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Doctor of Philosophy

Identifying Avoidable Waste in Research at Different Research Layers

Analysis of methods in evidence synthesis, editorial policies for transparency, and definitions for predatory journals

by

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If you need to choose between being kind or being right, choose to be kind.
(Unknown author)

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Abstract

Transparency and reproducibility practices in research and science are a cornerstone for its progress. Adequate editorial and peer-review processes are adequately available, although authors sometimes do not adhere to them. Available resources and routines may contribute to the improvement of the aforementioned transparency in science. So, this thesis aimed to investigate potential problems and solutions in the biomedical research in different levels, as follows: the quality, transparency and apparently excessive redudancy of systematic reviews and meta-analysis (SRMAs) in high-intensity interval training (HIIT) on cardiorrespiratory fitness; how journals of Cardiology currently adhere to transparency and reproducibility practices in their policies; and how to handle the burden of predatory journals through evaluating available checklists to identify them. In summary, in the study 1 we concluded that SRMAs in HIIT have a low methodological quality and transparency practices, such as the very low proportion of registration records, modest comprehensive literature searches and limited assessment of probability of publication bias. There was also some redundancy and heterogeneity among the includedSRMAs in terms of population, intervention settings and sometimes the absence of a comparator group. In the study 2, the main message is that Cardiology journals adhere at low proportion to transparency and reproducibility practices in their policies, such the a moderate proportion on how to report the study or how to find a guideline (e.g., EQUATOR Network); the low proportion of raw data sharing statements the guidance on how to share the data. Importantly, only one journal has a mandatory policy for data sharing of randomized controlled trials. Finally, in the study 3, we found 93 unique checklists to identify potential predatory journals, which may difficult the choice of most useful resources, and that there is a low proportion of evidence-based checklists. In summary, given the current suboptimal levels in different outcomes assessed herein, we argue thattraining, education, and specific policies may facilitate the implementation of transparency practices.

Keywords: research transparency; waste in research; HIIT; Cardiology; data sharing;

predatory journals.

Background and Rationale

In 2014, the Lancet Journal launched a series entitled "*Biomedical research: increasing value, reducing waste*" (1), composed by five articles exposing evident problems in biomedical research that could be avoided circumstantially. In respect to the concept of research waste, one of the major contributions of the series was the inclusion of patients, human resources and data usability in addition to monetary investments - which was recently re-stressed by Zarin and colleagues (2019) (2).

Avoidable waste in research can become present in different ways, like: research is often futile but it could be avoided by an a priori literature review within a core priorities set (3); a correct answer of a worthwhile project could be blunted by a project with wrong methods or conduct (4); regulators and funders may use their legal capacity to enforce stakeholders to adhere to good research practices but often refrain from it (5); sometimes, a good research was accomplished but is inaccessible/untraceable because it was not published (6); not rarely, after all, a very good experiment is unusable because it is poorly reported or misreported (7) although plenty of guidance is available for reporting, registering and compliance to the protocol (e.g., www.equator-network.org; www.clinicaltrials.gov; www.crd.york.ac.uk).

Importantly, these steps may occur at different stages of research such as planning, conduction, publishing, correction and reproduction; good practices to reduce the avoidable waste could be implemented in those different levels and could be also evaluated. It seems more important nowadays given the increasing volume of publication over time.

In terms of planning, conducing and publishing, systematic reviews seem to feature an important spot in the literature. It is estimated that the volume of systematic reviews and meta-analyses (SRMAs) increased by 2700% within an annual rate of 150% between 1991 and 2014 (8), and that for every single trial published we had at the beginning 0.14 SRMAs

and now 0.87, approaching a ratio of one SRMA for one published trial (9, 10). This significant shift in the number of systematic reviews could result in redundant publications, noise in the literature with inconclusive findings, a low methodological rigour and poorly reported pieces of research.

In the discipline of Cardiology (herein mentioned as 'Cardiology' for a matter of brevity), Dondoulakis and colleagues (2018) (11) recently exposed the case of overlapped SRMAs, mirroring the phenomenon of the whole biomedical literature (12, 13). By overlapped SRMAs, we are assuming SRMAs addressing the same topic, with the same settings (population, intervention/exposure, comparator, outcomes), but not necesserely achieving the same results.

In Cardiology, there is more to understand in the context of avoidable waste in research, particularly referred to non-pharmacological interventions. In this particular setting, the rise of high-intensity and intermittent physical exercise and cardiorespiratory fitness, that merits attention. We noticed an apparent burden of evidence-synthesis research on the same topic with potential risk of bias. Thus, we aimed to synthesize SRMAs of high-intensity interval training (HIIT) that evaluate cardiorespiratory fitness in apparently healthy subjects and outpatients. We evaluated methodological quality by the AMSTAR tool (14) as a primary outcome; design, methods, completeness of reporting and financial conflicts of interests measured as secondary outcomes, through a systematic method, underlying the study 1 of this thesis (https://osf.io/a9m8z/; CRD42017067269).

In addition to the quality of reporting in scientific articles, journals can impact the publication, correction and reproducibility processes. For example, in 2015, the British Medical Journal (BMJ) turned the data sharing of individual participant data (IPD) in randomized clinical trials (RCTs) into a mandatory condition for publication of RCTs, as a

way to improve the potential for reproducibility, verifiability, transparency, and usability of results (note: also an ethical obligation of researchers) (15).

Together, the International Committee of Medical Journal Editors (ICMJE) also provides authors a framework of guidance to data sharing in their transparency practices, whether data sharing being mandatory or not (16). Given the burden of research in Cardiology, consisting of large and expensive RCTs, we considered the investigation of their editorial policies for transparency and reproducibility practices in these journals would be worthwhile.

Then, we developed the Reproducibility Policies in Cardiology Journals Study (The REPLICA Study) (https://osf.io/sgb6u/), in which we synthesized in a population-based manner transparency and reproducibility policies and guidance of Cardiology journals. As a primary outcome, we investigated whether a journal had a data sharing policy or guidance, regardless of the level of enforcement. Secondary outcomes were evaluated such as the requirement of registration for RCTs, level of the policy, what type of materials were indicated to be shared and in which conditions in the guidance section, and if reporting guidelines guidance was provided for RCTs, consisting of study 2 of this thesis.

However, the correction and replication process just might be possible if research is published in an accessible journal, within a credible publication and dissemination process, receiving robust peer-review process, with clear disclosure of conflicts of interests and as transparent as it can be. So, if the publication layer is compromised, it impairs the rest of the sequence. In this scenario, the growth of journals of low quality, with deceptive practices for open access publication usually characterized by a low article processing charge and poor (or absent) editorial and peer review process has been concerning the scientific community (17).

These journals are often called as "predatory journals", "dark journals" or "deceptive journals" and were difficult to detect in the past (note: now with a structured definition

through Delphi exercise (18). The identification was highly dependent only of Jeffrey Beall's list on the past (19) leading some researchers have to gather salient characteristics of predatory (or potential predatory) journals to facilitate the identification of them by researchers (20) - and the list of available "checklists" apparently have grown. Then, we aimed to synthesize through a systematic review the available checklists for scientists with the aim to identify potential predatory/deceptive journals, consisting the study 3 of this thesis (https://osf.io/g57tf/). Our primary outcome was the number of available checklists. Secondary outcomes were the characteristics, domains, time to complete and the evidence-based proportion of checklists.

In summary, this thesis aims to identify some forms of avoidable waste in a particular case, and two different types of countermeasures. We believe the conducted studies will help stakeholders to understand the concept of the avoidable waste in research and how to act against. We also expect to contribute collaboratively with other initiatives investigating similar problems, in a composition of evidence and implementation solutions potentially useful to those aware about the value in research and waste reduction.

Literature Review

Increasing value, reducing waste in biomedical research: basic concepts, current initiatives and potential contributions

An overview of the burden of the avoidable waste in biomedical research

In 2009, Iain Chalmers and Paul Glasziou estimated that around 85% of the biomedical research was wasted (~ $200 billions), due to completely avoidable sources (21). This estimate came from the rationale that, among all research theoretically done, only 50% of them was published (22); among those published, only 50% was consistent with pre-specified methods ; and, of the remaining consistent research, only 50% have usable reports (23) (i.e., if you have 100 experiments that have been done, only 50 were published; of those 50, only 25 were consistent with pre-specified methods; and, of these 25, only 15% is adequately reported to be used and reproduced, comprising 85% of the initial amount).

One could say this proposed research waste based on cost estimates is too strict. However, empirical evidence shows that (a) underreporting; (b) inconsistencies between registers/protocols and final reports; (c) and completeness of reporting of research pieces are pivotal layers for the usability and replicability of a given study (24) - two aspects we need to emphasize as value in research. Although we will dedicate chapters of this thesis to some of these specific sources of value, a brief comment about value in this initial step of the reading could be worth to the reader.

The research in the way that is done and communicated today works basically under the publication in a peer-reviewed journal, preferable in an indexed and well-known database - otherwise, theoretically it will not reach the boundaries of the consumer. However, surrounded by publishers and open access policies, our editorial system turns research

information into an economic commodity (25), plenty of problems and at risk to be biased due to human decisions; indeed, nothing new for the overall public (26, 27).

Another potential determinant of the way that research is done and communicated is the process of assessment of researchers (e.g., promotion, hiring, tenure, grants etc.).

In a seminal piece that resulted in the recent 2019 Hong Kong Manifesto (https://osf.io/m9abx/), Moher and colleagues (2018) exposed the current metrics for evaluation of researchers. They concluded this is basically done by assessing them through published papers and journal impact factors, and it may put researchers and institutions at risk of misconduct (e.g., fraud, data manipulation) (28)(29)(30).

In 2000, the National Institutes of Health (NIH) released www.clinicaltrials.gov, a website in which clinical trials could be prospectively registered containing basic information about recruitment status, outcomes, eligibility criteria and interventions mainly, primarily for NIH-funded studies to combat bias, increase transparency, accelerate the cure for diseases and facilitate the access of the trial by the public (31). Overtime, other institutions have created their own register globally (e.g., World Health Organization (WHO), that today compiles several databases - http://apps.who.int/trialsearch/) and locally, such as the Brazilian Clinical Trials Register (ReBEC - http://www.ensaiosclinicos.gov.br/) or the Australian New Zealand Clinical Trials Register (http://www.anzctr.org.au/).

Four years after the creation of www.clinicaltrials.gov, the ICMJE required in a mandatory form for ICMJE's journals to instruct authors to include a data sharing statement for RCTs, disclaiming if researchers would or not the data and materials and in what conditions (32) - a movement that substantially changed registration system and, as a consequence of an affirmative policy to foster transparency and integrity, allows researchers to deeply understand the problem of inconsistencies between what as planned and what was done. At that moment, the ICMJE was essentially sharp with the problem of unplanned

changes in the manuscript (33) and the problem of reporting selectively previously defined outcomes (34):

"The purpose of clinical trial registration is to prevent selective publication and selective reporting of research outcomes, to prevent unnecessary duplication of research effort, to help patients and the public know what trials are planned or ongoing into which they might want to enroll, and to help give ethics review boards considering approval of new studies a view of similar work and data relevant to the research they are considering. Retrospective registration, for example at the time of manuscript submission, meets none of these purposes." (ICMJE, 2004)

If an article was published and consistent with the previous registration record, it needs to be adequately reported to be interpreted and reproduced *a posteriori* by any intended stakeholders.

In terms of reporting, numerous guidance documents are available to report academic pieces, especially for RCTs (for guidelines please see http://www.equator-network.org/). As for RCTs, the most used reporting guideline is the Consolidated Standards of Reporting Trials 2010 - CONSORT Statement (35), with extensions for non-pharmacological treatments (36), crossover trials (37), cluster trials (38) and others. Empirical evidence shows the completeness of reporting of core items of an RCT, such as randomization methods, allocation concealment, reporting of primary outcomes and the completeness of reporting of the intervention is still poor (39), although proposed solutions for increments, such as editorial policies, showed modest improvements overtime (40).

This said, what I have exposed has been repeatedly and considered as sources of avoidable waste in research, as exposed in 2014, together with varied ways to avoid waste in research.

Assessing the rigor of the evidence when considering the whole body of the evidence in a given topic: biases in systematic reviews with meta-analyses

Systematic reviews with meta-analysis (SRMAs) are considered the best source of credible evidence for decision making (41), although some concerns exist regarding, for example, planning and conduction (42). Then, stakeholders should interpret SRMAs in light of their methods and potential risk of bias all the time. In 2010, Bastian and colleagues (9) estimated that 11 SRMAs were published a day in 2007. Nowadays, we do not have the updated statistics but there is no reason to speculate this number did not rise significantly. With this huge number of sources of evidence generated, waste could be higher than benefits, likely when excessive overlap of SRMAs in the same topic could appears (43), generating futile, waste and biased research.

The combination of both is dangerous for the literature and should be avoided. We do not know exactly why too many SRMAs are being poorly published overtime, however, it is plausible to speculate that in an environment of publish or perish to survive (44), it is easier (and sometimes cheaper) for scientists to work on secondary studies without a purpose and a rationale. In an attempt to avoid the same type of waste generated by the plethora of RCTs, the York University launched the PROSPERO Register - International Prospective Register of Systematic Reviews (www.crd.york.au.uk), which aims to reach authors to define a priori the settings of the study as the same as for RCTs and to reduce unintended duplicated SRs/SRMAs. It was launched in 2011 and, according to Page and colleagues (45), in 2018 exactly 11,000 registrations were done reaching a cumulative value of 30,116 registrations.

However, despite advancements in transparency practices *a priori*, empirical data show that SRMAs are being poorly conducted, designed and reported. First, Page and colleagues (46) in a survey of more than 300 SRMAs demonstrated that the vast majority of the items of PRISMA were poorly addressed and did not change after 2004. In terms of methods, 70% of the SRMAs performed risk of bias assessment, however, only 16% incorporate its results into the discussion. Search strategies seemed to be also very poor - only 7% of the SRMAs searched for unpublished data, 16% contacted authors and 1% searched for clinical study reports (CSR) - this later on for pharmacological research. Finally, just an example, only 55% did the screening method in duplicate, as recommended by both the Cochrane Handbook for Systematic Reviews of Interventions versions 5.0 and 6.0 (https://training.cochrane.org/handbook).

About statistical approaches, another report of Page and colleagues that surveyed 110 SRMAs concluded that statistical approaches were flawed overall. For example, only 50% used random effects to meta-analyze studies, although 8% only interpreted the meta-analytic effect correctly; only 15% used a funnel plot to investigate asymmetry, only 24% statistically tested for heterogeneity (42).

Given that methods of SRMAs are clearly to be improved, now I comment on the overlap of SRMAs in the same topic, that is another source of waste and sadly viewed in light of the presence of the PROSPERO registry. Recently, Joshua Wallach commented on the problem of the plethora of meta-analysis in an article entitled "Meta-analysis metastasis", in JAMA Internal Medicine (47). Empirical evidence has shown the number of meta-analyses has been growing fast and "without control" (8, 48). It leads not only to a noise on the literature, but also the multiplicity of research in the same topic. For example, some fields can reach close to 200 SRMAs within a time frame, as for antidepressants between 2007 and 2014 (49), with a so-low likelihood to have different results (50). In the same report already

commented here by John Ioannidis, he estimated that 27% of the produced SRMAs are redundant/unnecessary through multiplicity (8).

In a real case in Cardiology, Doundoulakis et al (11) found 57 SRMAs covering 14 unique RCTs for direct oral anticoagulants (DOACs) and atrial fibrillation. In 2013, Siontis et al. in a seminal work found that of 73 SRMAs published in 2010, at last ⅔ had one overlapping MA at methods, rationale, eligibility criteria or outcomes (12).

Exposed the problem with methodology and redundancy with meta-analyses, we aimed to investigate the methodological and reporting characteristics of systematic reviews with meta-analysis in a particular setting - high-intensity interval training as an intervention and cardiorespiratory fitness as the outcome, and here I comment our rationale.

High-intensity interval training (HIIT) is a hype in exercise sciences. It is composed by brief high-intensity efforts (i.e., > 85% of VO_2max/peak) and longer rest period (an intermittent session). In a comment on hype interventions for health care, there are explicit concerns about the costs, risks and benefits (51). Thus, HIIT is as an alternative to improve cardiorespiratory fitness, which is an outcome that is very sensible to HIIT and also a predictor of mortality and other health care outcomes (52-54).

As an example, in 2015, HIIT was in the 2nd place in the ranking of the American College of Sports Medicine for trends in exercise (55). In 2019, it remains as 3rd, and in 2018 reached the 1st position (56).This said, given the society demand for this type of healthcare technology, we aimed the evaluation of the current evidence in terms of standards of methodology, transparency and reproducibility on the level of the current SRMAs.

Editorial policies to improve transparency, data usability and research reproducibility

Sharing the relevant data of a clinical trial improves the transparency and reproducibility of a given study and makes a large body of literature available to be reused. This behavior is a crucial way to reduce the avoidable waste in research.

In the clinical setting, in 2012, the British Medical Journal had a movement in its editorial policy signalizing that sharp modifications would be made in the near future (57). That is, they stated from January 2013 all drug and device trials should state inside the paper that anonymized data would be available on a reasonable request. Two years later, the policy was extended to all types of trials (e.g., behavioral interventions) (15). Importantly, another leading biomedical journal - PLoS Medicine - adhered to the practice together (58).

This movement was triggered by the ICMJE and has a strong background in widely publicized problems in the biomedical literature that could have been mitigated with full availability to study data, for example regarding the dubious effectiveness of Tamiflu (59); the sudden appearance of major adverse events by rosiglitazone after approval (60) etc. The editorial of the ICMJE was published in 2017 (16) and was a case of a huge debate comprising methodological aspects in trials, some required procedures for an adequate desidentification, and financial costs of data sharing (61).

The data sharing in RCTs depends upon authors' willingness or industry agreements (in case of industry-sponsored trials), and may also be influenced by determinants such as the direction and strength of the results. Because of this change in journals' editorial policies seems to be a way to improve the rate of data sharing overtime. A cross-sectional analysis of 49 articles published in two major psychology journals (Journal of Personality and Social Psychology; Journal of Experimental Psychology: Learning, Memory and Cognition) with a nested reanalysis of primary data found that only 42.9% shared the data (62). Interestingly,

the willingness to share was associated with the strength of the results – mainly the magnitude of the point-estimate and the *P*-value.

This simple example may reaffirm the need of impositive policies to reduce waste and add value in research through data sharing of randomized clinical trials, and not restricted to journals and the strength/format of the policy - for example, funders and regulators like the National Institutes of Health mandatory policy for some types of research (NIH) (https://www.nlm.nih.gov/nihbmic/nih_data_sharing_policies.html); the National Science Foundation (NSF) has required applicants to submit a data management plan in grants submissions (https://www.nsf.gov/bfa/dias/policy/dmp.jsp) etc.

Pragmatically, one may say that editorial policies are not sufficient to modify behaviors about data sharing; one may say that other solutions could act better.

For example, the widely-badges in Psychology (63); or independent initiatives such as the Yale University Open Data Access project (YODA Project - https://yoda.yale.edu/) may counteract the role of journals policies. For the best of our knowledge, the mandatory data sharing policy was never compared to reward systems, and we should acknowledge the range of possibilities to improve data sharing among authors.

In 2008, a cross-sectional analysis in the area of cell biology showed prevalences of data sharing policies among journals that had articles with microarray data submitted at the NCBI Gene Expression Omnibus (GEO) (64). They found that, of 70 journal policies, 18 made no mention to any type of data sharing. Academic society journals were more likely to have a policy than those published by commercial publishers. All the four journals published in open access journals as a publishing model had a data sharing policy. The impact factor was positively associated with the strength of the policy - weak policies had a median of 3.6, moderate as a median of 4.5 and strong 6.0 ($P < 0.001$ - P-value as displayed by the authors).

More recently, Vasilevsky and colleagues (65) analyzed 318 biomedical journals within the area of cell biology and correlates, and investigated requirements and characteristics related to data sharing policies. They found that only 11.9% required authors to share the data as a condition to publication and 9.1% did not specify details, whereas 23.3% only encouraged authors to share primary data. Also, the policy was again categorized into its strength and no clear statistical association was detected with the publishing model (i.e., open access vs subscription only/hybrid; P = 0.07) or with journal impact factor. This confrontation of data is not worth exploring once the first study found only four journals operating on open access model.

To our knowledge, empirical data on data sharing policies and other transparency practices such as endorsing reporting guidelines, registration being mandatory or not and so on are scarce and somewhat constrained to pre-clinical research - this last one, reasonable given the amount of data, which led scientists early on to be concerned with spurious findings; the apparent tradition to discuss the topic, regardless of the direction of the results.

This means we perceive a lack of literature in the clinical research and point evidence for specific areas - to our knowledge, only a very few journals journal have mandatory policies in clinical research, and this information came through anecdote - that is, we may miss journals that are in compliance with mandatory policies or at least movement towards a sharp mandate as a condition for publication. Not much more than the descriptive analysis by Vasilevsky and colleagues (65) and Piwowar and colleagues (64) are available to date on the level of the journals.

This said, we developed the Reproducibility Policies in Cardiology study as the study 2 of this thesis - the REPLICA Study, which aims to understand how journals in Cardiology are setting their editorial policies regarding to transparency practices mostly focused on data and material sharing as well as what type of guidance is available and reporting, based on the

established standards of the ICMJE (16). We hope this study adds to the literature evidence in a population-based manner, addressing a clinical area with a considerable burden of disease and scientific/care-providers/patient interest, and different layers (i.e., publishing and replication).

Predatory journals: impact, counteracting and identifying

Predatory journals are a growing phenomenon in the biomedical literature (but not restricted to it). They are a type of journal that approaches authors in an active and deceptive manner, usually with invitations for submissions by email (66). Jeffrey Beall coined the term "predatory" more than a decade ago due to this type of operations (19). Nowadays, empirical evidence is somewhat solid to understand this phenomenon.

