tool WebCONSORT (119)	1 RCT	Journal editor includes a link to WebCONSORT in the revision letter to authors. Authors are directed to an automatically generated list of items and a flow diagram customised to their specific trial design.	CONSORT & some CONSORT extensions	Checklist (10 of 25 items)	Percentage of items reported for each article	Difference of 0.04 (95% CI −0.02 to +0.10)
Involvement of experts	Statistician involvement (78,128-130)	4 Observational studies (cross sectional evaluations)	Statisticians (or epidemiologists or other quantitative methodologists) are involved in the design, conduct or reporting of the study	CONSORT	Checklist (all items)	Mean score for completeness of reporting (scale 0-10, items not weighted)	In Diaz-Ordaz (78): No global effect provided (see effects for individual items in Table 2 of the paper) In Pandis et al. (128): Difference of 0.93 In Péron et al. (129): No difference in medians In Kloukos et al. (130): 0.27

*Difference between adherence to RGs in intervention and non-intervention group. We did not report the CI of the effect size when authors did not report it in the original papers.

**As the 80 individual studies that belong to this category used different measures of adherence to reporting guidelines, we report here the measures used in the two systematic reviews that summarized the pooled results of most of these studies (3,6).

PRISMA-ScR Checklist*

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable) background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	1,2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	3,4 (“Background”)
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	5 (“Objectives”)
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	5 (“Methods”)
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	5,6 (“Eligibility Criteria”, “Exclusion Criteria”)
Information sources	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	6 (“Search Strategy and Study Selection”)
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	6 (“Search Strategy and Study Selection”)
Study selection	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	6,7 (“Search Strategy and Study

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PRISMA-ScR Checklist*

			Selection")
Data collection process	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	8 ("Data Extraction")
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	8 ("Data Extraction")
Risk of bias in individual studies	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	N/A
Summary measures	13	Not applicable for scoping reviews.	N/A
Synthesis of results	14	Describe the methods of handling and summarizing the data that were charted.	9 ("Data Synthesis)

Section/topic	#	Checklist item 10	Reported on page #
Risk of bias across studies	15	Not applicable for scoping reviews.	N/A
Additional analyses	16	Not applicable for scoping reviews.	N/A
RESULTS			
Study selection	17	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Figure 1
Study characteristics	18	For each source of evidence, present characteristics for which data were charted and provide the citations.	10 ("Results)
Risk of bias within studies	19	If done, present data on critical appraisal of included sources of evidence (see item 12).	N/A
Results of individual studies	20	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	10 ("Results")
Synthesis of results	21	Summarize and/or present the charting results as they relate to the review questions and objectives.	10-15 ("Results")

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Risk of bias across studies	22	Not applicable for scoping reviews.	
Additional analysis	23	Not applicable for scoping reviews.	
DISCUSSION			
Summary of evidence	24	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	15 (“Discussion)
Limitations	25	Discuss the limitations of the scoping review process.	17 (“Discussion”)
Conclusions	26	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	15-17 (“Discussion)
FUNDING			
Funding	27	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	18 (“Declarations – Funding”)

*Original source: http://annals.org/aim/fullarticle/2700389/prisma-extension-scoping-reviews-prisma-scr-checklist-explanation

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