Predatory journals can be called also by "dark", "deceptive", "fake" or "bogus" journals (17). Some of these other definitions may be related to the way the journal approaches authors (i.e., deceptive), but also their obscure editorial processes (i.e., dark), and sometimes the inexistence of the journal in fact (i.e., fake). Kurt and colleagues found that authors that published in predatory journals usually did it by high pressure to publish and societal identity threat, whereas some of them were unaware of the problem (67). Recently, Grudniewicz and colleagues (18) arrived in a formal definition for predatory journal through a Delphi exercise, as follows:

"Predatory journals and publishers are entities that prioritize self-interest at the expense of scholarship and are characterized by false or misleading information, deviation from best editorial and publication practices, a lack of transparency, and/or the use of aggressive and indiscriminate solicitation practices"

Back in the 80's the concept of publish or perish was already present in the scientific community (68) and has been recently reaffirmed by researchers challenging the way scientists are assessed for hiring, promotion and tenure worldwide (28), in which metrics seems to be based solely on publication volume and journal impact factor.

The burden of predatory journals and its geographic distribution was already studied. In 2017, Moher and colleagues showed a significant waste of research capital and some epidemiological characteristics of predatory publishing (69). Surveys traditionally have shown that authors are from India and Asia (70, 71). However, this analysis of 2,000 articles concluded that more than 50% of corresponding authors were from middle and high-income countries, conflicting the previous findings. Another important finding is that the United States produced more articles than India, and some of them funded by the NIH, by top-rank universities such as Harvard University or Cambridge University. Finally, it was estimated that 2 million patients and 8,000 animals were enrolled in published RCTs in these journals, and it should be acknowledged.

Although very recently a formal definition was currently available for predatory journals, Cobey and colleagues (17) conducted a scoping review to synthesize common characteristics and derive epidemiological information though. Of 334 records summarized, about 43 countries were covered. The most important contribution of the study was the proposed categories to access predatory journals, as follows: journal operations; article; editorial and peer review; communication; article processing charges; dissemination, indexing and archiving. Important to note, the presence of positive and negative descriptors has illustrated that predatory journals were usually seen as not nocive by some authors.

Although the availability of these characteristics and domains, they are somewhat difficult to operate among five different descriptors and the task to identify a predatory journal remains a challenge of importance. Anecdotal evidence shows that authors go through

different ways to solve this task. Some checklists to detect potential predatory journals are available in the literature (e.g., (72-74) and the identification of predatory journals were made for a long term based on Beall's list (19), which has some criticisms by being done through his own discretion and not being evidence-based. For this purpose, the most known checklist (and evidence-based) is the one developed by Shamseer and colleagues (20), although I have cited some examples and the literature is plenty of others as we will see thereafter. The list is composed by 12-item, covering the majority of the six domains of Cobey and colleagues (17), and was developed after a systematic review of the literature.

Anecdotally, these lists differ significantly and may lead authors to different conclusions. Also, the time to complete is probably not the same due to the different number of items, as well as the number of domains covered by each list. Shamseer and colleagues (20) checklist emphasizes the low APC fares (< $ 150 USD), the overuse of the Index Copernicus Value (i.e., a low-quality surrogate impact metric), the language directed to the authors. It is important to emphasize to authors that some items of the list (e.g., APC fares) can misclassify some journals at some circumstances, like a society-funded journal with no taxes for publication. In the same, illegitimate journals may be wrongly classified as legit asking for high APC fares. Also, predatory journals may leak into PubMed/MEDLINE (75) and, although MEDLINE and PubMed policies are known to be strong with journals for indexation (https://www.nlm.nih.gov/lstrc/jsel.html), they should not be used as threshold for consideration.

Considering the importance to attack the global predation of journals, illustrated by the reasons already shown in this review of the literature, the appropriate identification of potential predatory journals is of importance of researchers intending to publish and stakeholders intending to uptake information. Thus, we developed a systematic review of checklists to detect potential predatory journals to help authors in detecting and choosing the

best available tool, considering aspects such as if the tool is evidence-based or not, the approximate time to complete, the number of covered domains etc.

This study consists of the study 3 of this thesis and aims to add value in research by addressing the publication layer at first. As a comment with merit, all pragmatic proposals (such as checklists to detect potential predatory journals) should be accompanied by a deep modification in the assessment system of researchers, audits and education programs.

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Objectives

Primary Objective

To describe and quantify the avoidable waste in research at different layers addressing the methodological rigor and overlapping of systematic reviews in the same topic; policies and guidance for transparency and reproducibility practices of journals; and tools to identify predatory journals in the biomedical literature.

Secondary objectives

1. To synthesize current meta-analysis addressing HIIT and appraise their methodological quality, quality of reporting, registration status and sources of institutional bias (e.g., disclosures of conflicts of interests or not).
2. To map policies and guidance for transparency and reproducibility in editorial policies of Cardiology journals.
3. To identify the available checklists to detect predatory journals and their methodological characteristics.

Articles

High-intensity interval training and cardiorespiratory fitness: a systematic review of systematic reviews and meta-analyses with a nested meta-research study

Status: to be submitted to the BMC Systematic Reviews .

Cardiology journals have low adherence to reproducibility policies and guidance standards in a cross-sectional analysis: The Reproducibility Policies in Cardiology (REPLICA) Study

Status: to be submitted to the Journal of the American Medical Association.

Checklists to Detect Potential Predatory Biomedical Journals: A Systematic Review

Status: Accepted by the BMC Medicine journal.

High-intensity interval training and cardiorespiratory fitness: a systematic review of systematic reviews and meta-analyses with a nested meta-research study

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Running title: Bias on systematic reviews of high-intensity interval training

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Declaration of Interests

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Abstract

Background

High intensity interval training (HIIT) has been considered a way to improve cardiorespiratory fitness for apparently healthy subjects and patients with cardiovascular diseases. Mounting evidence have been disclaiming the impact and superiority of HIIT against moderate continuous training (MICT), with conflicting results. Thus, we aimed to synthesize current meta-analyses of these modalities and also evaluate the methodological quality and its completeness of reporting.

Study Design and Setting

We searched six databases (PubMed/MEDLINE, EMBASE, the Cochrane Database of Systematic Reviews, SciELO, Google Scholar and PROSPERO), as well as grey literature, without restrictions for publication date, quality, language, health status and age, and that addressed the impact of HIIT on cardiorespiratory fitness regardless of comparisons with other exercise modalities. We also included sprint interval training (SIT) in our eligibility criteria. Screening, data extraction and methodological quality were made in duplicate of reviewers for this study. Quantitative analyses are presented as absolute numbers and proportions.

Results

Twenty SRMAs were included out of 144 reports. Effect sizes varied from 1.53 mL.kg-1.min-1 (95% CI 0.84 to 2.23 mL.kg-1.min-1) to 3.60 mL.kg-1.min-1 (95% CI 2.28 to 4.91 mL.kg-1.min-1) – differences claimed to be clinically relevant in cohort-based studies. Some meta-analyses did not compare two different modalities and not all of them present their

results with the same summary measurement. Methodological and completeness of reporting were poorly addressed.

Conclusion

SRMAs often conclude superiority of HIIT against MICT, however, formal comparisons are not always conduced, as well as inter-trials comparability is reduced by important differences in participants' health conditions and training regimens, which reduces the potential to derive robust clinical conclusions from such syntheses. Moreover, methodological characteristics described our study indicate problems that could reduce the potential for reproducing some of the assessed systematic reviews.

Register CRD42017067269.

Protocol www.osf.io/a9m8z and www.osf.io/6xzyf.

Keywords: high-intensity interval training; cardiorespiratory fitness; meta-analysis; meta-research

What is new?

Firstly, this study found that claims of superiority of a given non-pharmacological treatment (i.e., different modalities of physical exercise) to improve cardiorespiratory fitness are not fully supported due to methodological characteristics of several SRMAs.

Secondly, SRMAs may incorporate several improvements in methods and quality of reporting, with would increase the robustness of finding and facilitate the methodological reproducibility.

We highlight that attention to pre-specification of methods (i.e., protocol) and registration of SRMAs could contribute to methodological transparency, avoid excessive overlapping, and therefore result in improved in scientific quality. Finally, adherence to recommendations from the PRISMA Statement (and its appropriate extensions) could improve the quality of reporting.

Introduction

Poor cardiorespiratory fitness is an established risk factor for all-cause and cardiovascular mortality (1), which has been used as a prognostic variable for several health conditions (2). Although this outcome is largely modifiable by physical exercise , barriers to engagement in regular exercise, such as lack of time (3), may reduce the intervention effects on cardiorespiratory fitness. Over time, time-efficient strategies such as high-intensity interval training (HIIT) have been proposed as an alternative for prolonged exercise. In HIIT, the exercise is conducted in high intensities (e.g., 85-95% of maximal heart rate) for brief periods of time (4), leading to observed benefits in various health-related outcomes (5). Cardiorespiratory fitness is widely set as an outcome because high sensitivity to exercise intensities within a considerable magnitude of effect.

There have been several primary studies investigating the effect of HIIT on cardiorespiratory fitness published over the last few years, along with an increase in systematic reviews and meta-analyses (SRMAs) on this topic (6-9). However, the primary studies are often small (< 30 participants per trial), non-randomized trials with partially controlled interventions, which may have led to divergent results (10-12). These features

could distort summary estimates from SRMAs (13) and ultimately affect the decision-making process in healthcare.

Although much guidance for conducting and reporting SRMAs is available (14-17), empirical evaluations of biomedical literature suggest that the adherence to recommended practices is still insufficient (18). Importantly, improper methods and incomplete reporting in evidence syntheses can reduce interpretability, reproducibility which ultimately increase uncertainty in the findings (19). To date, we do not know empirically how SRMAs addressing HIIT efficacy on VO_2max/VO_2peak are conducted and reported, despite this intervention being increasingly considered in clinical practice guidelines for people seeking to improve cardiorespiratory fitness (2, 20, 21).

We designed a systematic review of SRMAs with a nested meta-research study. First, we aimed to qualitatively synthesize the current evidence of SRMAs; second, we attempted to analyze the methodological and reporting quality of the included SRMAs. We hypothesized that results in different populations with similar interventions would differ in magnitude of effect estimates but not in direction accompanied by a modest proportion of SRMAs with robust methodology and complete reporting, in agreement with previous studies evaluating the quality of biomedical research (18).

Methods

This systematic review (SR) was prospectively registered in the International Prospective Register of Systematic Review – PROSPERO (CRD42017067269) (22) and has a publicly available protocol (www.osf.io/a9m8z) (23), which contains the folder of this publication (www.osf.io/6xzyf) and all of the data and materials related to this study publicly available, for independent authors without restrictions for requesting and using. Our methods

were guided by the Cochrane Handbook for Systematic Reviews of Interventions (16) and we reported this manuscript in accordance with the Preferred Reporting Items to Systematic Reviews and Meta-Analysis (PRISMA) Statement (15) whenever possible.

Eligibility criteria

Our eligibility criteria were defined as follows: articles needed to report a SRMA in which HIIT or sprint interval training (SIT) were compared to another exercise intervention or no-intervention (no-exercise control group or pre-post analysis), and which evaluated VO_2max/VO_2peak as a primary or secondary outcome in individual SRMAs in humans. We did not place any restrictions on population health status, participants' age, and publication status or publication language.

To discriminate definitions of HIIT and SIT, we followed the suggestion of MacInnis & Gibala (24) – i.e., HIIT was defined as any interval-based programs on near maximal intensity (e.g., 85-95% of maximal heart rate – HR); and SIT for programs at maximal intensity (above 100% of VO2max or all-out intensity). We did not place any restrictions on minimal exercise frequency, exercise mode and intervention duration. As for the eligible review outcomes, we considered both cases in which VO2max or VO2peak were directly evaluated.

Searching for reports

To comprehensively survey the literature, we searched four electronic databases for indexed reports (PubMed, EMBASE, the Cochrane Database of Systematic Reviews and SciELO), one database for grey literature (Google Scholar), and one database for registered reviews (PROSPERO) from the earliest available date to June 2017. Additional potentially eligible reviews were hand-searched by checking reference lists and, for unpublished data,

we contacted authorship networks to track those not retrieved by the PROSPERO search. The full-search strategy for each database can be found in the online Supplemental file 1.

Study inclusion process

Because of the low number of SRMAs to screen, we retrieved the full texts of all reports returned by our searches and evaluated each against the eligibility criteria. This process was conducted independently by two reviewers (LH and MRD) and discrepancies in decisions were resolved by discussion or adjudication by another reviewer (DU).

Data extraction

We extracted the following items from SRMAs: (a) summary findings (Population, Intervention, Comparator group, Outcome with directions and Design) through a developed form; (b) epidemiological characteristics (e.g., country of corresponding authors, number of authors, journal impact factor etc.); (c) methodological characteristics through a form developed by Page et al (18) (e.g., screening process, number of searched databases etc.); (d) and reporting characteristics (e.g. title identification as a SRMA, reporting of the eligibility criteria etc.). Our definitions, the first piloted extraction form and final forms are publicly available at www.osf.io/6xzyf.

Variables from a structured form were independently extracted by one author (ATN) and double-checked further by another author (LH). Data on epidemiological, methodological and reporting characteristics were independently extracted by two reviewers (LH and CEB) and discrepancies were solved by discussion or adjudication by another reviewer (DU). The full process was defined a priori (23). The data were first extracted as qualitative variables and then numerically coded into categorical nominal or ordinal variables by a third investigator not involved in the extraction process (MRD). Contact with authors for

additional information was not necessary because all included studies had sufficient data for our analysis.

Data organization (presented data)

The extracted data were organized according to the four domains of characteristics previously mentioned. More specifically, we structured data to present characteristics of included samples (health status and age), intervention (exercise frequency, intensity, interval, type and length), comparator group (exercise frequency, intensity, interval, type and length), results of outcomes (summary statistics with confidence intervals and heterogeneity), experimental designs of the studies and disclosures (containing the disclosure of potential conflicts of interest and also specific funding for the evaluated research). For each included SRMA, the results of sub-group or sensitivity analysis were also discriminated.

AMSTAR appraisal

We assessed the appropriateness of methods of SRMAs by a formal tool using the AMSTAR, developed by Shea et al (17). There is some overlap between some items included in our form to evaluate methodological characteristics of the SRMAs with those listed in the AMSTAR. However, the form was used to record which methods were applied, while the AMSTAR tool was used to evaluate the appropriateness of particular methods used.

Statistical analysis

All analyses were performed using Stata® software (version 14.0.0). We calculated frequencies and percentages for categorical variables. For continuous variables, mean and/or median are displayed for central tendency. For dispersion, we adopted the minimum and maximum values. We planned in our protocol to conduct analyses of possible factor

associated with completeness of reporting and methodological quality, mainly journal impact factor, year of publication and PRISMA citation. However, we did not conduct these analyses because of the low number of included SRMAs. The output from our statistical package software is available at https://osf.io/a9m8z/.

Results

Summary of findings

Our search strategy returned 144 records. Of these, 142 references were retrieved from bibliographic databases of published literature, one was retrieved by contacting authors, and the other was identified in PROSPERO. After excluding duplicates/records, we retrieved 98 full text reports of all records and assessed their eligibility. After exclusions at the full-text level, 20 unique SRMAs met our eligibility criteria and were included in our SR (Figure 1). The raw data related to this process (i.e., records retrieved per database, duplicates removed, included and excluded studies) are available at https://osf.io/a9m8z/.

< **Figure 1**. Flow diagram of the inclusion process. >

Of the 20 assessed SRMAs (5-9, 25-39) two were unpublished now at the time of our search strategy. All SRMAs were available at (or submitted to) specialty journals and none was a Cochrane Review. Moreover, 60% of the SRMAs (12/20) were conducted by a group of 4 (6/20) or 5 (6/20) authors. Eleven out of the 20 SRMAs addressed ill or at-risk populations, and nine stated that trial samples were composed by healthy subjects (**S2**).

<<< **Table 1**. Features of published SRMAs. >>>

SRMAs often included randomized and non-randomized trials, as well as controlled and uncontrolled interventions. As for the primary intervention, 9/20 studies focused only in HIIT, 3/20 in SIT and 8/20 included both interventions. In general, SRMAs often conclude about efficacy and superiority of HIIT/SIT against moderate-intensity continuous training for cardiorespiratory fitness (**S2**) when this comparison is made. However, among all the evaluated SRMAs, we observed differences between the pooled effect sizes in pairwise comparisons (i.e., mean differences between the HIIT/SIT and moderate-intensity continuous training) ranging from a summary mean estimate of 1.53 $mL.kg^{-1}.min^{-1}$ (95% CI 0.84 to 2.23 $mL.kg^{-1}.min^{-1}$) to 3.60 $mL.kg^{-1}.min^{-1}$ (95% CI 2.28 to 4.91 $mL.kg^{-1}.min^{-1}$), which is a difference that could be claimed as clinically relevant given that small improvements of cardiorespiratory fitness are associated with survival, especially in the disease-state population. Moreover, several SRMAs reported only before-after comparisons, with studies without comparator group, being one factor limiting us to make a strong statement about efficacy/superiority (**S3**).

<<< **Figure 2**. AMSTAR-1 for each single included SRMA. >>>

Also, we noticed a low adherence to several AMSTAR items, especially the item 9 – "Were the methods used to combine the findings of studies appropriate?" and the item 10 – "Was the likelihood of publication bias assessed?" Also, the items 3 – "Was a comprehensive literature search performed?", 5 – "Was a list of studies (included and excluded) provided?" and 11 – "Was the conflict of interest included?" were poorly addressed. The form that contains the assessment with final decisions and the AMSTAR questions are available at https://osf.io/a9m8z/, contributing to reduce the credibility of estimates of SRMAs.

Methodological characteristics

Regarding the methodological characteristics of the included SRMAs, several items related to transparency and reproducibility were inadequately addressed. None of the SRMAs had publicly available protocols, only 15% (3/20) were registered, and 50% (10/20) claimed to have followed a reporting guideline (e.g., PRISMA). Based on the PICOS acronym, the eligibility criteria were partially clear among SRMAs, with differences in the specific criteria reported. Eight out of 20 (40%) SRMAs clearly presented eligibility criteria for the studied population, 25% (5/20) the intervention (frequency, intensity, duration and type) and 14% (2/14) the comparator group (frequency, intensity, duration and type – six studies did not present a comparator group). In addition, seventeen out of 20 (85%) of the authors restricted their search strategy based on article's language and 75% (15/20) on study design (**S3**). In terms of outcomes, VO_2max/VO_2peak was the variable analyzed in primary (or index) meta-analyses nine (45%) of the included SRMAs (**S4**).

Completeness of reporting

The reporting of the included SRMAs was also suboptimal in many respects. For example, only 10% (2/20) reported searching a trial registry database and a grey literature database, and we could only identify the full-text strategy in 35% of the articles (7/20) (**S4**). Regarding the screening and extraction process, 55% (11/20) of the authors clearly disclosed that two authors were involved in the process, and the same proportion was observed for the reporting of study risk of bias assessment. In general, authors disclaimed exploratory analyses whenever done, with 40% (8/20) of the SRMA's indicating further analyses after meta-analysis (e.g. subgroup analysis or sensitivity analyses). Of these, 75% (6/8) of sub-group analyses and 100% (8/8) for sensitivity analyses were previously reported in the methods section. However, we did not evaluate registers/protocols (if reported), so we are not

able to consider whether they were planned analyses or not. Nearly 95%, (19/20) SRMAs reported meta-analytical models used for pooling results, and 70% (14/20) used random effects models. 90% (18/20) used mean differences (MD) or standardized mean differences (SMD) to present the summary effect size 65% (13/20) for MD and 25% (5/20) for SMD.

As for heterogeneity of results of primary studies, 16/20 (80%) SRMAs assessed the statistical heterogeneity in meta-analyses and 80% (16/20) described their methods to evaluate it (note: we were unable to identify the meta-analytical model and heterogeneity method in two SRMAs). In result sections, few SRMA's 20% (4/20) presented a comprehensive table displaying a minimal set of characteristics of interventions in included primary studies and the number of participants per meta-analysis 40% (8/20).

Finally, while less than half of the SRMA's reported potential limitations in the included studies and within the review itself 45% (9/20), most reported potential conflicts of interest of the review authors 70% (14/20) and conclusion statements that were consistent with the findings 85% (17/20) (**S4**). Other methodological characteristics can be found at the **S5** table.

Discussion

Overall, we identified wide variability in effect estimates and lack of adherence to methodological and reproducibility standards in SRMAs of studies comparing HIIT/SIT against moderate-intensity continuous training. This ultimately impairs the potential for reproducibility and may weaken usability of evidence. Although SRMAs intend to summarize distinct sources of evidence, we identified that inter-trials comparability may be reduced by excessively ample eligibility criteria.

Among our evaluated meta-analyses, not all of them compared two active interventions, which usually facilitates the assessment of evidence for effectiveness (or at

least against placebo/sham interventions). Of particular concern, methodological flaws were observed then, which may lead to risk of bias in review findings and restrict author's conclusions. For example, a high proportion of SRMAs used narrow search strategies and restrictive eligibility criteria, which reduces the potential of identifying unpublished and negative results (publication bias). These are pivotal aspects that impact meta-analytic effect sizes (40). In addition, some studies did not assess the risk of publication bias (5, 8, 26, 29, 36, 37, 39, 41), and those that did concluded that there was some evidence of publication bias (7, 33, 38).

Incomplete or generic reporting of an experiment may impair the appraisal of a study by any stakeholder due to unclear information (42), and contributes to not generate an accurate cumulative evidence context to be appraised as well as lowers reproducibility process. In this context, we found that the majority of SRMAs on HIIT/SIT were inadequately reported. For example, the full search strategy was not reported in most studies, therefore precluding immediate reproducibility of the search processes by interested stakeholders (43). Also, lists of excluded studies were not displayed in any of the assessed SRMAs. The lack of registration records and protocols for the SRMAs did not allow us to compare what was done to what was planned. This is relevant as the literature suggests that bias can arise through deviations from protocols (44). Finally, some authors did not disclose potential conflicts of interests related to their research, i.e., financial, cultural, personal, religious etc.

There are several ways to improve reporting in future SRMAs. Many of the included SRMAs did not report using a reporting guideline such as the PRISMA Statement, which provides clear guidance for reporting SRMAs. Also, protocols for SRMAs are increasingly easy to deposit in online registries such preprint servers or the Open Science Framework. Financial and non-financial (for example, intellectual) conflicts of interests were mostly

omitted, however, we do not believe this practice is restricted to SRMAs or other studies of HIIT/SIT. Rather, disclosures of conflicts of interest should be a practice to be deliberately stimulated by specialty journals in the area of exercise sciences as a whole. We deem that further research appraising the patterns of disclosures in the field or exercise interventions is needed.

This study has relevant limitations to be addressed. First, although we did not restrict our synthesis according to health status, we have exclusively included SRMAs that assessed cardiorespiratory fitness which limits prompt generalization to other SRMAs addressing HIIT/SIT and we then we retrieved only 20 SRMAs. Second, we may have oversimplified some domains of methodological assessment and reporting (15, 17, 18) – for example, when an item was clearly reported in our evaluated SRMAs, we did not address the merit if it was correctly conducted or not. Further, the small number of included SRMAs precluded further exploration on associations between methodological and reporting standards with summary estimates of cardiorespiratory fitness. Finally, we did not evaluate how the variability in effect sizes could be explained due to methodological and settings (e.g., population, type of exercise, etc.) differences among studies.

After identifying strengths and limitations of the summarized SRMAs, we suggest that SRMAs in this field could incorporate: (a) the prospective registering and public availability of a protocol for the SRMA, with report of possible deviations in the final publication; (b) a clear definition of the population, interventions, comparator groups and outcomes, which allow readers to appraise and more easily implement the interventions of primary studies; (c) a well-documented search strategy for all databases consulted; (d) a less restricted eligibility criteria of primary studies to improve pragmatism; (e) pre-planned analyses; (f) the use of establishedtools to evaluate the risk of bias of primary studies (e.g.,

RoB 1.0 or 2.0); (g) the list of excluded studies; (h) and disclosure of any potential conflicts of interests.

In conclusion, this SR of SRMAs cannot provide evidence to support claims of superiority of a given type of exercise neither consistent differences for overall single estimates. Also, the limitations of SRMAs outlined in this systematic review question the principle of cumulative evidence through reproducibility of results, a fundamental aspect in empirical research. Not the least, SRMAs were often limited in terms of its openness (i.e., sharing of materials, methods, data, prospective register etc.), limiting researchers to access the research in full for the purpose they deem appropriate.

Compliance with Ethical Standards

Sources of Funding

This study did not receive any specific funding for its conduction.

Authors' contributions

Conceptualization: LH, DU; Methodology: LH, CEB, ATD, MJP; DU; Formal Analysis: LH; MD; Investigation: LH, CEB, ATD, MRD, MJP, DU; Data Curation: LH; Writing – Original Draft: LH; Writing – Review & Edit: LH, CEB, ATD, MJP, MRD, DU; Visualization: LH, DU; Supervision: LH, DU; Project Administration: LH, DU; Funding Acquisition: N/A.

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Data Sharing Statement and Compliance with Reproducibility Standards

This study complies with reproducibility standards and has all its materials fully accessible in a public repository, accompanied by its protocol and register under the Creative Commons 4.0 BY License. Stakeholders can have access to all the materials without any restriction. No expiration date was imposed on the data sharing. There is no need to contact the curator, as well as no formal proposal, to have access to all the materials of this study.

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Appendix

Figure 1. Flow Diagram of the Inclusion Process.

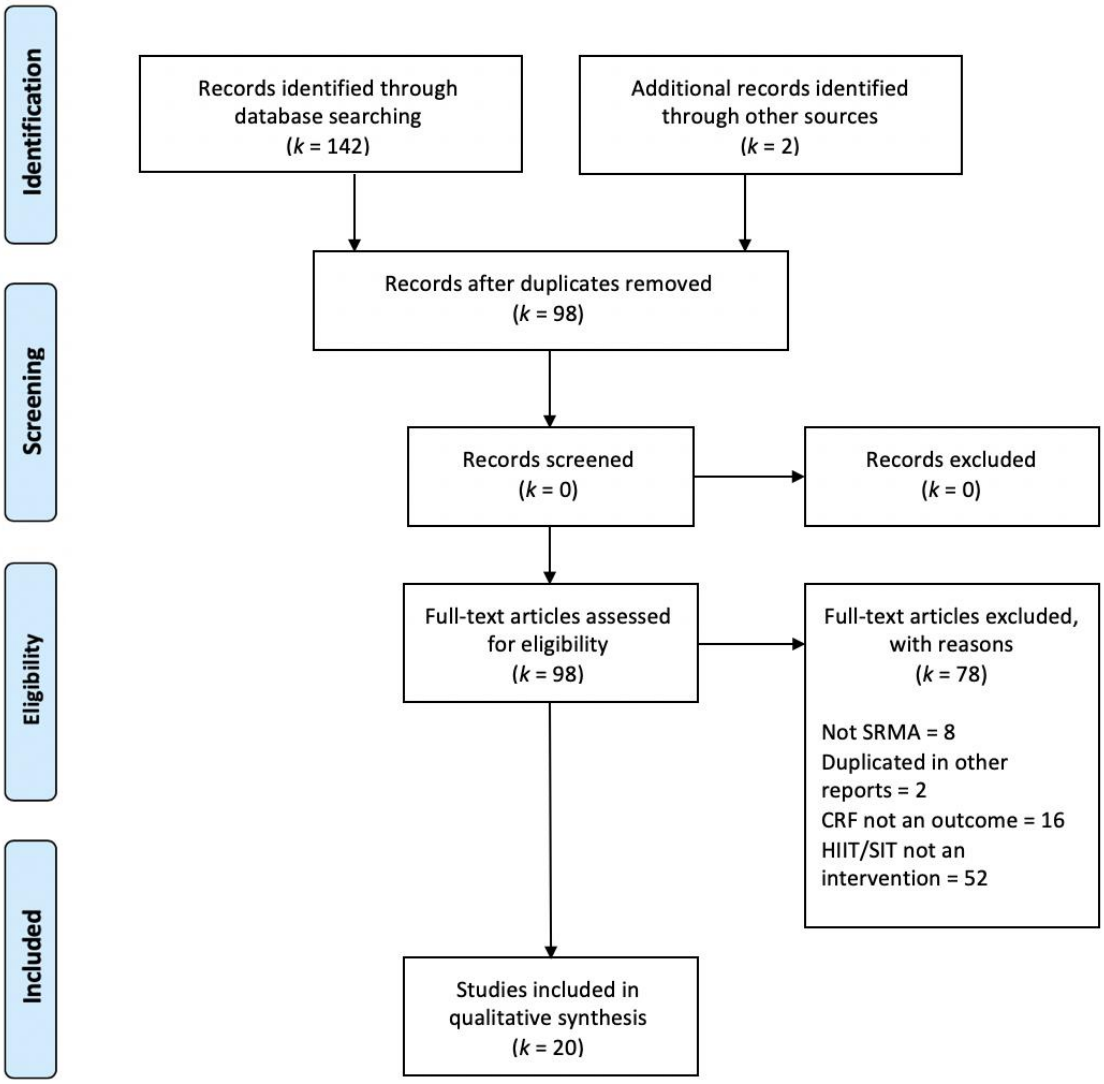
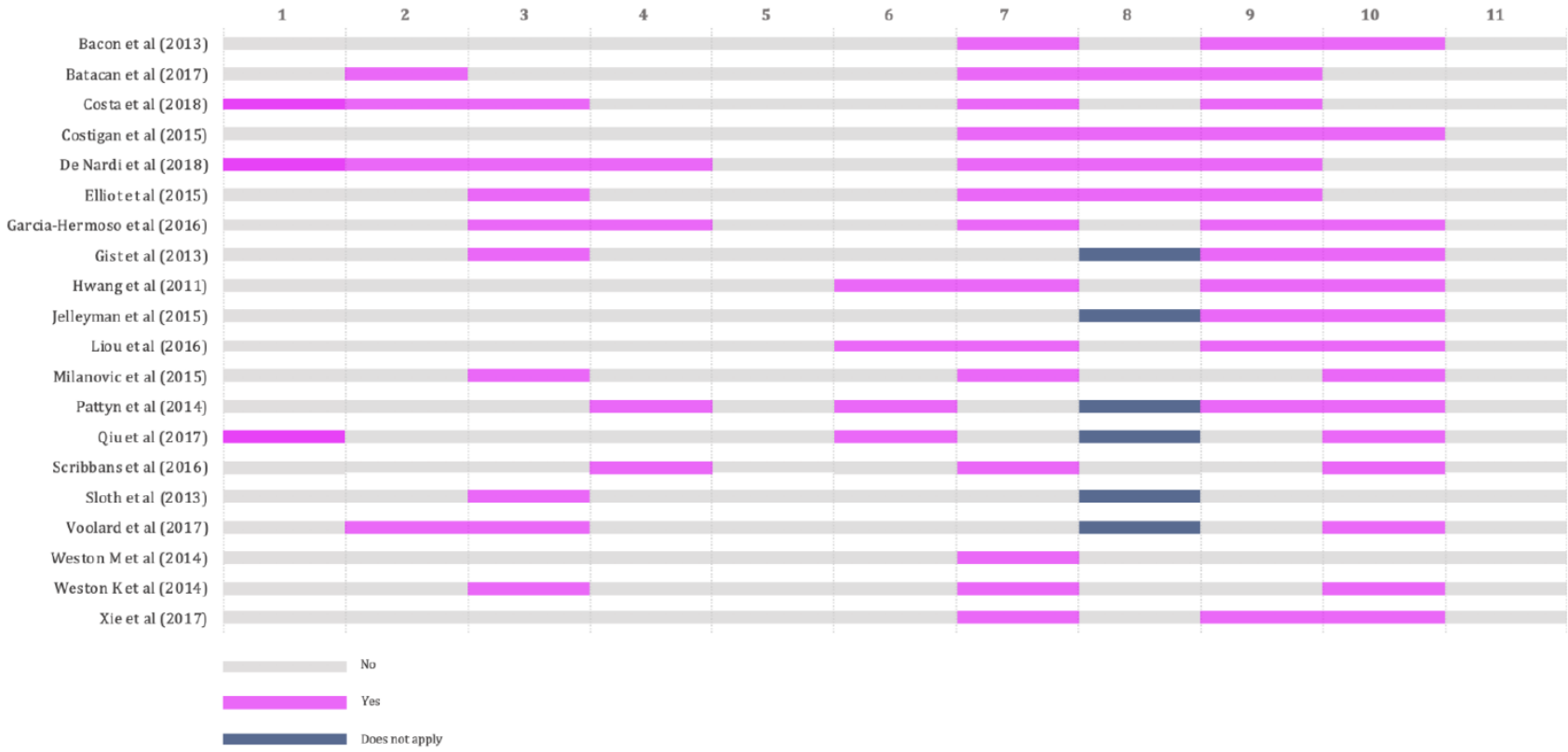


Figure 2. AMSTAR-1 for each single included SRMA.



Note: For the item #4, a positive score was conveyed if the authors searched for studies regardless of their publication type. For the description of AMSTAR-1 items, please check www.osf.io/a9m8z and www.osf.io/6xzyf.

1. Was an a priori design provided? **2.** Was there duplicate study selection and data extraction? **3.** Was a comprehensive literature search performed? **4.** Was the status of publication (i.e., grey literature) used as inclusion criterion? **5.** Was a list of studies (included and excluded) provided? **6.** Were the characteristics of the included studies provided? **7.** Was the scientific quality of the included studies assessed and documented? **8.** Was the scientific quality of included studies used appropriately in formulating conclusions? **9.** Were the methods used to combine the findings of studies appropriate? **10.** Was the likelihood of publication bias assessed? **11.** Was the conflict of interest stated?

Search Strategy (S1)

The search strategies were tested previously with and without descriptors (e.g., [tiab], [mesh], [ti]) and the one that returned the maximal titles and abstracts values was chosen.

PubMed/MEDLINE

#1 (high intensity interval training OR high intensity interval exercise OR HIIT OR HIIE OR aerobic interval training OR sprint exercise OR sprint interval training OR sprint interval exercise OR SIT)

#2 (cardiorespiratory fitness OR maximal oxygen uptake
OR aerobic fitness OR aerobic capacity OR
VO2max OR VO2peak)

#3 ((Medline[tiab] OR (systematic[tiab] AND review[tiab]) OR meta-analysis[ptyp])

#1 AND #2 AND #3

EMBASE

#1 ('high intensity interval training'/exp OR 'high intensity interval exercise'/exp OR high intensity interval training OR high intensity interval exercise OR HIIT OR HIIE OR aerobic interval training

OR ‘aerobic interval training’/exp OR ‘sprint exercise’/exp OR sprint exercise OR sprint interval training OR ‘sprint interval training ’/exp OR sprint interval exercise OR ‘sprint interval exercise’/exp OR SIT)

#2 (‘cardiorespiratory fitness’/exp OR maximal oxygen uptake OR aerobic fitness OR aerobic capacity OR VO2max OR VO2peak) #3 ((systematic AND review) OR meta-analysis)

#1 AND #2 AND #3

Cochrane Database of Systematic Reviews - no filter need (directly to SRMA

#1 (high intensity interval training OR high intensity interval exercise OR HIIT OR HIIE OR aerobic interval training OR sprint exercise OR sprint interval training OR sprint interval exercise OR SIT)

#2 (cardiorespiratory fitness OR maximal oxygen uptake OR aerobic fitness OR aerobic capacity OR VO_2max OR VO_2peak)

Scielo

Search 1

#1 (high intensity interval training OR high intensity interval exercise OR HIIT OR HIIE OR aerobic interval training OR sprint exercise OR sprint interval training OR sprint interval exercise OR SIT)

#2 (cardiorespiratory fitness OR maximal oxygen uptake OR aerobic fitness OR aerobic capacity OR VO_2max OR VO_2peak)

#3 ((systematic AND review) OR meta-analysis)

#1 AND #2 AND #3

Search 2

#1 (treinamento intervalado de alta intensidade OR exercício intervalado de alta intensidade OR HIIT OR HIIE OR treinamento intervalado aeróbico OR exercício de sprints OR treinamento intervalado de sprints OR SIT)

#2 (aptidão cardiorrespiratória OR consumo máximo de oxigênio OR aptidão aeróbica OR capacidade aeróbica OR VO_2max OR VO_2peak)

#3 ((sistemática AND revisão) OR meta-análise)

#1 AND #2 AND #3

S2. Features of published SRMAs.

Number of publications per journal		
	Sports Medicine	4
	British Journal of Sports Medicine	4
	Obesity Reviews	2
	Unpublished	1
	Others	9
	Total	**20**
Continents of corresponding authors		
	Americas	6
	Europe	6
	Asia	3
	Oceania	5
	Total	**20**
Number of publications per number of authors		
	3 authors	4
	4 authors	6
	5 authors	6
	6 authors	2
	7 authors	1
	8 authors	1
Types of conditions studied		
	Healthy	9
	Heart disease	11
	Type 2 diabetes	4
	Hypertension	3
	Others	12

Note: The population status was compiled whenever evaluated. **Healthy**: as clear stated by the authors; **Heart disease**: Coronary artery disease, heart failure (with or without preserved ejection fraction); **Others**: Pre- hypertension/diabetes, metabolic syndrome and overweight/obesity. All the evaluated questions had a *k* of 20

S3. Overview of systematic reviews and meta-analysis on high-intensity interval and cardiorespiratory fitness (2011-2018; *k* = 22).

Study	Population	Intervention	Comparator	Outcome	Settings	Potential Conflicts of Interest (COI) and Funding have been Disclosed?
Bacon et al 2013	**Status**: Healthy (sedentary/ recreationally active) **Age**: 18 to 45 years old **Sex**: Both	**Type**: Interval training or interval training plus continuous training **Mode**: Running or cycling or a combination of both	**Type**: No comparator group	**Mean difference**: - Random effects 0.51 L.min^{-1} (0.43 to 0.60 L.min^{-1}, I^2 = 70%) - Fixed effects 0. 45 L.min^{-1} (0.41 to 0.49 L.min^{-1}, I^2 = 70%)	**Design**: Not reported **Studies in the meta-analysis:** 40 **Participants:** 334	**COI**: The authors disclosed no potential COI related to the research. **Funding**: Yes

	Intensity: 80-85% VO_2max or above **Duration**: 6-12 weeks **Frequency**: ≥3 days/week	**Standardized mean difference:** - Random effects 0.86 (0.72 to 0.99, heterogeneity not reported) **Sensitivity analysis:** **(**Trim and fill approach**)** - Random effects 0.37 $L.min^{-1}$ (0.28 to 0.46 $L.min^{-1}$, heterogeneity not reported)

Batacan et al 2016	**Status:** Healthy and disease (no-disease, hypertension, diabetes, metabolic, syndrome, post MI, CAD, TX, overweight, obese) **Age:** ≥18 years old **Sex:** Both	**Type:** Short-term high-intensity interval training **Mode:** Treadmill running, swimming and cycling **Intensity:** 80-170% VO_2max, 85-120% VO_2peak, 70% - 95% max HRR, 85-95% HRpeak, 85-95% HRmax,	**Type:** No comparator group	**Standardized mean difference:** (Normal weight populations) - Random effects 0.83 (0.56 to 1.10, I_2 = 0%)	**Design:** Clinical trials, randomized controlled trials, non-randomized controlled clinical trials and quasi-experimental **Studies in the meta-analysis:** 12 **Participants:** 123	The authors disclosed no potential COI related to the research.

	120% max aerobic speed, 105% max aerobic velocity, 120-140% lactate threshold, max sprints **Duration**: <12 weeks **Frequency**: 1 - 4 days/week

Batacan et al 2016	**Status:** Same as above **Age:** ≥18 years old **Sex:** Both	**Type:** Short-term HIIT **Mode:** same as above **Intensity:** Same as above **Duration:** <12 weeks **Frequency**: 1 - 4 days/week	**Type:** No comparator group	**Standardized mean difference:** (Overweight/obese populations) - Random effects 0.74 (0.36 to 1.12, I^2 = 0%)	**Design:** Same as above **Studies in the meta-analysis:** 5 **Participants:** 58	The authors disclosed no potential COI related to the research.

Batacan et al 2016	**Status:** Same as above **Age:** ≥18 years old **Sex:** Both	**Type:** Long-term high-intensity interval training **Mode:** Same as above **Intensity:** Same as above **Duration**: ≥12 weeks **Frequency**: 1 - 4 days/week	**Type:** No comparator group	**Standardized mean difference:** (Normal weight populations) - Random effects 1.20 (0.57 to 1.83, I^2 = 73%)	**Design:** Same as above **Studies in the meta-analysis:** 5 **Participants:** 96	The authors disclosed no potential COI related to the research.

Costigan et al 2015	**Status:** Healthy (scholars, obese, soccer players, adolescents with intellectual disabilities and range of elite/professional athletes) **Age:** 11 to 20 years old **Sex:** Both	**Type:** HIIT **Mode:** Sprint running, treadmill walking/running incline, roller ski and sprint cycling **Intensity:** 85–95% HRmax, 75–80% VO_2peak, 100-120% max aerobic speed. **Duration**: 4-12 months	**Type:** MICT, usual care or non-exercise group **Mode**: Small sided games, jogging, exercise and dietary advice **Intensity**: 60-80% HRmax **Duration**: 4-12 months	**Mean difference:** - Random effects 2.6 mL.kg^{-1}.min^{-1} (1.8 to 3.3 mL.kg^{-1}min^{-1}) - Fixed effects 2.8 mL.kg^{-1}.min^{-1} (2.4 to 3.2 mL.kg^{-1}.min^{-1}) **Standardized mean difference:** (Cohen's *d*) 1.05 (0.36 to 1.75, I^2 = 28.3%)	**Design:** Clinical trials, randomized controlled trials **Studies in the meta-analysis:** 8 **Participants:** 255	The authors disclosed no potential COI related to the research.

		Frequency: 2 - 6 days/week				
Costa et al 2018 (*unpublished*)	**Status:** Disease (pre-hypertension and hypertension) **Age:** ≥18 years old **Sex:** Both	**Type:** HIIT **Mode:** Treadmill, cycle, boxing, walking **Intensity:** 75-95% HRpeak **Duration**: 4-16 weeks **Frequency**: 3 - 4 days/week	**Type:** MICT **Mode:** Treadmill, cycle, boxing, walking **Intensity:** 40-70% HRpeak **Duration**: 4-16 weeks	**Mean difference:** - Random effects 2.01 mL.kg^{-1}.min^{-1} (0.86 to 3.16 mL.kg^{-1} .min^{-1}, I^2 = 43%)	**Design:** Randomized clinical trials **Studies in the meta-analysis:** 9 **Participants:** 230	The authors disclosed no potential COI related to the research.

De Nardi et al 2017	**Status:** Disease (type 2 diabetes) **Age:** ≥18 years old **Sex:** Both	**Type:** HIIT **Mode:** Walking or cycling **Intensity:** 77-95% HRmax, 85-90% HRpeak 70-	**Type:** MICT **Mode:** Walking or cycling **Intensity:** 70%HRmax, 60-65% HRpeak, 55-	**Mean difference:** - Random effects 3.02 mL.kg^{-1}.min^{-1} (1.42 to 4.61 mL.kg^{-1} .min^{-1}, I^2 = 0%)	**Design:** Randomized clinical trials **Studies in the meta-analysis:** 3 **Participants:** 89	The authors disclosed no potential COI related to the research.

		85%VO_2peak, 100% VO_2R **Duration**: 2 - 16 weeks **Frequency**: 2 - 5 days/week	60% HRR, 50-65% VO_2peak, 40% VO_2R **Duration**: 2-16 weeks **Frequency**: 2 - 5 days/week			
Elliot et al 2014	**Status:** Disease (CAD) **Age:** 47-73 years old **Sex:** Both	**Type:** HIIT **Mode:** Treadmill walking and cycling **Intensity:** 80-90% VO_2peak, 90%	**Type:** MICT **Mode**: Unclear **Intensity:** 50-60% VO_2peak, 65% VO_2R, 70% HRmax,	**Mean difference:** - Fixed effects 1.53 $mL.kg^{-1}min^{-1}$ (0.84 to 2.23 $mL.kg^{-1}min^{-1}$, X^2 = 2.69)	**Design:** Randomized clinical trials **Studies in the meta-analysis:** 6 **Participants:** 229	Undisclosed

		VO_2R, 85-95% HRpeak, 80-90% HRR, 89% peak power output **Duration**: 4-16 weeks **Frequency**: 2 - 5 days/week	58% peak power output, 60-80% HRR **Duration**: 4-16 weeks **Frequency**: 2 - 5 days/week			
Garcia - Hermoso et al 2016	**Status:** Disease (overweight or obese children and adolescents)	**Type:** HIIT **Mode:** Walking, cycling or running	**Type:** Other forms of exercise	**Standardized mean difference:** - Random effects 0.59 SD (0.17 to 1.01 SD, I^2 = 35%)	**Design:** Randomized clinical trials	The authors disclosed no potential COI related to the research.

	Intensity: 100-120% max aerobic speed, 80-95% HRmax, 80-90% VO_2max	**Mode**: Walking, cycling or running		**Studies in the meta-analysis:** 6
Age: 8 to18 years old			**Mean difference:** - Random effects 1.92 mL.kg^{-1}.min^{-1} (confidence interval not reported)	**Participants:** 137
Sex: Both		**Intensity:** 60-80% of HRmax or VO_2max or maximum aerobic speed		
	Duration: 4-12 weeks		**Subgroup analysis:** (HIIT vs MICT)	
	Frequency: 2 - 4 days/week	**Duration**: 4-12 weeks	**Standardized mean difference:** - Random effects 0.70 (0.29 to 1.11, I^2 = 0%)	
		Frequency: 2 - 4 days/week		

		Mean difference: 2.62 mL.kg^{-1}.min^{-1} (confidence interval and heterogeneity not reported)
		Subgroup analysis: (≥ 12 weeks)
		Standardized mean difference: - Random effects 0.70 (0.32 to 1.06, I^2 = 0%)
		Mean difference:

				1.98 mL.kg^{-1}.min^{-1} (confidence interval and heterogeneity not reported)		
Gist et al 2013	**Status:** Healthy (sedentary, recreational or trained) **Age:** 11 to 29 years old **Sex:** Both	**Type:** SIT **Mode:** Walking, cycling, running and rowing **Intensity:** All out, supramaximal or maxima, 175% peak power output, 130% VO_2max,	**Type:** MICT or non-exercise control groups **Mode**: Walking, cycling, running and rowing **Intensity:** 65-80% VO_2max, 70-80%	**Standardized mean difference:** (Cohen's *d*) - Random effects 0.32 (0.10 to 0.55, I^2 = 74.95%) **Sensitivity analysis:** (SIT vs control)	**Design:** Randomized clinical trials **Studies in the meta-analysis:** 16 **Participants:** 318	Undisclosed

	HRmax, 90%	
Duration: 2-10 weeks	gas exchange threshold	**Standardized mean difference:** (Cohen's d)
Frequency: 2 - 5 days/week	**Duration**: 2-10 weeks	- Random effects 0.69 (0.46 to 0.93, heterogeneity not reported)
	Frequency: 2 - 5 days/week	
		Sensitivity analysis: (SIT vs MICT)
		Standardized mean difference (Cohen's d) - Random effects

				0.04 (- 0.17 to 0.24, heterogeneity not reported)		
Hwang et al 2011	**Status:** Disease (adults with overweight or obese, metabolic syndrome, HD) **Age:** adults and elderlies **Sex:** both	**Type:** AIT **Mode:** Treadmill and cycle ergometer **Intensity:** 80-105% VO_2peak, 85-95% HRmax **Duration**: 4-16 weeks	**Type:** MICT **Mode:** Treadmill and cycle ergometer **Intensity:** 50-65% VO_2peak, 60 - 75% HRmax	**Mean difference:** - Random effects 3.60 mL.kg^{-1}min^{-1} (2.28 to 4.91 mL.kg^{-1} min^{-1}, I^2 = 0%)	**Design:** Randomized clinical trials **Studies in the meta-analysis:** 4 **Participants:** 111	The authors disclosed no potential COI related to the research.

			Duration: 4-16 weeks **Frequency**: 3 - 5 days/week			
Jelleyman et al 2015	**Status:** Healthy and disease (well-trained/ recreationally active/sedentary, overweight/obese	**Type:** HIIT **Mode:** Treadmill and cycle ergometer **Intensity:** 85–95% HRpeak, 90% max	**Type:** MICT **Mode:** Treadmill and cycle ergometer **Intensity:** 70-75% HRpeak, 60–75% max	**Standardized mean difference:** (pre-post) - Random effects 0.30 L.min^{-1} (0.25 to 0.35 L.min^{-1}, I^2 = 97.9%) **Mean difference:**	**Design:** Controlled and non-controlled **Studies in the meta-analysis:** 42 **Participants:** Not reported	The authors disclosed no potential COI related to the research.

metabolic syndrome/T2DM with co-morbidity) **Age:** 21-68 years old **Sex:** Both	workload, 80%-104% peak power output, 100% peak work rate, 80% max power, 80% VO_2peak, 75-95% HRR, 90% VO_2R **Duration**: 4-24 weeks **Frequency**: 2 - 5 days/week	workload, 51–65% peak power output, 50% peak work rate, 40-60% VO_2peak, 45–85% HRR, 65%VO_2R **Duration**: 4-24 weeks **Frequency**: 2 - 5 days/week	(HIIT vs control) - Random effects 0.28 L.min^{-1} (0.12 to 0.44 L.min^{-1}, I^2 = 91.8%) **Mean difference:** (HIIT vs MICT) - Random effects 0.16 L.min^{-1} (0.06 to 0.25 L.min^{-1}, I^2 = 76.3%)

Liou et al. 2015	**Status:** Disease (CAD with or without HF) **Age:** Older adults **Sex:** Both	**Type:** HIIT **Mode:** Treadmill and bicycle **Intensity:** 45-95% HRpeak, 90% VO_2R, 80-104% peak power output. **Duration**: 4-16 weeks **Frequency**: 2 – 3 days/week	**Type:** MICT **Mode:** Treadmill and bicycle **Intensity:** 65% VO_2R, 50-80% HR peak, 51-65% peak power **Duration**: 4-16 weeks **Frequency**: 2 – 3 days/week	**Mean difference:** - Fixed-effects 1.78 mL.kg^{-1}.min^{-1} (0.45 to 3.11 mL.kg^{-1}.min^{-1}, I^2 = 93%) **Sensitivity analysis:** (Wisloff et al 2007 excluded) **Mean difference:** - Fixed-effects 0.98 mL.kg^{-1}.min^{-1} (0.44 to 1.53 mL.kg^{-1}.min^{-1}, I_2 = 0%)	**Design:** Randomized clinical trials **Studies in the meta-analysis:** 10 **Participants:** 472	The authors disclosed no potential COI related to the research.

Milanovic et al 2015	**Status:** Healthy (young to middle-aged adults untrained, sedentary, recreational and non-athletic) **Age:** 18 to 45 years old **Sex:** Both	**Type:** HIIT **Mode**: Not reported **Intensity:** All out, 90-100% HRmax, 100% HRR, 80-90% VO_2max, 125%Pmax, 80% pVO_2max, 105-110% MAS, 120-140% LT, 75-130% vVO_2max	**Type:** MICT or non-exercise group **Mode**: Not reported **Intensity:** 60-85% HRmax, 75-85% HRR, 60-70% VO_2max, 65%VO_2peak, 75-100%	**Mean difference:** (HIIT vs non-exercise group) - Random effects 5.5 mL.kg^{-1}.min^{-1} (4.3 to 6.7 mL.kg^{-1}.min^{-1}, heterogeneity not reported) **Mean difference:** (HIIT vs MICT) 1.2 mLkg^{-1}min^{-1} (0.3 to 2.1 mL.kg^{-1}min^{-1},	**Design:** Randomized and non-randomized controlled trials **Studies in the meta-analysis:**28 **Participants:** 723	The authors disclosed no potential COI related to the research.

		Duration: 3-24 weeks **Frequency**: Not reported	vVO_2max, 85-95% LT **Duration**: 3-24 weeks **Frequency**: Not reported	heterogeneity not reported)		
Pattyn et al 2014	**Status:** Disease (CAD with or without HF) **Age:** Older adults	**Type:** AIT **Mode:** Cycling and treadmill walking	**Type:** MICT **Mode:** Cycling and treadmill walking	**Mean difference:** - Random effects 1.60 $mL.kg^{-1}.min^{-1}$ (0.18 to 3.02 $mL.kg^{-1}.min^{-1}$, I^2 = 83%)	**Design:** Randomized trials controlled and not controlled **Studies in the meta-analysis:**	The authors disclosed no potential COI related to the research.

Sex: Both	**Intensity:** 70-90%VO_2 peak, 85–95% HRmax, 80-90% HRR/ VO_2R, 89-120% peak work rate **Duration**: 4-16 weeks **Frequency**: 2 - 5 days/week	**Intensity:** 50-70% VO_2peak, 45-65% HRR/ VO_2R, 70-75% HRmax, 50-60% peak work rate **Duration**: 4-16 weeks **Frequency**: 2 - 5 days/week	**Subgroup analysis:** (CAD with preserved LVEF) **Mean difference:** - Fixed effects 0.84 mL.kg^{-1}.min^{-1} (0.05 to 1.63 mL.kg^{-1}.min^{-1}, I^2 = 0%) **Subgroup analysis:** (CAD with reduced LVEF) **Mean difference:** - Fixed effects	9 **Participants:** 206

				2.14 mL.kg^{-1}.min^{-1} (-0.15 to 4.43 mL.kg^{-1}.min^{-1}, I^2 = 85%)		
Qiu et al 2017	**Status:** Disease (T2DM) **Age:** Adults and older adults **Sex:** Both	**Type:** Vigorous to maximal aerobic interval training **Mode:** Cycling, walking, jogging and running **Intensity:** 90% peak energy expenditure rate, 100% VO_2 R, 80-	**Type:** MICT or non-exercise group **Mode:** Cycling, walking, jogging and running **Intensity:** 73% peak energy expenditure rate; 40-65%	**Mean difference: (**HIIT vs MICT) - Random effects 2.60 mL.kg^{-1}.min^{-1} (1.32 to 3.88 mL.kg^{-1}.min^{-1}, I^2 = <1%) **Sensitivity analysis:** (INT vs EEM-MICT) **Mean difference:** - Random effects	**Design:** Randomized controlled trials **Studies in the meta-analysis:** 4 **Participants:** 110	The authors disclosed no potential COI related to the research.

	85% VO_2peak, 90-100% HRmax **Duration**: 12-16 weeks **Frequency**: 2 - 5 days/week	VO_2 R, 55-60% HRR **Duration**: 12-16 weeks **Frequency**: 2 - 5 days/week	2.18 mL.kg^{-1}.min^{-1} (0.06 to 4.30 mL.kg^{-1}.min^{-1}, I^2 = 5.6%) **Sensitivity analysis:** (INT vs non-exercise group) - Random effects 6.38 mL.kg^{-1}.min^{-1} (3.66 to 9.10 ml.kg^{-1}.min^{-1}, I^2 = <1%)

Scribbans et al 2016	**Status:** Healthy **Age:** 17-30 years old **Sex:** Both	**Type:** MICT, HIIT and SIT **Mode:** Running, cycling, snowshoeing and soccer ball dribbling drills **Intensity:** 60-250% VO_2max **Duration**: 4-8 weeks	**Type:** No comparator group	**Standardized mean difference:** (Cohen's *d*) - Random effects 0.29 (0.44 to 0.73, heterogeneity not reported)	**Design:** Unclear **Groups (instead of studies) in the meta-analysis:** 28 **Participants:** 390	Undisclosed

		Frequency: 2 - 6 days/week				
Sloth et al 2013	**Status:** Healthy (sedentary or recreationally active) **Age:** Not reported **Sex:** Both	**Type:** SIT **Mode:** Bicycle sprints, treadmill **Intensity:** Maximal, all-out	**Type:** No comparator group	**Standardized mean difference:** (Hedges' g) - Random effects 0.63 (0.39 to 0.87, Q = 2.79)	**Design:** Randomized controlled trials, matched-controlled trials and not controlled **Studies in the meta-analysis:**	Undisclosed

		Duration: 2-8 weeks **Frequency**: Not reported			13 **Participants:** 238	
Voollard et al 2017	**Status:** Healthy **Age:** ≥18 years old **Sex:** Both	**Type:** SIT **Mode:** Cycling **Intensity:** All-out **Duration**: 2-12 weeks	**Type:** No	**Standardized mean differences (modified GLMM)**:** - Random effects 7.8% (3.8 to 11.8%, heterogeneity not reported)	**Design:** Controlled and not-controlled study **Studies in the meta-analysis:** 34 **Participants:** 418	The authors disclosed no potential COI related to the research.

		Frequency: 3 - 5 days/week				
Weston K et al 2014	**Status:** Disease (vascular disease, coronary artery disease, heart failure patients, hypertension, obesity and metabolic syndrome) **Age**: Not reported **Sex:** Both	**Type:** HIIT **Mode:** Uphill walking/running on a treadmill, treadmill walking, cycle ergometers **Intensity:** 85-95% max HR; 80-120% peak work rate; 75–80% HRR/ VO_2 peak	**Type:** MICT **Mode**: Unclear **Intensity:** 60-75% HRpeak **Duration**: 4-16 weeks. **Frequency**: 3 - 6 days/week	**Mean difference:** - Random effects 3.03 mL.kg-1.min-1 (2.0 to 4.07 mL.kg-1.min-1, I^2 = 9%)	**Design:** Randomized controlled trials **Studies in the meta-analysis:** 10 **Participants:** 273	The authors disclosed no potential COI related to the research.

		Duration: 4-16 weeks **Frequency**: 3 - 6 days/week				
Weston M et al 2014	**Status:** Healthy (adults sedentary, active non-athletic or athletic) **Age**: ≥18 years old	**Type:** HIIT **Mode:** Unclear **Intensity:** 65-130%VO_2max, all-out, 60-125%Pmax,	**Type:** MICT or non-exercise group **Mode**: Unclear **Intensity:** 65 - 80% VO_2max, 60 - 70% Pmax,	**Standardized mean difference by modified GLMM:** (HIIT vs control adjusted) - Sedentary males	**Design:** Controlled and non-controlled trials **Studies in the meta-analysis:** 32 **Participants:**	The authors disclosed no potential COI related to the research.

	75-130 %vVO2max, 70–80 %HRmax **Duration**: 2-10 weeks **Frequency**: 2 - 6 days/week	90% gas exchange threshold, 70 - 80% HRmax **Duration**: 2-10 weeks **Frequency**: 2 - 6 days/week	10.0 % (4.9 to 15.1%, heterogeneity not reported) - Sedentary females 7.3 % (2.5% to 12.1%, heterogeneity not reported) - Active non-athletic males 6.2 % (3.1 to 9.3 %, heterogeneity not reported) **Standardized mean difference by modified GLMM:**	Not reported
Sex: Both				

		(HIIT vs endurance training)* -1.6% (-5.9 to 2.7%, heterogeneity not reported) **Standardized mean difference by modified GLMM:** (HIIT vs control)* - Active non-athletic females 3.6% (-0.7 to 7.9%, heterogeneity not reported)

				Standardized mean difference by modified GLMM: (Athletic males) 2.7% (-1.9 to 7.3%, heterogeneity not reported)		
Xie et al 2017	**Status:** Disease (CAD and HF) **Age:** 53.1 to 69 years old **Sex:** Both	**Type:** HIIT **Mode:** Treadmill, walking **Intensity:** 85–95% HRpeak, 90% max	**Type:** MICT **Mode:** Treadmill, walking	**Mean difference:** - Random effects 1.76 mL.kg.$^{-1}$min^{-1} (1.06 to 2.46 mL.kg.$^{-1}$min^{-1}, I^2 = 60%) **Subgroup analysis:**	**Design:** Randomized controlled trials **Studies in the meta-analysis:** 21	The authors disclosed no potential COI related to the research.

workload, 80-104% peak power output, 100% peak work rate, 80% max power, 80% VO_2peak, 75-95% HRR, 90% VO_2R **Duration**: 4-24 weeks **Frequency**: 2 - 5 days/week	**Intensity:** 70%-75% HRpeak, 60-75% maximal workload, 51-65% peak power output, 50% peak work rate, 40-60% VO_2peak, 45-85% HRR, 65% VO_2R **Duration**: 4-24 weeks	(< 60 years) Random effects 1.8 mL.kg.$^{-1}$min^{-1} (1.10 to 2.50 mL.kg.$^{-1}$min^{-1}, I^2 = 22%) **Subgroup analysis:** (61–75 years) Random effects 1.10 mL.kg.$^{-1}$min^{-1} (0.36 to 1.83 mL.kg.$^{-1}$min^{-1}, I^2 = 0%)	**Participants:** 736

	Frequency: 2 - 5 days/week	**Subgroup analysis:** (Patients with CAD) Random effects 1.62 mL.kg.$^{-1}$min^{-1} (0.94 to 2.30 mL.kg.$^{-1}$min^{-1}, I^2 = 14%) **Subgroup analysis:** (Patients with CHF) Random effects 1.70 mL.kg.$^{-1}$min^{-1} (0.53 to 2.86 mL.kg.$^{-1}$.min^{-1}, I^2 = 73%)

* ± 90% Confidence interval

Notes: HIIT: high-intensity interval training; AIT: aerobic interval training; INT: vigorous to maximal aerobic interval training; MICT: moderate-intensity continuous training; SIT: sprint interval training; VO_2max/ VO_2peak/VO_2R maximum/ peak/ reserve oxygen consumption; vVO_2max running speed at VO_2max, HRR/HRpeak/HRmax Heart rate reserve/peak/maximum; EEM energy expenditure-matched; LT lactate threshold; CAD: Coronary artery disease; HF: heart failure; HD: heart disease; T2DM: type 2 diabetes; TX: heart transplant; MI: myocardial infarction; WMD: Weighted mean difference; SMD: Standardized mean difference; SDs: standard deviation

S4. Core methodological items related to intervention, methods and outcomes of included studies and statistics of SRMA.

Overall methods		
Citation of Cochrane Review Methods for SRMAs		
	Yes	3
	Not stated	17
	Total	**20**
Existence of a registration record		
	Yes	3
	No	17
	Total	**20**
Existence of a SRMA protocol		
	Yes	0
	No	20
	Total	**20**
PICOS		
Definition of study population (general statements like "*cardiometabolic conditions such as*" was not considered as a definition)		
	Yes	8
	No	12
	Total	**20**
Reviews' scope for conditions studied		
	Healthy	9
	Disease	11
	Total	**20**
Definition of study interventions (frequency, intensity, time and type)		
	Yes	5
	No	15
	Total	**20**
Primary interventions in included studies		
	HIIT	9
	SIT	3
	HIIT and SIT	8
	Total	**20**
Definition of comparator interventions (frequency, intensity, time and type)		
	Yes	2
	No	12
	Does not have a comparator intervention	6
	Total	**20**

Definition of evaluated outcomes described in the methods		
	Yes	17
	No	3
	Total	**20**
Number of outcomes described in SRMA methods		
	< 7	12
	> 7	6
	Unclear	2
	Total	**20**
Number of SRMAs having VO_2max/VO_2peak as the primary outcome		
	Yes	9
	No	1
	Unclear	10
	Total	**20**
Number of SRMA including design of included primary as an elegibility criterion		
	Yes	15
	No	5
	Total	**20**
Trial designs included by SRMAs		
	Only randomized controlled trials	11
	Not restricted to RCTs (i.e., uncontrolled trials, non-randomized controlled trials etc.)	9
	Total	**20**
Statistics		
Meta-analysis model used to assess VO_2max/VO_2peak data		
	Random effects	14
	Fixed effect	2
	Random and fixed effects	2
	Unclear	2
	Total	**20**
Analysis of statistical heterogeneity in VO_2max/VO_2peak meta-analyses		
	Yes	16
	No	4
	Total	**20**

Summary effect measure used to present meta-estimates of VO_2max/VO_2peak		
	Mean difference	13
	Standardized mean difference	5
	Other	2
	Total	**20**
Direction of results in regard to VO_2max/VO_2peak and HIIT/SIT		
	Favorable, statistically significant	17
	Favorable, non-statistically significant	1
	Unclear	2
	Total	**20**

S5. Completeness of reporting of included SRMAs.

Title and abstract		
Reporting of “Systematic Review” and “Meta-Analysis” both included in the title or abstract		
	Yes	9
	No	11
	Total	**20**
Total number of participants included in the abstract		
	Yes	12
	No	8
	Total	**20**
Matching of total numbers of included participants between the abstract and full-text		
	Identical numbers	10
	Distinct numbers	10
	Total	**20**
Presence of information regarding the risk of bias of primary studies included in the abstract		
	Yes	1
	No	14
	Does not apply	5
	Total	**20**
Matching between conclusions reported in the abstract and full-text		
	Similar conclusions	12
	Different conclusions	8
	Total	**20**
Background and Rationale		
Did the authors report the primary outcome the SRMA?		
	Yes	4
	No	12
	Does not apply	4
	Total	**20**
Did the authors report SRMA’s hypothesis?		
	Yes	2
	No	18
	Total	**20**
Did the authors state that a reporting guideline was followed?		
	Yes	10
	No	10
	Total	**20**

Methods		
Did the authors report the publication status of primary studies to be included in the SRMA's eligibility criteria?		
	Yes	7
	No	13
	Total	**20**
Did the authors report the language of primary studies to be included in the SRMA's eligibility criteria?		
	Yes	17
	No	3
	Total	**20**
Did the authors report the design of primary studies to be included in the SRMA's eligibility criteria?		
	Yes	15
	No	5
	Total	**20**
Did the authors report complete search strategy in the full text or supplementary file (at least for one database that allows replication)?		
	Yes	7
	No	13
	Total	**20**
Did the authors report the searched databases?		
	Yes	20
	No	0
	Total	**20**
Did the authors report both the start and end date of the search strategy?		
	Yes	9
	No	11
	Total	**20**
Did the authors report search any registry database of RCTs?		
	Yes	2
	No	18
	Total	**20**
Did the authors report searching any kind of grey literature for primary study inclusion?		

	Yes	2
	No	18
	Total	**20**
Did the authors report if both the screening and extraction process was made or not in duplicate?		
	Yes	11
	No	9
	Total	**20**
Did the authors report contacting primary study's authors for additional data sources?		
	Yes	11
	No	9
	Total	**20**
Did the authors report if the risk of bias of primary studies was assessed?		
	Yes	11
	No	9
	Total	**20**
Did the authors report a *priori* sub-group analysis?		
	Yes	6
	No	2
	Does not apply	12
	Total	**20**
Did the authors report a *priori* sensitivity analysis?		
	Yes	8
	No	0
	Does not apply	12
	Total	**20**
Did the authors report a *priori* meta-regression analysis?		
	Yes	8
	No	0
	Does not apply	12
	Total	**20**
Did the authors report the meta-analysis model?		
	Yes	19
	No	1
	Total	**20**
Did the authors report a rationale to support the chosen meta-analysis model?		

	Yes	5
	No	15
	Total	**20**
Did the authors report a formal method to evaluate results' heterogeneity?		
	Yes	16
	No	4
	Total	**20**

Results

Was a review flow reported in the full-text? (e.g., flow-diagram or flow description in the text)?		
	Yes	11
	No	9
	Total	**20**
Were the reasons for primary study's exclusion reported?		
	Yes	14
	No	6
	Total	**20**
Was the number of excluded duplicates reported?		
	Yes	10
	No	10
	Total	**20**
Was the number of screened full-text articles reported?		
	Yes	19
	No	1
	Total	**20**
Was the number of included studies reported?		
	Yes	20
	No	0
	Total	**20**
Were the included study's details reported comprehensively in the summary table (i.e., population, intervention, comparator group, outcomes with direction and settings)?		
	Yes	4
	No	16
	Total	**20**
Was the total number of pooled participants reported?		
	Yes	17

	Not reported	3
	Total	**20**
Was the number of pooled participants per meta-analysis reported?		
	Yes	8
	Not reported	12
	Total	**20**
Discussion		
Did the authors discuss potential limitations?		
	Yes, only at primary study level	6
	Yes, in both primary and SRMA level	11
	No	3
	Total	**20**
Conclusions		
Did the authors make adequate conclusions based on their pre-specified methods and findings?		
	Yes	17
	No	3
	Total	**20**
Funding and Disclosures		
Did the authors report SRMA's funding source?		
	Yes	4
	No	8
	Not supported	8
	Total	**20**
Did the authors disclosure any potential conflicts of interests related to the study?		
	Yes	14
	No	6
	Total	**20**

A Cross-Sectional Analysis of Reproducibility and Transparency Policies in Cardiology Journals: (REPLICA) Study

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Key Points

Question: What is the proportion of policies and guidance for data sharing in cardiology journals?

Findings: We found a very incipient prevalence of transparency and reproducibility standards related to data sharing in cardiology journals, through the presence of policies and guidance, details, individual patient data sharing, registration and completeness of reporting, for example.

Meaning: The ways to improve reproducibility and transparency are a work in progress. Cardiology journals should improve their policies and guidance for contribution.

Abstract

Importance: Transparency and data sharing are good research practices, contribute to individual patient data (IPD) meta-analysis; and ultimately expand the research ecosystem addressing one of the philosophical research norms that implies in the common property of the society.

Objectives: The objective of the REPLICA study was to estimate the proportions of policies and guidance for reproducibility and transparency among cardiology journals in a population-based manner, as well as doing secondary analysis on details of completeness of reporting, what should be shared and in what conditions should be shared.

Design: This study is a cross-sectional design.

Setting: Population-based study through analyses of journals deposited in the National Library of Medicine (NLM) Catalog tagged with the "Cardiology" and "Vascular Diseases" entry terms.

Participants: Cardiology journals that have published at least one randomized trial in 2018 published in English, Spanish, French or Portuguese from the NLM Catalog database.

Exposures: Journal policies and guidance (separated) in the instructions for authors section of the journal as well as instructions on completeness of reporting; what should be shared; in which conditions should be shared; and the mode of journal's operation in regard to accessibility (i.e., open access or not).

Main outcomes and measures: The primary outcome was a pre-specified composite outcome being the proportion of any mention to data sharing guidance or policy. Secondary outcomes were proportions of completeness of reporting, materials and conditions for data sharing.

Results: Among 150 eligible journals, 75 mentioned a data sharing policy or guidance – 50% (CI 41.97% to 58.02%) whereas 73 journals– 48.6% (CI 40.67% to 56.72%) did not and 2 remained unclear – 1.33% (CI 0.32% to 5.25%). The results were similar to only policy – 74 journals had a policy for data sharing – 49.33% (41.32% to 57.37%) and 76 did not – 50.67% (CI 42.62% to 58.67%). For guidance to reproducibility practices, the prevalence was a bit lower – 70 journals had a guidance section – 46.67% (CI 38.74% to 54.75%) whilst 78 did not – 52% (CI 43.93% to 59.96%) and 2 remained unclear 1.33% (CI 0.32% to 5.25%). Notably, only 3 policies presented any mention to IPD data sharing – 4.05% (1.27% to 12.11%), 80 journals did not cite CONSORT neither any other reporting guideline – 53.33% (45.24% to 61.25%) and 118 did not cite the EQUATOR Network – 78.67% (71.29% to 84.55%). Finally, among the journals that have policy or guidance in their instructions to authors, only 5 were indexed in the Directory for Open Access Journals (DOAJ).

Conclusion and relevance: This study synthesized representatively and systematically selected transparency and reproducibility practices in cardiology journals. In summary, cardiology journals adhere incipiently to transparency and reproducibility standards.

Key-Words: Data sharing; Cardiology; Reproducibility; Transparency.

Rationale and Background

Mounting evidence exists describing the inability of researchers to reproduce methods and results of previous studies (45-48), as well as difficulties having access to data and materials of previous studies (49). This issue contributes to avoidable waste related to poorly designed, unnecessary or low-priority studies, and substantially impairs scientific advancement. Among the barriers for reproducibility, authors have little attention to guarantee public availability to the used data and analytical code. Whenevercontact have been made to obtain the data sets, such material is provided in suboptimal ways (49-51). As for empirical initiatives attempting to reproduce results, some have tried to replicate original studies with the original authors, with modest results. For example, Nosek and collaborators from the Open Science Collaboration reproduced 100 experiments in the Psychology field by re-doing the studies (i.e., results reproducibility), and the proportion of statistical replication was 47% (considering replicated effect sizes within the 95% CI of the original effect sizes) (52). There may be additional factors that influence attempts for replication, such as poorly elaborated protocols (if any), standard operating procedures, details of the implemented interventions and the outcomes assessed (53). This said, the standards for reproducibility should be implemented/required, involving stakeholders in the research replicability (policies, initiatives, funding, etc.).

Empirical evidence has been showing that journals may play a role on failure to replication due the lack of standards for replication(54), even with policies and guidance to educate authors about the importance, relevance and methods to share data and make a study reproducible– mainly the manifestation of the International Committee of Medical Journal

Editors in 2017 for Data Sharing (55) and the Transparency and Openness Promotion Guidelines (TOP Guidelines)(56).

This may imbalance the benefits and harms and lead to biased results either in primary studies or in meta-analyses (57). For example, the reanalysis of the trial of rofecoxib (58) (namely Vioxx© (a non-steroidal anti-inflammatory) found an augmented risk of cardiovascular disease resulting in the marketing withdrawal, and such assessment is possible to be explored by availability of individual participant data (59). In addition, cases of retractions due to data problems could be more readily clarified if the data were made available for verification (60).

Despite some engagement of researchers and the pharmaceutical industry, and evidence that it is feasible from independent authors – indeed an evidence from the cardiology field (61), it seems the authors in the field of cardiology did not learn with past lessons the potential harms of not sharing the data (62). Then, after all, it seems that journals are considered gatekeepers ensuring a final published study complied with the reproducibility standards, although previous experiences showed that the improvements in the rate of data sharing, despite better than no policy, are still at modest levels (63).

In terms of journals' compliance with reproducibility standards, few analyses have addressed clinical research, . especially when in disciplines with large research funding like in the cardiovascular sciences (64, 65). In this regard, cardiology trials present a low rate of data sharing (62), in accordance with the overall literature (53, 66). Therefore, we designed the Reproducibility Policies in cardiology – The REPLICA Study to cross-sectionally assess the presence of guidance and policy of cardiology journals to reproducibility standards through a population-based design.

Our primary objective was to identify the proportion of cardiology journals that have data sharing policies or guidance for prospective authors of RCTs (primary outcome). Secondary objectives are to describe: (a) the proportion of policy for data sharing of RCTs in cardiology journals; (b) the proportion of guidance for data sharing of RCTs in cardiology journals; (c) guidance on how to report an RCT; (d) the level of requirement of data sharing policies (mandatory of RCTs); (e) the completeness of data sharing guidance; (f) the level of requirement on how to report an RCT (i.e., mandatory or encouragement); (g) proportions of policies or guidance in different operations models of journals (open access).

Methods

This manuscript was written guided by the Strengthening the Reporting of Observational Studies in Epidemiology Statement (STROBE Statement whenever applicable in its extension for cross-sectional studies(67). A full protocol was deposited at our Open Science Framework (OSF) repository (https://osf.io/rta68/) prior to data collection and all materials related to this study are available in this repository.

Eligibility criteria

Journals classified as "Cardiology" of "Vascular Disease" by the National Library of Medicine (NLM) that have published at least one randomized clinical trial (RCT) in 2018 (**note:** no time constraints for these journals; please see descriptions below). We excluded journals in which the website's language was not English, Spanish, Portuguese or French for feasibility.

Electronic searches, eligibility and data collection process

An experienced medical information specialist (BS) queried the NLM Catalog through Ovid© to identify the eligible journals. We used the broad subject terms "Cardiology" and "Vascular Diseases" to identify these journals and restrict retrieval to those journals currently indexed in the National Library of Medicine (NLM) Catalog. We then ran queries for each journal in PubMed/MEDLINE© using the Cochrane Highly Sensitive Search Strategy (HSSS) filter for RCTs (68) limiting date to the year of 2018. Thereafter, a library in Zotero (Zotero, v. 5.0.76) was created with all retrieved journals that accused non-zeros (at least one return accordingly to the combination of journals and the HSSS) and their respective publications in 2018. One reviewer (FF) checked the list of titles and abstracts trials ordered by journals. In the

case of any doubt if a record would be a trial or not, the full text was assessed. Whenever a journal had published at least one trial in 2018, the record was moved to a folder labeled as eligible. After the whole final process, the journals in which the trials were published were tabulated in an Excel spreadsheeted with a list of included and excluded journals. The search strategy is presented in Appendix 1. After this, a library technician uploaded all the eligible journals in a knowledge synthesis software to proceed for data extraction (DistillerSR©) using a standardized piloted electronic form. A sample of 10% of journals were piloted at first. The data items extraction was collected independently by two duplicates of reviewers (LH, DBR, FF, NA) and disagreements were solved by consensus. The Clarivate Analytics Impact Factor was retrieved and refers to the year of 2017. We collected the following variables: a) website; b) publisher; c) mode of operation (openness); d) indexed in DOAJ; e) if cites CONSORT; f) if cites EQUATOR Network; g) if cites any reporting guideline; h) the completeness of guidance for reporting; i) the presence of a registration record for RCTs; j) policy for data sharing; k) if for general designs or only RCTs; l) if cites the ICMJE Statement; m) the policy level; n) policy for IPD; o) accessibility of the policy; p) guidance for data sharing; q) if for general designs or only RCTs; r) mechanism; s) method of analysis; t) who can access the data; u) when can access the data; v) the presence of IPD data sharing; w) the presence of materials; v) repository. A glossary of variables will be made available at the time of publication to readers.

Statistical Analysis

Statistical analysis was done only by descriptive analysis. We used counts and proportions with 95% confidence intervals for all categorical outcomes and mean ± standard deviation (SD) (or median and interquartile range (IQR)) for continuous outcomes. Descriptive analysis was done in Stata© (v. 14.0.0).

Data Sharing Statement

This project is in accordance with transparency and reproducibility standards of the ICMJE and others. Independent authors have full access to our raw data (eligible and not eligible journals, Zotero library and dataset), statistical codes used in analysis, statistical analysis, glossary of variables and protocol in our public repository without time constraints neither request conditions (https://osf.io/rta68/).

Results

Deviations from the protocol

We decided to remove the journals Annals of Internal Medicine, Journal of the Medical American Association, The New England Journal of Medicine, British Medical Jounal and The Lancet from the eligibility criteria once it would not reflect what cardiology journals are trying to set as policy and guidance and add “Vascular Disease” as a term for the NLM Catalog for inclusion criteria to increase the likelihood to capture cardiology journals.

Main Results

After our initial search, 225 unique records (journals) were retrieved. 23 were excluded by not accusing publications in 2018 with HSSS resulting in 201 potentially eligible journals. Among them, 50 were excluded due the lack of at least one RCT published in 2018 and one was excluded at the extraction process because it was published in Chinese. A total of 150 unique cardiology journals were included. A complete PRISMA Flow Diagram Chart is displayed below.

<**Figure 1**. PRISMA Flow Diagram>

In terms of characteristics, the mean impact factor (IF) was 3.67 (SD 3.46), median 2.73 (IQR 2.8), minimum 0.3 and maximum 23.42 (SD: standard deviation; IQR: interquartile range, *N* analyzed: 133). Of the 150 journals, only 14 (9.33%, CI 5.57% to 15.22%) were included in the Directory of Open Access Journals. Moreover, only 80 journals (53.33%, CI 45.24% to 61.25%, *N* analyzed: 150) mentioned the necessity of registration of randomized clinical trials any public database. Please see Table 1 for an in-depth analysis.

As for characteristics related to instructions on how to report an RCT and other designs, 70 journals – 46.67% (CI 38.74% to 54.75%, *N* analyzed: 150) recommended or stated requiring the use of the Consolidated Standards of Reporting Trials Checklist (CONSORT), and the same number of journals recommended another type of reporting guideline rather than CONSORT. However, the proportion of endorsement of the Enhancing the Quality and Transparency of Health Research Network (EQUATOR Network) was modest - 32 journals (21.33%, CI 15.44% to 28.7%, *N* analyzed: 150) and a small number of journals provided instructions on how to use reporting guidelines - 30 journals (20%, CI 14.29% to 27.25%, *N* analyzed: 150). Please see Table 1 for detailed journal and reporting characteristics.

<**Table 1**. Journalology and reporting characteristics of evaluated journals.>

As for our primary outcome, 75 journals – 50% (CI 41.97% to 58.02%) did any mention to data sharing in their webpage (whether being policy or guidance), whilst 73 journals – 48.6% (CI 40.67% to 56.72%) did not mention anything and 2 journals – 1.33% (CI 0.32% to 5.25%) remained unclear. When analyzing policies and guidance separately, the results somewhat

similar. 74 journals – 49.33% (CI 41.32% to 57.37%) did have a policy section for data sharing whereas 76 – 50.67% (CI 42.62% to 58.67%) did not. To for data sharing, 70 journals – 46.67% (CI 38.74% to 54.75%) presented a minimal core set of items when 78 – 52% (CI 43.93% to 59.96%) did not and 2 – 1.33% (CI 0.32% to 5.25%) remained unclear. Table 2 shows in full details the aforementioned results.

Regarding the policy details, out of a total of 74 assessed policies, 71 journals - 95.95% (CI 87.88% to 98.72%) - directed it in a generalized scope not related to research designs, whereas the 3 remaining journals – 4.05% (CI 1.27% to 12.11%) designed the policy specifically to RCTs. Likewise, a very few journals cited the need of a data sharing statement in accordance with the requirements of the ICMJE Editorial from 2017 (55) – 5 journals, 6.76% (CI 2.78% to 15.5%) and 69 journals did not mention the ICMJE at all in their policy section – 93.24% (84.49% to 97.21%).

We also summarized how the policies operated in levels of requirement and whether they based on or mentioning the ICMJE Statement. 65 journals – 87.84% (CI 77.96% to 93.64%) encouraged authors to share their data without ICMJE document, whereas 2 journals – 2.7% (CI 0.65% to 10.47%) encouraged authors citing the ICMJE Statement for data sharing. 3 journals – 4.05% (1.27% to 12.11%) policies for data sharing were described as mandatory, without citing the ICMJE Statement. Some journals did not state the level of requirement but only the need to have a statement for data sharing in the main paper – 3 journals (4.05%, CI 1.27% to 12.11%) and one journal did not report any information about this topic – 1.35% (CI 0.18% to. 9.36%). In terms of the accessibility of the information for authors, we found that all the journals made (whether or not having the information) them easily accessible (74 journals). Finally we also quantified how many journals did any mention to the necessity to share individual participant

data (IPD), which was identified in only 3 journals, 4.05% (CI 1.27% to 12.11%), whilst the majority did not impose the necessity to share IPD data – 71 journals, 95.95% (CI 87.88% to 98.72%). Full details are presented in Table 3.

Among the guidance for data sharing, we first investigated for what type of research designs they provided. 62 journals – 88.57% (CI 77.46% to 94.28%, *N* analyzed: 70) provided guidance for data sharing for journals in general (i.e., no specific design), while 6 journals – 8.57% (CI 3.82% to 18.10%) provided guidance specifically for RCTs and 2 journals – 2.85% (CI 0.69% to 11.05%) mentioned guidance both for general and RCTs (see Table 4 for more details). The details of guidance were also evaluated. 67 journals – 95.71% (CI 87.21% to 98.65%) provided by what mechanism the data should be shared, whereas 3 journals – 4.29% (CI 87.21% to 98.65%) did not provide this type of information.

Only one journal provided the required type of analysis, who could access the data and if the data should be IPD or not – 1.43% (CI 0.19% to 9.88%), and 69 journals did not provide this type of information – 98.57% (CI 90.11% to 99.80%). 5 journals – 7.14% (CI 2.93% to 16.34%) provided the information of when the data would be available while 65 – 92.86% (CI 83.65% to 97.06%) did not provide it. 62 journals provided what materials should be shared – 88.57% (CI 78.46% to 94.28%) and 8 did not – 11.43% (CI 5.71% to 21.53%). Finally, 100% of the journals (N: 70) had in the guidance section the necessity to state in what repository the data would be. Full details are able in Table 5.

Stated necessary materials to be shared were also collected. Among IPD data sharing, none of the 74 journals specified the necessity (or encouraged) to share IPD labeled either as raw data or as treated (clean) data. However, one journal – 1.43% (CI 0.19% to 9.88%) made a statement for IPD in general, whereas 69 journals – 98.57% (CI 90.11% to 99.8%) did not. This

prevalence was very different to data in general, in 38 journals did any mention – 54.29% (42.3% to 65.79%), whilst 25 journals did not – 35.71% (CI 25.18% to 47.83%) and in 7 journals this information was unclear – 10% (CI 4.75% to 19.83%). Policies addressing study protocols and registration were modestly prevalence. 25 journals did some mention – 35.71% (CI 25.18% to 47.83%) to the necessity of a protocol whereas 45 did not – 64.29% (CI 52.16% to 74.81%) and only one journal did a mention about sharing details in a public registration platform – 1.43% (CI 0.19% to 9.88%), within same results for the glossary of variables – 1.43% (CI 0.19% to 9.88%). All journals that had a guidance for data sharing gave instructions for repositories to deposit materials and data (Table 6).

Regarding the detailed information of study interventions, none of the XY journals did mention to the necessity of sharing this type of supporting data.

Finally, we observed whether a journal has a mention to data sharing by having a policy or a guidance section in its webpage it is indexed in the DOAJ. Only 14 were indexed in the DOAJ and, among them, 5 - 3.33% mentioned data sharing in its web page. The majority of the journals were not indexed in the DOAJ (136 journals, 90.67%). For full details please see Table 7.

Discussion

Overall, we found the journals in our study had a mild adherence to our primary outcome – that is, a policy or guidance section in their instructions for authors sections, implying that half of cardiology journals had, at the time of our data collection, mention to such practices that may increase data transparency and accessibility. Moreover, similar results were found for only policy

for data sharing and guidance. The reporting instructions followed a similar pattern, with almost half of the journals having indication to use CONSORT or any other reporting guideline, despite the fact that a low prevalence of indications to the EQUATOR Network website were found, in which prospective authors can find further guidance. As a countermeasure for publication bias and other outcome biases, the prevalence of indication/requirement/encouragement to register studies was identified in approximately half of the assessed journals. Finally, instructions on how to share the data and the indication of what data should be shared was found to be at an incipient stage..

Primarily, we found that 75 journals (50%) provided any mention to data sharing through a section of policy or guidance, and the same was true for the section of only policy or only guidance, which means that journals could advance in specifying and adhering to data sharing policies and provide guidance. These results are quite analogous to those by Resnik and colleagues in a survey that included clinical sciences(69).

Stodden and colleagues found a lower proportion of data sharing policy in computational sciences - only 38% of 170 evaluated journals had a data policy (70), inferior to Vasilevsky and colleagues findings (54) for Biology and Microbiology, who found that ~31% of journals did not mention anything about data sharing and of Alsheikh-Ali and colleagues who found a prevalence of 88% in data sharing mention among policies of high impact factor journals in the overall biomedical field (71). The policies varied to from encouragement (N= x) to mandatory (N = y), without a major pattern in the citation of the ICMJE 2017 Statement which requested that manuscripts from ICMJE journals reporting results from clinical trials from July 1st 2018 should include a data sharing statement.

One possibility to explain these findings among others (like the lack of awareness of lack of education) is the low impact of the journals, mirrored by their IF (which may be a proxy of the quality of the journal, despite the well-known several limitations). In our sample we found a mean IF 3.67. Resnik and colleagues (69) recently provided empirical evidence through logistic regression models that IF is associated with data sharing policies. Another finding of this study is that computational and mathematical sciences are more likely to have data sharing policies than clinical sciences (maybe by culture and not policies – a point to be further investigated), which may also explain our results.

The time lag of journals to adopt such positions may be partially mediated by fear of reduced submissions through resistance of researchers that ultimately arrived in reward systems to remediate (56, 72). A potential reason for journals in cardiology showing a modest adherence to practices explored by our study may relato to a considerable proportion of industry-funded RCTs and their proportion (and resistance) of data availability is low (73).

We also observed that full open access journals were indexed moderately indexed in DOAJ (5 out of 14 journals) and among these only 3.33% had policy or guidance in their instructions to authors. It seems that journals endorsing policies/guidance for data sharing should operate more in an open-access manner – after all, if authors cannot access the manuscript and its content, the policy lowers its efficacy.

The results of the analysis of our primary outcome (availability of sharing policies or guidance for RCTs) may imply lack or low reproducibility of findings (74) and issues for post-marketing monitoring (especially adverse outcomes) (75)..

Also, check for internal and external consistencies or even contribute to IPD meta-analysis (76) and unjustifiable once empirical evidence shows that mandatory journal policies are

effective (47, 77); and that data sharing is an ethical obligation of researchers, especially for RCTs, once patients put themselves at risk whenever they are being enrolled in a trial and see more benefits than harms (78, 79).

We also collected data in regard to what conditions data should be shared and what should be shared within those journals that have guidance for data sharing. First, the vast majority of the guidance was oriented for general designs, only 6 journals stating the instructions were for RCTs. The type of analysis, the specification of who could access the data and in when was stated.

Claiming our attention, only one journal required IPD data sharing. IPD data sharing is a cornerstone for clinical research, allowing researchers to reanalyze the data, doing secondary and post-marketing analysis etc. (80). The very low prevalence we found should be acknowledged in a high priority manner. On the other hand, editorial policies are doing a good work on guiding authors on what materials should be shared and the necessity to deposit in a repository, although actual repositories vary in their mode of operation (public or hosted, conditions of access, metadata, etc.) (81). Notably, our results are way superior to Resnik and colleagues, that found a mild prevalence of instructions of repositories for a variety of disciplines (69).

The level of jornal guidance was modest in terms of instruction for materials that should be shared.. Such information like data (in general), protocol and intervention details were poorly addressed and needs to be used in light of its importance. Several studies have demonstrated that original studies did not accomplish data sharing standards, and here we cite an example of Iqbal and colleagues (53) of the overall literature. Guidance is available for journals likely the TOP Guidelines and the FAIR Data Principles (82), and implementations of such guidance may remediate these important problems.

We should acknowledge that the instruction on how to report an experiment (RCT or not) was incipient – both by endorsing reporting guidelines (CONSORT or any reporting guideline) and citing EQUATOR Network. An adequate reporting is crucial for reproducibility (83). Usually, they have the minimal necessary items to describe how a study was conducted and how to interpret them in a form of checklist with a nested guidance document. The endorsement of the CONSORT Statement by a journal, for example, improves reporting (84). Once several steps through the reproducibility of a given study are necessary (not only the data in hands), but several information also, a crystal-clear reported experiment is necessary for that.

Our study is not without limitations. First, our list of variables present some degree of subjectivity to the assessor because there is no well-defined lexicon for reproducibility parts (e.g., code versus materials) or sometimes journals may oversimplify detailed information through a more general statement (e.g., glossary of variables embedded in materials). Second, we limited our sample to journals from the NLM Catalog and that have published at least one RCT in 2018, which put us at risk to have lost some journals even from our eligible languages. Also, the term "IPD", and consequently the IPD prevalence, may be embedded in the term "data" when the policies explain their rules, thus not reflecting the fidelity of the intention to share IPD data. Lastly, our list of variables was based on the very essential parts to take a picture of the policies and guidance of Cardiology journals for data sharing and some depiction of variables (e.g., type of repository) or omission of variables (e.g., computational codes) were removed both for feasibility and also by the apparently low prevalence/importance to this field, so we do not know the effect of these missing variables on the picture we do have.

In conclusion, cardiology journals are still incipient in transparency and reproducibility standards and our empirical data supports a claim to an urgent improvement of such policies for data sharing.

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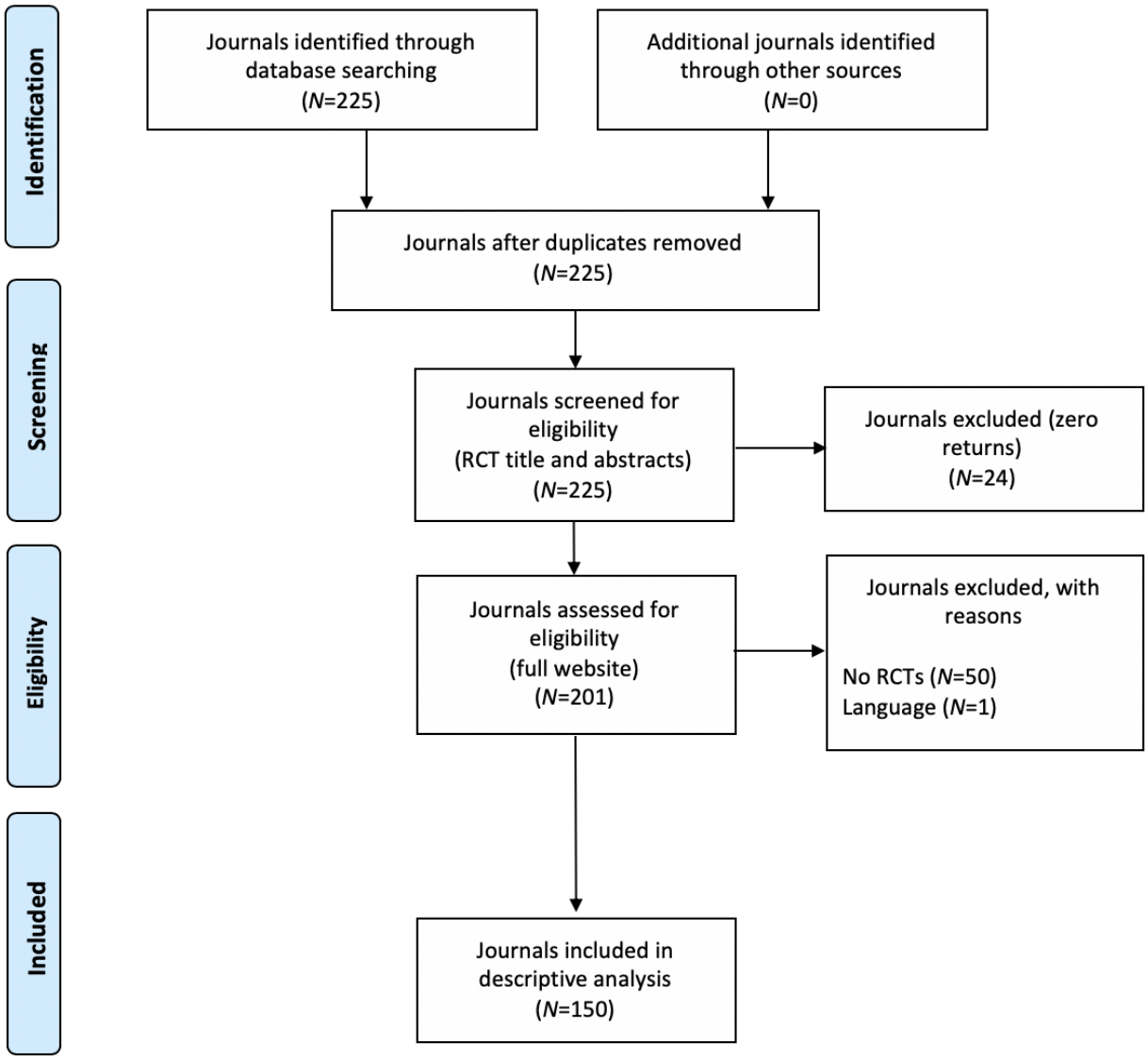
Appendix

Figure 1. PRISMA Flow Diagram of Included and Excluded Journals.



Search Strategy

Final Strategy
2018 Dec 27

MEDLINE

Database: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily <1946 to December 26, 2018>
Search Strategy:
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1 randomized controlled trial.pt. (473462)
2 controlled clinical trial.pt. (92820)
3 randomized.ab. (430114)
4 placebo.ab. (194218)
5 clinical trials as topic.sh. (185597)
6 randomly.ab. (302507)
7 trial.ti. (191861)
8 or/1-7 (1189111)
9 exp animals/ not humans.sh. (4530051)
10 8 not 9 (1093782)
11 limit 10 to yr="2018" (63666)
12 acta cardiologica.jn. (4415)
13 acta myologica.jn. (311)
14 acute cardiac care.jn. (356)
15 advances in cardiology.jn. (1047)
16 american heart journal.jn. (24134)
17 "american journal of cardiology".jn. (36653)
18 "american journal of cardiovascular drugs".jn. (808)
19 "american journal of hypertension".jn. (7185)
20 "american journal of physiology".jn. (54733)
21 "anatolian journal of cardiology".jn. (1125)
22 angiologiia i sosudistaia khirurgiia angiology & vascular surgery.jn. (1396)
23 angiology.jn. (7725)
24 annales de cardiologie et d angeiologie.jn. (3917)
25 "annals of cardiac anaesthesia".jn. (1275)
26 "annals of noninvasive electrocardiology".jn. (1290)
27 "annals of thoracic & cardiovascular surgery".jn. (2061)
28 "annals of vascular surgery".jn. (6304)
29 "archives of cardiovascular diseases".jn. (1119)
30 archivos de cardiologia de mexico.jn. (1334)
31 arquivos brasileiros de cardiologia.jn. (8305)
32 arteriosclerosis thrombosis & vascular biology.jn. (8916)
33 asian cardiovascular & thoracic annals.jn. (2760)
34 atherosclerosis.jn. (13504)
35 atherosclerosis supplements.jn. (383)
36 basic research in cardiology.jn. (3492)
37 blood coagulation & fibrinolysis.jn. (3945)
38 blood pressure.jn. (1500)
39 blood pressure monitoring.jn. (1393)
40 bmc cardiovascular disorders.jn. (1839)

41 "brazilian journal of cardiovascular surgery".jn. (292)
42 "canadian journal of cardiology".jn. (6079)
43 cardiac electrophysiology clinics.jn. (461)
44 cardiology.jn. (4517)
45 cardiology clinics.jn. (1886)
46 "cardiology in review".jn. (1006)
47 cardiology in the young.jn. (3693)
48 cardiology journal.jn. (1466)
49 cardiorenal medicine.jn. (267)
50 cardiovascular & interventional radiology.jn. (5736)
51 cardiovascular diabetology.jn. (1557)
52 cardiovascular drugs & therapy.jn. (2629)
53 cardiovascular engineering & technology.jn. (255)
54 cardiovascular & hematological agents in medicinal chemistry.jn. (355)
55 cardiovascular & hematological disorders drug targets.jn. (365)
56 "cardiovascular intervention and therapeutics".jn. (555)
57 "cardiovascular journal of africa".jn. (1217)
58 cardiovascular pathology.jn. (1549)
59 cardiovascular research.jn. (10628)
60 cardiovascular revascularization medicine.jn. (1399)
61 cardiovascular therapeutics.jn. (620)
62 cardiovascular toxicology.jn. (694)
63 cardiovascular ultrasound.jn. (701)
64 catheterization & cardiovascular interventions.jn. (8541)
65 cerebrovascular diseases.jn. (3071)
66 cerebrovascular diseases extra.jn. (142)
67 circulation.jn. (43168)
68 "circulation arrhythmia and electrophysiology".jn. (1838)
69 circulation cardiovascular imaging.jn. (1512)
70 circulation cardiovascular interventions.jn. (1462)
71 circulation cardiovascular quality & outcomes.jn. (1295)
72 "circulation genomic and precision medicine".jn. (151)
73 circulation heart failure.jn. (1416)
74 Circulation journal.jn. (6511)
75 circulation research.jn. (17193)
76 clinical & applied thrombosis hemostasis.jn. (1947)
77 clinical & experimental hypertension.jn. (192)
78 clinical cardiology.jn. (6339)
79 clinical hemorheology & microcirculation.jn. (2290)
80 clinical research in cardiology.jn. (1874)
81 clinical research in cardiology supplements.jn. (45)
82 clinica e investigacion en arteriosclerosis.jn. (268)
83 congenital heart disease.jn. (1295)
84 coronary artery disease.jn. (2766)
85 "critical pathways in cardiology a journal of evidence based medicine".jn. (552)
86 current atherosclerosis reports.jn. (1475)
87 current cardiology reports.jn. (1795)
88 current cardiology reviews.jn. (469)
89 current heart failure reports.jn. (597)
90 current hypertension reports.jn. (1737)
91 current hypertension reviews.jn. (195)

92 current neurovascular research.jn. (607)
93 current opinion in cardiology.jn. (2441)
94 current opinion in nephrology & hypertension.jn. (2484)
95 current problems in cardiology.jn. (614)
96 current vascular pharmacology.jn. (1131)
97 diabetes & vascular disease research.jn. (747)
98 echocardiography.jn. (4912)
99 esc heart failure.jn. (365)
100 eurointervention.jn. (3530)
101 europace.jn. (5210)
102 european heart journal.jn. (17292)
103 european heart journal acute cardiovascular care.jn. (606)
104 european heart journal cardiovascular imaging.jn. (2010)
105 european heart journal cardiovascular pharmacotherapy.jn. (211)
106 "european heart journal quality of care & clinical outcomes".jn. (199)
107 "european journal of cardio thoracic surgery".jn. (12260)
108 "european journal of cardiovascular nursing".jn. (1001)
109 "european journal of heart failure".jn. (3426)
110 "european journal of preventive cardiology".jn. (1718)
111 "european journal of vascular & endovascular surgery".jn. (6235)
112 "expert review of cardiovascular therapy".jn. (2059)
113 future cardiology.jn. (1063)
114 general thoracic & cardiovascular surgery.jn. (1771)
115 giornale italiano di cardiologia.jn. (6827)
116 global heart.jn. (417)
117 harvard heart letter.jn. (1851)
118 heart.jn. (10152)
119 heart advisor.jn. (1129)
120 heart & vessels.jn. (2561)
121 heart failure clinics.jn. (772)
122 heart failure reviews.jn. (973)
123 heart lung & circulation.jn. (2733)
124 heart & lung.jn. (4256)
125 heart rhythm.jn. (5542)
126 heart surgery forum.jn. (1751)
127 "hjc hellenic journal of cardiology".jn. (1373)
128 herz.jn. (3289)
129 herzschrittmachertherapie und elektrophysiologie.jn. (854)
130 high blood pressure & cardiovascular prevention.jn. (362)
131 hipertension y riesgo vascular.jn. (137)
132 hypertension.jn. (14155)
133 hypertension in pregnancy.jn. (765)
134 hypertension research clinical & experimental.jn. (3495)
135 indian heart journal.jn. (5139)
136 innovations.jn. (40)
137 interactive cardiovascular & thoracic surgery.jn. (6457)
138 international angiology.jn. (2153)
139 international heart journal.jn. (1626)
140 "international journal of cardiology".jn. (25551)
141 "international journal of stroke".jn. (1949)
142 interventional cardiology clinics.jn. (368)

143 jacc cardiovascular imaging.jn. (2748)
144 jacc cardiovascular interventions.jn. (3812)
145 jacc clinical electrophysiology.jn. (752)
146 jacc heart failure.jn. (966)
147 jama cardiology.jn. (906)
148 journal de medecine vasculaire.jn. (95)
149 "journal of atherosclerosis & thrombosis".jn. (1874)
150 "journal of cardiac failure".jn. (2611)
151 "journal of cardiac surgery".jn. (4187)
152 "journal of cardiology".jn. (3761)
153 "journal of cardiopulmonary rehabilitation & prevention".jn. (704)
154 "journal of cardiothoracic & vascular anesthesia".jn. (6770)
155 "journal of cardiothoracic surgery".jn. (1694)
156 "journal of cardiovascular computed tomography".jn. (980)
157 "journal of cardiovascular electrophysiology".jn. (6387)
158 "journal of cardiovascular magnetic resonance".jn. (1380)
159 "journal of cardiovascular medicine".jn. (2554)
160 "journal of cardiovascular nursing".jn. (1847)
161 "journal of cardiovascular pharmacology".jn. (11559)
162 "journal of cardiovascular pharmacology & therapeutics".jn. (1093)
163 "journal of cardiovascular surgery".jn. (7033)
164 "journal of cardiovascular translational research".jn. (826)
165 "journal of cerebral blood flow & metabolism".jn. (6142)
166 "journal of clinical hypertension".jn. (3218)
167 "journal of echocardiography".jn. (403)
168 "journal of electrocardiology".jn. (4950)
169 "journal of endovascular therapy".jn. (2533)
170 "journal of heart & lung transplantation".jn. (6412)
171 "journal of heart valve disease".jn. (3427)
172 "journal of human hypertension".jn. (4508)
173 "journal of hypertension".jn. (9769)
174 "journal of interventional cardiac electrophysiology".jn. (2071)
175 "journal of interventional cardiology".jn. (1771)
176 "journal of invasive cardiology".jn. (4815)
177 "journal of molecular & cellular cardiology".jn. (8129)
178 "journal of nuclear cardiology".jn. (3968)
179 "journal of stroke & cerebrovascular diseases".jn. (4546)
180 "journal of the american college of cardiology".jn. (25113)
181 "journal of the american heart association".jn. (3640)
182 "journal of the american society of hypertension".jn. (1088)
183 "journal of thoracic & cardiovascular surgery".jn. (26498)
184 "journal of thrombosis & haemostasis".jn. (6520)
185 "journal of vascular access".jn. (1492)
186 "journal of vascular & interventional radiology".jn. (6893)
187 "journal of vascular nursing".jn. (694)
188 "journal of vascular research".jn. (1321)
189 "journal of vascular surgery".jn. (15047)
190 j vasc surg venous lymphat disord.ja. (794)
191 "journal of veterinary cardiology".jn. (583)
192 kardiologia polska.jn. (6764)
193 kardiologiia.jn. (13528)

194 methodist debakey cardiovascular journal.jn. (579)
195 microcirculation.jn. (1315)
196 microvascular research.jn. (3525)
197 minerva cardioangiologica.jn. (5861)
198 "multimedia manual of cardiothoracic surgery".jn. (419)
199 nature reviews cardiology.jn. (1941)
200 nutrition metabolism & cardiovascular diseases.jn. (2277)
201 pacing & clinical electrophysiology.jn. (11111)
202 pediatric cardiology.jn. (5323)
203 perfusion.jn. (2019)
204 phlebology.jn. (1101)
205 pregnancy hypertension.jn. (1018)
206 progress in cardiovascular diseases.jn. (2187)
207 reviews in cardiovascular medicine.jn. (787)
208 revista espanola de cardiologia.jn. (8986)
209 revista portuguesa de cardiologia.jn. (3966)
210 revista portuguesa de cirurgia cardio toracica e vascular.jn. (745)
211 scandinavian cardiovascular journal.jn. (1371)
212 scandinavian cardiovascular journal supplement.jn. (33)
213 seminars in thoracic & cardiovascular surgery.jn. (1884)
214 seminars in thoracic & cardiovascular surgery pediatric cardiac surgery annual.jn. (384)
215 seminars in thrombosis & hemostasis.jn. (3115)
216 seminars in vascular surgery.jn. (932)
217 shock.jn. (4807)
218 stroke.jn. (19491)
219 techniques in vascular & interventional radiology.jn. (614)
220 texas heart institute journal.jn. (3766)
221 therapeutic advances in cardiovascular disease.jn. (381)
222 thoracic & cardiovascular surgeon reports.jn. (121)
223 thrombosis & haemostasis.jn. (13516)
224 thrombosis research.jn. (13042)
225 topics in stroke rehabilitation.jn. (1143)
226 translational stroke research.jn. (671)
227 trends in cardiovascular medicine.jn. (1767)
228 turk kardiyoloji dernegi arsivi.jn. (1877)
229 vasa.jn. (2946)
230 vascular.jn. (1210)
231 vascular & endovascular surgery.jn. (1708)
232 vascular health & risk management.jn. (1121)
233 vascular medicine.jn. (1343)
234 vascular pharmacology.jn. (1317)
235 world journal for pediatric & congenital heart surgery.jn. (1049)
236 zhonghua xin xue guan bing za zhi.ja. (4685)
237 or/12-236 [CARDIOLOGY JOURNALS - NLM CATALOG] (917693)
238 11 and 12 [acta cardiologica] (3)
239 11 and 13 [acta myologica] (0)
240 11 and 14 [acute cardiac care] (0)
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244 11 and 18 [american journal of cardiovascular drugs] (31)

245 11 and 19 [american journal of hypertension] (17)
246 11 and 20 [american journal of physiology] (0)
247 11 and 21 [anatolian journal of cardiology] (8)
248 11 and 22 [angiologiia i sosudistaia khirurgiia angiology & vascular surgery] (5)
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250 11 and 24 [annales de cardiologie et d angeiologie] (5)
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252 11 and 26 [annals of noninvasive electrocardiology] (7)
253 11 and 27 [annals of thoracic & cardiovascular surgery] (3)
254 11 and 28 [annals of vascular surgery] (22)
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269 11 and 43 [cardiac electrophysiology clinics] (3)
270 11 and 44 [cardiology] (8)
271 11 and 45 [cardiology clinics] (2)
272 11 and 46 [cardiology in review] (9)
273 11 and 47 [cardiology in the young] (6)
274 11 and 48 [cardiology journal] (22)
275 11 and 49 [cardiorenal medicine] (2)
276 11 and 50 [cardiovascular & interventional radiology] (17)
277 11 and 51 [cardiovascular diabetology] (21)
278 11 and 52 [cardiovascular drugs & therapy] (22)
279 11 and 53 [cardiovascular engineering & technology] (0)
280 11 and 54 [cardiovascular & hematological agents in medicinal chemistry] (1)
281 11 and 55 [cardiovascular & hematological disorders drug targets] (5)
282 11 and 56 [cardiovascular intervention and therapeutics] (4)
283 11 and 57 [cardiovascular journal of africa] (1)
284 11 and 58 [cardiovascular pathology] (0)
285 11 and 59 [cardiovascular research] (9)
286 11 and 60 [cardiovascular revascularization medicine] (47)
287 11 and 61 [cardiovascular therapeutics] (16)
288 11 and 62 [cardiovascular toxicology] (4)
289 11 and 63 [cardiovascular ultrasound] (1)
290 11 and 64 [catheterization & cardiovascular interventions] (88)
291 11 and 65 [cerebrovascular diseases] (5)
292 11 and 66 [cerebrovascular diseases extra] (0)
293 11 and 67 [circulation] (127)
294 11 and 68 [circulation arrhythmia and electrophysiology] (15)
295 11 and 69 [circulation cardiovascular imaging] (3)

296 11 and 70 [circulation cardiovascular interventions] (30)
297 11 and 71 [circulation cardiovascular quality & outcomes] (24)
298 11 and 72 [circulation genomic and precision medicine] (4)
299 11 and 73 [circulation heart failure] (19)
300 11 and 74 [Circulation journal] (33)
301 11 and 75 [circulation research] (18)
302 11 and 76 [clinical & applied thrombosis hemostasis] (15)
303 11 and 77 [clinical & experimental hypertension] (0)
304 11 and 78 [clinical cardiology] (46)
305 11 and 79 [clinical hemorheology & microcirculation] (13)
306 11 and 80 [clinical research in cardiology] (37)
307 11 and 81 [clinical research in cardiology supplements] (0)
308 11 and 82 [clinica e investigacion en arteriosclerosis] (4)
309 11 and 83 [congenital heart disease] (5)
310 11 and 84 [coronary artery disease] (19)
311 11 and 85 [critical pathways in cardiology] (3)
312 11 and 86 [current atherosclerosis reports] (6)
313 11 and 87 [current cardiology reports] (19)
314 11 and 88 [current cardiology reviews] (5)
315 11 and 89 [current heart failure reports] (5)
316 11 and 90 [current hypertension reports] (9)
317 11 and 91 [current hypertension reviews] (5)
318 11 and 92 [current neurovascular research] (1)
319 11 and 93 [current opinion in cardiology] (18)
320 11 and 94 [current opinion in nephrology & hypertension] (6)
321 11 and 95 [current problems in cardiology] (2)
322 11 and 96 [current vascular pharmacology] (14)
323 11 and 97 [diabetes & vascular disease research] (7)
324 11 and 98 [echocardiography] (5)
325 11 and 99 [ESC heart failure] (38)
326 11 and 100 [eurointervention] (47)
327 11 and 101 [europace] (50)
328 11 and 102 [european heart journal] (80)
329 11 and 103 [european heart journal acute cardiovascular care] (13)
330 11 and 104 [european heart journal cardiovascular imaging] (12)
331 11 and 105 [european heart journal cardiovascular pharmacotherapy] (10)
332 11 and 106 [european heart journal quality of care & clinical outcomes] (6)
333 11 and 107 [european journal of cardio thoracic surgery] (26)
334 11 and 108 [european journal of cardiovascular nursing] (19)
335 11 and 109 [european journal of heart failure] (54)
336 11 and 110 [european journal of preventive cardiology] (26)
337 11 and 111 [european journal of vascular & endovascular surgery] (21)
338 11 and 112 [expert review of cardiovascular therapy] (13)
339 11 and 113 [future cardiology] (4)
340 11 and 114 [general thoracic & cardiovascular surgery] (7)
341 11 and 115 [giornale italiano di cardiologia] (9)
342 11 and 116 [global heart] (2)
343 11 and 117 [harvard heart letter] (0)
344 11 and 118 [heart] (21)
345 11 and 119 [heart advisor] (0)
346 11 and 120 [heart & vessels] (20)

347 11 and 121 [heart failure clinics] (3)
348 11 and 122 [heart failure reviews] (18)
349 11 and 123 [heart lung & circulation] (15)
350 11 and 124 [heart & lung] (8)
351 11 and 125 [heart rhythm] (24)
352 11 and 126 [heart surgery forum] (3)
353 11 and 127 [HJC hellenic journal of cardiology] (9)
354 11 and 128 [herz] (31)
355 11 and 129 [herzschrittmachertherapie und elektrophysiologie] (5)
356 11 and 130 [high blood pressure & cardiovascular prevention] (7)
357 11 and 131 [hipertension y riesgo vascular] (1)
358 11 and 132 [hypertension] (27)
359 11 and 133 [hypertension in pregnancy] (6)
360 11 and 134 [hypertension research clinical & experimental] (9)
361 11 and 135 [indian heart journal] (12)
362 11 and 136 [innovations] (0)
363 11 and 137 [interactive cardiovascular & thoracic surgery] (37)
364 11 and 138 [international angiology] (11)
365 11 and 139 [international heart journal] (13)
366 11 and 140 [international journal of cardiology] (126)
367 11 and 141 [international journal of stroke] (48)
368 11 and 142 [interventional cardiology clinics] (5)
369 11 and 143 [jacc cardiovascular imaging] (30)
370 11 and 144 [jacc cardiovascular interventions] (65)
371 11 and 145 [jacc clinical electrophysiology] (15)
372 11 and 146 [jacc heart failure] (27)
373 11 and 147 [jama cardiology] (38)
374 11 and 148 [journal de medecine vasculaire] (3)
375 11 and 149 [journal of atherosclerosis & thrombosis] (17)
376 11 and 150 [journal of cardiac failure] (17)
377 11 and 151 [journal of cardiac surgery] (6)
378 11 and 152 [journal of cardiology] (24)
379 11 and 153 [journal of cardiopulmonary rehabilitation & prevention] (24)
380 11 and 154 [journal of cardiothoracic & vascular anesthesia] (66)
381 11 and 155 [journal of cardiothoracic surgery] (8)
382 11 and 156 [journal of cardiovascular computed tomography] (5)
383 11 and 157 [journal of cardiovascular electrophysiology] (19)
384 11 and 158 [journal of cardiovascular magnetic resonance] (4)
385 11 and 159 [journal of cardiovascular medicine] (8)
386 11 and 160 [journal of cardiovascular nursing] (13)
387 11 and 161 [journal of cardiovascular pharmacology] (14)
388 11 and 162 [journal of cardiovascular pharmacology & therapeutics] (17)
389 11 and 163 [journal of cardiovascular surgery] (24)
390 11 and 164 [journal of cardiovascular translational research] (7)
391 11 and 165 [journal of cerebral blood flow & metabolism] (9)
392 11 and 166 [journal of clinical hypertension] (23)
393 11 and 167 [journal of echocardiography] (0)
394 11 and 168 [journal of electrocardiology] (5)
395 11 and 169 [journal of endovascular therapy] (11)
396 11 and 170 [journal of heart & lung transplantation] (15)
397 11 and 171 [journal of heart valve disease] (0)

398 11 and 172 [journal of human hypertension] (14)
399 11 and 173 [journal of hypertension] (49)
400 11 and 174 [journal of interventional cardiac electrophysiology] (25)
401 11 and 175 [journal of interventional cardiology] (21)
402 11 and 176 [journal of invasive cardiology] (18)
403 11 and 177 [journal of molecular & cellular cardiology] (1)
404 11 and 178 [journal of nuclear cardiology] (8)
405 11 and 179 [journal of stroke & cerebrovascular diseases] (62)
406 11 and 180 [journal of the american college of cardiology] (83)
407 11 and 181 [journal of the american heart association] (85)
408 11 and 182 [journal of the american society of hypertension] (13)
409 11 and 183 [journal of thoracic & cardiovascular surgery] (58)
410 11 and 184 [journal of thrombosis & haemostasis] (28)
411 11 and 185 [journal of vascular access] (21)
412 11 and 186 [journal of vascular & interventional radiology] (20)
413 11 and 187 [journal of vascular nursing] (1)
414 11 and 188 [journal of vascular research] (0)
415 11 and 189 [journal of vascular surgery] (61)
416 11 and 190 [j vasc surg venous lymphat disord] (15)
417 11 and 191 [journal of veterinary cardiology] (0)
418 11 and 192 [kardiologia polska] (8)
419 11 and 193 [kardiologiia] (8)
420 11 and 194 [methodist debakey cardiovascular journal] (2)
421 11 and 195 [microcirculation] (2)
422 11 and 196 [microvascular research] (6)
423 11 and 197 [minerva cardioangiologica] (14)
424 11 and 198 [multimedia manual of cardiothoracic surgery] (0)
425 11 and 199 [nature reviews cardiology] (5)
426 11 and 200 [nutrition metabolism & cardiovascular diseases] (22)
427 11 and 201 [pacing & clinical electrophysiology] (25)
428 11 and 202 [pediatric cardiology] (9)
429 11 and 203 [perfusion] (17)
430 11 and 204 [phlebology] (15)
431 11 and 205 [pregnancy hypertension] (9)
432 11 and 206 [progress in cardiovascular diseases] (13)
433 11 and 207 [reviews in cardiovascular medicine] (1)
434 11 and 208 [revista espanola de cardiologia] (12)
435 11 and 209 [revista portuguesa de cardiologia] (7)
436 11 and 210 [revista portuguesa de cirurgia cardio toracica e vascular] (0)
437 11 and 211 [scandinavian cardiovascular journal] (4)
438 11 and 212 [scandinavian cardiovascular journal supplement] (0)
439 11 and 213 [seminars in thoracic & cardiovascular surgery] (8)
440 11 and 214 [seminars in thoracic & cardiovascular surgery pediatric cardiac surgery annual] (0)
441 11 and 215 [seminars in thrombosis & hemostasis] (4)
442 11 and 216 [seminars in vascular surgery] (0)
443 11 and 217 [shock] (47)
444 11 and 218 [stroke] (90)
445 11 and 219 [techniques in vascular & interventional radiology] (0)
446 11 and 220 [texas heart institute journal] (1)
447 11 and 221 [therapeutic advances in cardiovascular disease] (4)
448 11 and 222 [thoracic & cardiovascular surgeon reports] (0)

449 11 and 223 [thrombosis & haemostasis] (21)
450 11 and 224 [thrombosis research] (31)
451 11 and 225 [topics in stroke rehabilitation] (19)
452 11 and 226 [translational stroke research] (9)
453 11 and 227 [trends in cardiovascular medicine] (5)
454 11 and 228 [turk kardiyoloji dernegi arsivi] (2)
455 11 and 229 [vasa] (11)
456 11 and 230 [vascular] (7)
457 11 and 231 [vascular & endovascular surgery] (7)
458 11 and 232 [vascular health & risk management] (6)
459 11 and 233 [vascular medicine] (7)
460 11 and 234 [vascular pharmacology] (3)
461 11 and 235 [world journal for pediatric & congenital heart surgery] (3)
462 11 and 236 [zhonghua xin xue guan bing za zhi] (10)

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Table 1. Journalology and reporting characteristics of evaluated journals.

Variable		Proportion (*N*)	Lower Limit 95% CI	Upper Limit 95% CI
DOAJ				
	Yes	9.33% (14)	5.57%	15.22%
	No	90.67% (136)	84.77%	94.42%
CONSORT				
	Yes	46.67% (70)	38.74%	54.75%
	No	53.33% (80)	45.24%	61.25%
Any Reporting Guideline				
	Yes	46.67% (70)	38.74%	54.75%
	No	53.33% (80)	45.24%	61.25%
EQUATOR				
	Yes	21.33% (32)	15.44%	28.7%
	No	78.67% (118)	71.29%	84.55%
Instructions on how to use a reporting guideline				
	Yes	20% (30)	14.29%	27.25%
	No	80% (120)	72.74%	85.70%
Register				
	Yes	53.33% (80)	45.24%	61.25%
	No	44.67% (67)	36.82%	52.78%
	Unclear	2% (3)	0.6%	6.09%

N: sample; sample analyzed: 150.

Table 2. Policy and guidance proportions among evaluated journals.

Variable		Proportion (*N*)	Lower Limit 95% CI	Upper Limit 95% CI
Policy or Guidance				
	Yes	50% (75)	41.97%	58.02%
	No	48.6% (73)	40.67%	56.72%
	Unclear	1.33 (2)	0.32%	5.25%
Policy				
	Yes	49.33% (74)	41.32%	57.37%
	No	50.67% (76)	42.62%	58.67%
Guidance				
	Yes	46.67% (70)	38.74%	54.75%
	No	52% (78)	43.93%	59.96%
	Unclear	1.33% (2)	0.32%	5.25%

N: sample; sample analyzed: 150.

Table 3. Descriptions of policy details.

Variable		Proportion (N)	Lower Limit 95% CI	Upper Limit 95% CI
Type of Policy				
	General	95.95% (71)	87.88%	98.72%
	RCTs	4.05% (3)	1.27%	12.11%
Cites ICMJE Statement				
	Yes	6.76% (5)	2.78%	15.5%
	No	93.24% (69)	84.49%	97.21%
Policy Level				
	Encouragement in general without ICMJE	87.84% (65)	77.96%	93.64%
	Mandatory in general without ICMJE	4.05 (3)	1.27%	12.11%
	Only cites the need to cite the ICMJE Statement	4.05 (3)	1.27%	12.11%
	Encouragement in general with ICMJE	2.7 (2)	0.65%	10.47%
	Not reported	1.35 (1)	0.18%	9.36%
Is the policy easily accessible?				
	Yes	100% (74)	-	-
	No	0% (0)	-	-
Does the policy do any mention to IPD data sharing?				
	Yes	4.05 (3)	1.27%	12.11%
	No	95.95 (71)	87.88%	98.72%

N: sample; sample analyzed: 74; ICMJE: International Committee of Medical Journal Editors; IPD: Individual Participant Data.

Table 4. Type of Guidance among type of studies of evaluated journals.

Variable		Proportion (*N*)	Lower Limit 95% CI	Upper Limit 95% CI
Type of Guidance				
	General	88.57% (62)	77.46%	94.28%
	RCTs	8.57% (6)	3.82%	18.10%
	Both (Explicitly RCT and General)	2.85% (2)	0.69%	11.05%

N: sample; *N* analyzed: 70.

Table 5. Proportions of instructions on what should be mentioned in a data-sharing plan among the journals which have data-sharing guidance.

Variable		Proportion (*N*)	Lower Limit 95% CI	Upper Limit 95% CI
Mechanism				
	Yes	95.71% (67)	87.21%	98.65%
	No	4.29% (3)	1.34%	12.78%
Analysis				
	Yes	1.43% (1)	0.19%	9.88%
	No	98.57% (69)	90.11%	99.80%
Who				
	Yes	1.43% (1)	0.19%	9.88%
	No	98.57% (69)	90.11%	99.80%
When				
	Yes	7.14% (5)	2.93%	16.34%
	No	92.86% (65)	83.65%	97.06%
IPD Data Sharing				
	Yes	1.43% (1)	0.19%	9.88%
	No	98.57% (69)	90.11%	99.80%
Materials				
	Yes	88.57% (62)	78.46%	94.28%
	No	11.43% (8)	5.71%	21.53%
Repository				
	Yes	100% (70)	-	-
	No	0% (0)	-	-

N: sample; sample analyzed for all variables: 70; IPD: Individual Participant Data.

Table 6. What materials should be shared accordingly to journal's guidance.

Variable		Proportion (*N*)	Lower Limit 95% CI	Upper Limit 95% CI
IPD Raw				
	Yes	0% (0)	-	-
	No	100% (0)	-	-
IPD Treated				
	Yes	0%	-	-
	No	100%	-	-
IPD General				
	Yes	1.43% (1)	0.19%	9.88%
	No	98.57% (69)	90.11%	99.80%
Data in General				
	Yes	54.29% (38)	42.3%	65.79%
	No	35.71% (25)	25.18%	47.83%
	Unclear	10% (7)	4.75%	19.83%
Protocol				
	Yes	35.71% (25)	25.18%	47.83%
	No	64.29% (45)	52.16%	74.81%
Register				
	Yes	1.43% (1)	0.19%	9.88%
	No	98.57% (69)	90.11%	99.80%
Glossary of Variables				
	Yes	1.43% (1)	0.19%	9.88%
	No	98.57% (69)	90.11%	99.80%
Intervention Details				
	Yes	0% (0)	-	-
	No	100% (70)	-	-
Repository				
	Yes	100% (70)	-	-
	No	0% (0)	-	-

N: sample; sample analyzed: 70; IPD: Individual Participant Data.

Table 7. Frequency of open access model per the presence or not of any mention to data-sharing.

	DOAJ	
Policy or Guidance		
	Yes	No
Yes	5 (3.33%)	70 (46.67%)
No	9 (6%)	64 (42.67%)
Unclear	0 (0%)	2 (1.33%)

DOAJ: Directory of Open Access Journal.

Checklists to Detect Potential Predatory Biomedical Journals: A Systematic Review

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ABSTRACT

Background: The increase in the number of predatory journals puts scholarly communication at risk. In order to guard against publication in predatory journals, authors may use checklists to help detect predatory journals. We believe there are a large number of such checklists yet it is uncertain whether these checklists contain similar content. We conducted a systematic review to identify checklists that help to detect potential predatory journals and examined and compared their content and measurement properties.

Methods: We searched MEDLINE, Embase, PsycINFO, ERIC, Web of Science and Library, and Information Science & Technology Abstracts (January 2012 to November 2018); university library websites (January 2019); and YouTube (January 2019). We identified sources with original checklists used to detect potential predatory journals published in English, French or Portuguese. Checklists were defined as having instructions in point form, bullet form, tabular format or listed items. We excluded checklists or guidance on recognizing "legitimate" or "trustworthy" journals. To assess risk of bias, we adapted five questions from A Checklist for Checklists tool a priori as no formal assessment tool exists for the type of review conducted.

Results: Of 1528 records screened, 93 met our inclusion criteria. The majority of included checklists to identify predatory journals were in English (n = 90, 97%), could be completed in fewer than five minutes (n = 68, 73%), included a mean of 11 items (range = 3 to 64) which were not weighted (n = 91, 98%), did not include qualitative guidance (n = 78, 84%), or quantitative guidance (n = 91, 98%), were not evidence-based (n = 90, 97%) and covered a mean of four of

six thematic categories. Only three met our criteria for being evidence-based, i.e. scored three or more “yes” answers (low risk of bias) on the risk of bias tool.

Conclusion: There is a plethora of published checklists that may overwhelm authors looking to efficiently guard against publishing in predatory journals. The continued development of such checklists may be confusing and of limited benefit. The similarity in checklists could lead to the creation of one evidence-based tool serving authors from all disciplines.

Registration: The project protocol was publicly posted prior to data extraction on the Open Science Framework (http://osf.io/g57tf).

Key Words: Predatory publishing, Predatory journals, Scholarly communication, Systematic review

BACKGROUND

The influx of predatory publishing along with the substantial increase in the number of predatory journals pose a risk to scholarly communication (1,2). Predatory journals often lack an appropriate peer-review process and frequently are not indexed (3), yet authors are required to pay an article processing charge. The lack of quality control, the inability to effectively disseminate research and the lack of transparency compromise the trustworthiness of articles published in these journals. Until recently, no agreed-upon definition of predatory journals existed. However, through a consensus process (4), an international group of researchers, journal editors, funders, policy makers, representatives of academic institutions, and patient partners, developed a definition of predatory journals and publishers. The group recognized that identifying predatory journals and publishers was nuanced; not all predatory journals meet all 'predatory criteria' nor do they meet each criterion at the same level. Thus, in defining predatory journals and publishers, the group identified four main characteristics that could characterize journals or publishers as predatory: "Predatory journals and publishers are entities that prioritize self-interest at the expense of scholarship and are characterized by false or misleading information, deviation from best editorial/publication practices, lack of transparency, and/or use of aggressive and indiscriminate solicitation practices" (4). Lists of suspected predatory journals and publishers are also available, although different criteria for inclusion are used (5).

Various groups have developed checklists to help prospective authors and/or editors identify potential predatory journals; these are different from efforts, such as "Think. Check. Submit." to identify legitimate journals. Anecdotally, we have recently noticed a steep rise in the number of checklists developed specifically to identify predatory journals, although to our

knowledge this has not been quantified previously. Further, we are unaware of any research looking at the uptake of these checklists. On the one hand, the development of these checklists – practical tools to help detect potential predatory journals – may lead to a substantial decrease in submissions to these journals. On the other hand, large numbers of checklists with varying content may confuse authors, and possibly make it more difficult for them to choose any one checklist, if any at all, as suggested by the choice overload hypothesis (6). That is, the abundance of conflicting information could result in users not consulting any checklists. Additionally, the discrepancies between checklists could impact the credibility of each one. Thus, these efforts to reduce the number of submissions to predatory journals will be lost. Therefore, we performed a systematic review of peer reviewed and grey literature that include checklists to help detect potential predatory journals in order to identify the number of published checklists and to examine and compare their content and measurement properties.

METHODS

We followed standard procedures for systematic reviews and reported results according to Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines (7). The project protocol was publicly posted prior to data extraction on the Open Science Framework (http://osf.io/g57tf).

Data Sources and Searches

An experienced medical information specialist (BS) developed and tested the search strategy using an iterative process in consultation with the review team. The strategy was peer reviewed

by another senior information specialist prior to execution using the Peer Review of Electronic Search Strategies (PRESS) Checklist (8) (see Additional file 1).

We searched multiple databases with no language restrictions. Using the OVID platform, we searched Ovid MEDLINE® ALL (including in-process and epub-ahead-of-print records), Embase Classic + Embase, PsycINFO and ERIC. We also searched Web of Science and the Library, Information Science and Technology Abstracts (LISTA) database (Ebsco platform). The LISTA search was performed on November 16, 2018 and the Ovid and Web of Science searches were performed on November 19, 2018. Retrieval was limited to the publication dates 2012 to the present. We used 2012 as a cut-off since data about predatory journals were first collected in 2010, (9) and became part of public discourse in 2012 (10). The search strategy for the Ovid databases is included in Additional file 2.

In order to be extensive in our search for checklists that identify potential predatory journals, we identified and then searched two relevant sources of grey literature, based on our shared experiences in this field of research: university library websites and YouTube. Neither search was restricted by language. We used the Shanghai Academic Rankings of World Universities (http://www.shanghairanking.com/ARWU-Statistics-2018.html) to identify university library websites of the top 10 universities in each of the four world regions (Americas, Europe, Asia / Oceania, Africa). We chose this website because it easily split the world into four regions and we saw this as an equitable way to identify institutions and their libraries. As our author group is based in Canada, we wanted to highlight the universities in our region and therefore identified the library websites of Canada's most research-intensive universities (U15) (search date January 18, 2019) and searched their library websites. We also searched YouTube for videos that contained checklists (search date January 6, 2019). We limited our YouTube

search to the top 50 results filtered by “relevance” and used a private browser window. Detailed methods of these searches are available on the Open Science Framework (http://osf.io/g57tf).

Eligibility criteria

Inclusion criteria

Our search for studies was not restricted by language, however, for reasons of feasibility, we included studies and/or original checklists developed or published in English, French or Portuguese (languages spoken by our research team). We defined checklist as a tool whose purpose is to detect a potential predatory journal and the instructions are in point form / bullet form / tabular format / listed items. To qualify as an original checklist, the items had to have been identified and/or developed by the study authors or include a novel combination of items from multiple sources, or an adaptation of another checklist plus items added by the study authors. We included studies that discussed the development of an original checklist. When a study referenced a checklist, but did not describe the development of the checklist, we searched for the paper that discussed the development of the original checklist and included that paper.

Exclusion criteria

Checklists were not considered original if items were hand-picked from one other source; for example, if authors identified the five most salient points from an already existing checklist.

We did not include lists or guidance on recognizing a "legitimate" or "trustworthy" journal. We stipulated this exclusion criterion since our focus was on tools that specifically identify predatory journals, not tools that help to recognize legitimate journals.

Study selection

Following de-duplication of the identified titles, we screened records using the online systematic review software program Distiller Systematic Review (DSR) (Evidence Partners Inc., Ottawa, Canada). For each stage of screening, data extraction and risk of bias assessment, we pilot tested a 10% sample of records among five to six reviewers. Screening was performed in two stages: Stage 1: title and abstract; Stage 2: full-text screening (see Figure 1). Both stages were completed by two reviewers independently and in duplicate. At both stages, discrepancies were resolved either through consensus or third party adjudication.

Data Extraction and Risk of Bias Assessment

For each eligible study, two reviewers independently extracted relevant data into DSR and a third reviewer resolved any conflicts. The extracted data items were as follows: 1- checklist name, 2- number of items in the checklist, 3- whether the items were weighted, 4- the number of thematic categories covered by the checklist (six-item list developed by Cobey et al. (3)), 5- publication details (name of publication, author and date of publication), 6- approximate time to complete checklist (reviewers used a timer to emulate the process that a user would go through to use the checklist and recorded the time as 0-5 minutes, 6-10 minutes, or more than 10

minutes), 7- language of the checklist, 8- whether the checklist was translated and into what language(s), 9- methods used to develop the checklist (details on data collection, if any), 10- whether there was qualitative guidance (instructions on how to use the checklist and what to do with the results) and/or 11- quantitative guidance (instructions on summing the results or quantitatively assessing the results to inform a decision). The list of extracted data items can be found on the Open Science Framework (https://osf.io/na756/).

In assessing checklists identified via YouTube, we extracted only data items that were presented visually. Any item or explanation that was delivered by audio only was not included in our assessment. We used the visual presentation of the item to be a sign that the item was formally included in the checklist. For example, if presenters only talked about a checklist item but did not have it on a slide in the video or in a format that could be seen by those watching the video, we did not extract this data.

To assess risk of bias, we developed an a priori list of five questions for the purpose of this review, adapted from A Checklist for Checklists tool (11), and principles of internal and external validity (12). The creation of a novel tool to assess risk of bias was necessary since there is no appropriate formal assessment tool that exists for the type of review we conducted. Our author group looked over the three areas identified in the Checklist for Checklists tool (Development, Drafting and Validation). Based on extensive experience working with reporting guidelines (DM), which are checklists, we chose a feasible number of items from each of the three categories to be used in our novel tool. We pilot tested the items among our author group to ensure that all categories were captured adequately, and that the tool could be used feasibly.

We used the results of this assessment to determine whether the checklist was evidence-based. We assigned each of the five criteria (listed below) a judgement of "yes" (i.e. low risk of bias), "no" (i.e. high risk of bias) or "can't tell" (i.e. unclear risk of bias) (see coding manual with instructions for assessment to determine risk of bias ratings: https://osf.io/sp4vx/). If the checklist scored three or more "yes" answers on the questions below, assigning the checklist an overall low risk of bias, we considered it evidence-based. We made this determination based on the notion that a low risk of bias indicates that there is a low risk of systematic error across results. Two reviewers independently assessed data quality in DSR and discrepancies were resolved through discussion. A third reviewer was called to resolve any remaining conflicts.

The five criteria, adapted from the Checklist for Checklists tool (11), used to assess risk of bias in this review were as follows:

Did the developers of the checklist represent more than one stakeholder group (e.g. researchers, academic librarians, publishers)?
Did the developers report gathering any data for the creation of the checklist (i.e. conduct a study on potential predatory journals, carry out a systematic review, collect anecdotal data)?
Does the checklist meet at least one of the following criteria: 1- Has title that reflects its objectives; 2- Fits on one page; 3- Each item on the checklist is one sentence?
Was the checklist pilot-tested or trialed with front-line users (e.g. researchers, students, academic librarians)?
Did the authors report how many criteria in the checklist a journal must meet in order to be considered predatory?

In assessing websites, we used a “two-click rule” to locate information. Once on the checklist website, if we did not find the information within two mouse clicks, we concluded no information was available.

Data Synthesis and Analysis

We examined the checklists qualitatively and conducted qualitative comparisons of the items. We compared the items in the included checklists to gauge their agreement on content by item and overall. We summarized the checklists in table format to facilitate inspection and discussion of findings. Frequencies and percentages were used to present characteristics of the checklists. We used the list developed by Shamseer et al. (13) as the reference checklist and compared our results to this list. We chose this as the reference list because of the rigorous empirical data generated by authors to ascertain characteristics of potential predatory journals.

RESULTS

Deviations from our protocol

We refined our definition of an original checklist to exclude checklists that were comprised of items taken solely from another checklist. Checklists made up of items taken from more than one source were considered original even when the developers did not create the checklist items themselves. For reasons of feasibility, we did not search the reference lists in these checklists to identify further potentially relevant studies.

To screen the titles and abstracts, we had anticipated using the liberal accelerated method where only one reviewer is required to include citations for further assessment at full-text screening and two reviewers are needed to exclude a citation (14). Instead, we used the traditional screening approach: we had two reviewers screen records independently and in duplicate. We changed our screening methods because it became feasible to use the traditional screening approach, which also reduced the required number of full-text articles to be ordered.

After completing data collection, we recognized that checklists were being published in discipline-specific journals, within biomedicine. We wanted to determine what disciplines were represented and in what proportion. We conducted a scan of the journals and used an evolving list of disciplines to assign to the list of journals, i.e. we added disciplines to the evolving list as we came across them.

Study selection

Following the screening of 1529 records, we identified 93 original checklists to be included in our study (see full details in Figure 1: PRISMA flow diagram).

Checklist characteristics

We identified 53 checklists identified through our search of electronic databases. The numbers of checklists identified increased over time: one each in 2012 (10), 2013 (15), rising to 16 in 2017 (13,16–30) and 12 in 2018 (31–42). We identified 30 original checklists (1, 43–71) from university library websites. More checklists were published in more recent years (2017 = 4 (45–48); 2018 = 7 (49–55); 2019 = 11 (56–66); five checklists listed no publication date). We identified 10 more checklists from YouTube (72–81) that included one uploaded in 2015 (72), six in 2017 (73–78) and three in 2018 (79–81). See Table 1 for full checklist characteristics.

Language and translation

Almost all checklists were published in English (n = 90, 97%), and the remaining checklists in French (n = 3, 10%) (49, 52, 61). Two additional English checklists identified through university library websites were translated into French (55, 67) and one was translated into Hebrew (69).

Approximate time for user to complete checklist, number of items per checklist and weighting

Most checklists could be completed within five minutes (n= 68, 73%); 17 checklists (18%) could be completed in six to 10 minutes (16, 17, 19, 21, 32, 34, 39–42, 53–55, 62, 72, 82, 83) and eight checklists (9%) took more than 10 minutes to complete (10, 20, 46, 49, 66, 76, 84, 85).

Checklists contained a mean of 11 items each, and a range of between three and 64 items. Items were weighted in two checklists (55,85).

Qualitative and quantitative guidance

Qualitative guidance on how to use the results of checklists was provided on 15 checklists (16%) (21, 31, 38, 47, 50, 51, 55, 59, 65, 67, 68, 82, 85–87), and quantitative guidance was provided on two checklists (55,85), i.e. prescribing a set number of criteria that would identify the journal or publisher as predatory.

Methods used to develop checklists

In order to develop the checklists, authors noted using analysis by specialists (46), information from already existing checklists (84, 88, 89), using existing literature on predatory journals to pick the most salient features to create a new checklist (31, 42, 86), developing checklists after empirical study (13, 27, 39, 85) or after personal experiences (15).

Risk of bias assessment

Among all 93 checklists, there were three (3%) assessed as evidence-based (27,85,86) (see Table 2 for detailed risk of bias assessment results including whether a checklist was determined to be evidence-based, i.e. rated as low risk of bias for at least three of the criteria).

Results for risk of bias criteria

Criterion #1: Representation of more than one stakeholder group in checklist development

For the majority of checklists (n = 88, 94%), it was unclear whether there was representation of more than one stakeholder group in the checklist development process (unclear risk of bias). The remaining five checklists reported the inclusion of more than one stakeholder group (low risk of bias) (22, 46, 55, 59, 86).

Criterion #2: Authors reported gathering data to inform checklist development

In most studies (n = 55, 59%) there was no mention of data gathering for checklist development (unclear risk of bias); in 26 cases (28%), one or two citations were noted next to checklist items, with no other explanation of item development or relevance (high risk of bias) (18, 19, 22–24, 30, 32, 33, 35, 36, 40–42, 45, 53, 84, 90–99). Twelve records (13%) included a description of authors gathering data to develop a checklist for this criterion (low risk of bias) (13, 15, 26, 31, 37–39, 43, 50, 85, 86, 100).

Criterion #3: At least one of the following: Title that reflected checklist objective; Checklist fits on one page; Items were one sentence long

Most checklists were assessed as low risk of bias on this criterion, with 81 of the checklists (87%) meeting at least one of the noted criteria (relevant title, fits on one page, items one sentence long).

Criterion #4: Authors reported pilot testing the checklist

In the majority of studies (n = 91, 98%), authors did not report pilot testing during the checklist development stages (unclear risk of bias).

Criterion #5: Checklist instructions included a threshold number of criteria to be met in order to be considered predatory

The majority of studies (n = 90, 97%), did not include a threshold number of criteria to be met in order for the journal or publisher to be considered predatory (high risk of bias).

Assessment of the thematic content of the included checklists

We found checklists covered the six thematic categories, as identified by Cobey et al., (3) as follows (see Table 3 for thematic categories and descriptions of categories):

Journal operations: 85 checklists (91%) assessed information on the journal's operations.

Assessment of previously published articles: 40 checklists (43%) included questions on the quality of articles published in the journal in question.

Editorial and peer review process: 77 checklists (83%) included questions on the editorial and peer review process.

Communication: 71 checklists (76%) included an assessment of the manners in which communication is set up between the journal / publisher and the author.

Article processing charges: 61 checklists (66%) included an assessment of information on article processing charges.

Dissemination, indexing and archiving: 62 checklists (67%) included suggested ways in which submitting authors should check for information on dissemination, indexing and archiving procedures of the journal and publisher.

Across all 93 checklists, a mean of four out of the six thematic categories was covered, demonstrating similar themes covered by all checklists. Twenty percent of checklists (n = 19), including the reference checklist, covered all six categories. (10, 13, 16, 19, 20, 26, 32, 34, 40, 42, 46, 53, 55, 62, 66, 67, 76, 83, 84) Assessment of previously published articles was the category least often included in a checklist (n = 40, 43%), and a mention of the journal operations was the category most often included in a checklist (n = 85, 91%).

Discipline-specific journals

Of the checklists published in academic journals, 10 (22%) were published in nursing journals (25, 31, 35, 38, 41, 88, 89, 92, 95, 101) , eight (18%) were published in journals related to general medicine (13, 16, 20, 22, 23, 34, 96, 100), four (9%) in emergency medicine journals (29, 36, 86, 94), four (9%) in information science journals (19, 30, 40, 82), four (9%) in psychiatry and behavioural science journals (18, 24, 90, 102). The remaining checklists were published in a variety of other discipline-specific journals, within the field of biomedicine, with three or fewer checklists per discipline (e.g. specialty medicine, paediatric medicine, general medicine and surgery, medical education, and dentistry).

DISCUSSION

Many authors have developed checklists specifically designed to identify predatory journals; the number of checklists developed has increased since 2012, with the majority of checklists published since 2015 (n = 81, 87%). Comparing the 93 identified checklists to the reference checklist, we observed that on average, the content of the checklist items were similar, including the categories or domains covered by the checklist; all checklists were also similar on the following: time to complete the checklist, number of items in the checklist (this number does vary considerably, however the average number of items is more consistent with the reference list), and lack of qualitative and quantitative guidance on completing the checklists. Furthermore, only 3% of checklists (n = 3) were deemed evidence-based, few checklists weighted any items (n = 2, 2%) and few checklists were developed through empirical study (n = 4, 4%). Of note, one of the checklists (33) was in a paper, in a journal that is potential predatory.

Summary of evidence

In total, we identified 93 checklists to help identify predatory journals and/or publishers. A search of electronic databases resulted in 53 original checklists, a search of library websites of top universities resulted in 30 original checklists and a filtered and limited search of YouTube returned 10 original checklists. Overall, checklists could be completed quickly, covered similar categories of topics and were lacking in guidance that would help a user determine if the journal or publisher was indeed predatory.

Strengths and Limitations

We used a rigorous systematic review process to conduct the study. We also searched multiple data sources including published literature, university library websites, globally, and YouTube. We were limited by the languages of checklists we could assess (English, French and Portuguese). However, the majority of academic literature is published in English (103). Thus, we are confident that we captured the majority of checklists or at least a representative sample. For reasons of feasibility, we were not able to capture all checklists available.

Our reference checklist did not qualify as evidence-based when using our predetermined criteria to assess risk of bias, which could be because the list of characteristics in the reference list was not initially intended as a checklist per se. However, the purpose of the reference checklist was to serve as a reference point for readers, regardless of its qualification as evidence-based or not.

Creating a useable checklist tool requires attention not only to the development of the content of items but also to other details, such as pilot testing and making the items succinct, as identified in our risk of bias criteria. This perhaps was not attended to by Shamseer et al. because of the difference in the intended purpose of their list.

Our risk of bias tool was created based on other existing tools and developed through expertise of the authors. Although useful for the purpose of this exercise, the tool remains based on our expert judgement although it does include elements of scientific principles.

We noted that the "Think. Check. Submit." checklist (104) was referenced in many publications and we believe it is used often as guidance for authors to identify presumed legitimate journals. However, we did not include this checklist in our study because we excluded checklists that help to identify presumed legitimate publications. Instead, our specific focus was on checklists that help to detect potential predatory journals.

CONCLUSION

In our search for checklists to help authors identify potential predatory journals, we found great similarity across checklist media and across journal disciplines in which the checklists were published.

Although many of the checklists were published in field-specific journals and / or addressed a specific audience, the content of the lists did not differ much. This could be reflective of the idea that checklist developers are all looking to identify the same items. Only a small proportion of the records included the empirical methods used to develop the checklists, and only a few checklists were deemed evidence-based according to our criteria. We noted that checklists with more items did not necessarily mean that it took longer to complete; this speaks to the level of complexity of some checklists versus others. Importantly, very few authors offered concrete guidance on using the checklists or offered any threshold that would guide authors to identify definitively if the journal was predatory. The lack of checklists providing threshold values could be due to the fact that a definition of predatory journals did not exist until this year (3,4) . We identify a threshold value as important for the checklist's usability. Without a recommended or suggested threshold value, checklist users may not feel confident to make a decision on submitting or not submitting to a journal. We are recommending a threshold value as a way for users to actively engage with the checklist and make it a practical tool. The provision of detailed requirements that would qualify a journal as predatory therefore would have been a challenge.

With this large number of checklists in circulation, and the lack of explicit and exacting guidelines to identify predatory publications, are authors at continued risk of publishing in journals that do not follow best publication practices? We see some value in discipline-specific

lists for the purpose of more effective dissemination. However, this needs to be balanced against the risk of confusing researchers and overloading them with choice (6). If most of the domains in the identified checklists are similar across disciplines, would a single list, relevant in all disciplines, result in less confusion and maximize dissemination and enhance implementation?

In our study, we found no checklist to be optimal. Currently, we would caution against any further development of checklists and instead provide the following as guidance to authors: Look for a checklist that:

Provides a threshold value for criteria to assess potential predatory journals, e.g. if the journal contains these three checklist items then we recommend avoiding submission;
Has been developed using rigorous evidence, i.e. empirical evidence that is described or referenced in the publication.

We note that only one checklist (85) out of the 93 we assessed fulfills the above criteria. There may be other factors (length of time to complete, number of categories covered by the checklist, ease of access, ease of use or other) that may influence usability of the checklist.

Using an evidence-based tool with a clear threshold for identifying potential predatory journals may help reduce the burden of research waste occurring as a result of the proliferation of predatory publications.

List of Abbreviations

DSR	Distiller Systematic Review
LISTA	Library, Information Science and Technology Abstracts
PRESS	Peer Review of Electronic Search Strategies
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses

DECLARATIONS

Ethics approval and consent to participate

Ethical approval was not required as this study did not involve human participants.

Consent to publish

Not applicable.

Availability of data and materials

All data are available upon request. Supplementary material is available on the Open Science Framework (http://osf.io/g57tf).

Competing Interests

The authors declare that they have no competing interests

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The funders had no involvement in the study design, in the collection, analysis or interpretation of the data, in the writing of the report, or in the decision to submit the paper for publication. All authors confirm their work is independent from the funders. All authors, external and internal, had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Authors' Contributions (CReDiT: https://www.casrai.org/credit.html):

Conceptualization: SC and DM

Methodology: BS

Project administration: SC

Investigation (data collection): SC, LH, DBR, JP, NA, MW

Writing – Original Draft: SC

Writing – Review & Editing: All authors read and approved the final manuscript

Supervision: DM, ML

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Appendix

Additional File 1: Peer Review of Electronic Search Strategies (PRESS) Checklist; Word document (.docx)

PRESS Guideline 2015— Search Submission & Peer Review Assessment

Reference: McGowan J, Sampson M, Salzwedel DM, Cogo E, Foerster V, Lefebvre C. PRESS Peer Review of Electronic Search Strategies: 2015 guideline statement. J Clin Epidemiol 2016;75:40-6. Available: http://www.jclinepi.com/article/S0895-4356(16)00058-5/pdf.

Search submission: This section to be filled in by the searcher

Searcher: Becky Skidmore Email: bskidmore@rogers.com

Date submitted: 7 Nov 2018 Date requested by: 10 Nov 2018 AM

Systematic Review Title

Systematic Review of Checklists to Detect Potential Predatory Biomedical Journals and Publishers

This search strategy is …

X	My PRIMARY (core) database strategy — First time submitting a strategy for search
	My PRIMARY (core) strategy — Follow-up review NOT the first time submitting a strategy for search question and database. If this is a response to peer review, itemize the
	SECONDARY search strategy— First time submitting a strategy for search question and

	SECONDARY search strategy — NOT the first time submitting a strategy for search question and database. If

Database (e.g., MEDLINE, CINAHL)

MEDLINE

Interface (e.g., Ovid, EbscoHost…)

Ovid

Research Question (Describe the purpose of the search) (mandatory)

PICO Format Outline the PICOs for your question — i.e., Patient, Intervention, Comparison, Outcome, and Study Design — as applicable

P	Predatory Journals
I / Exposure	Checklists to detect a potentially predatory journal or publisher
C	
O	

S	

Inclusion Criteria (List criteria such as age groups, study designs, etc., to be included) (optional)
Publication years 2012-current

Exclusion Criteria (List criteria such as study designs, date limits, etc., to be excluded) (optional)
Opinion pieces and editorials

Was a search filter applied? No

If YES, which one(s) (e.g., Cochrane RCT filter, PubMed Clinical Queries filter)? Provide the source if this is a published filter. (mandatory if YES to previous question — textbox)

Notes or comments you feel would be useful for the peer reviewer (optional)
It is possible info will not be restricted to biomedical field so terminology and choice of databases have been adjusted for this possible broader scope (e.g., also including library science databases, Web of Science)

Have shown Ovid multifile search instead of just MEDLINE

“Series” was suggested as a possible synonym for checklists but was tested and discarded

Much of the vocabulary pertaining to predatory journals has been previously PRESSed (dark and rogue have been added)

There will be an extensive follow-up grey literature search of library web sites, YouTube, etc.

Volume in published literature is very small – one option is to only search on the population (predatory journals) for the electronic database searches (684 records after removing duplicates in Ovid). Thoughts?

Please copy and paste your search strategy here, exactly as run, including the number of hits per line. (mandatory)

Database: Embase Classic+Embase <1947 to 2018 November 06>, Ovid MEDLINE(R) ALL <1946 to November 06, 2018>, PsycINFO <1806 to October Week 5 2018>, ERIC <1965 to August 2018>

Search Strategy:

---

1 (predator* adj3 edit*).tw,kw,kf. (29)

2 (predator* adj3 journal*).tw,kw,kf. (393)

3 (predator* adj3 periodical?).tw,kw,kf. (6)

4 (predator* adj3 publication?).tw,kw,kf. (48)

5 (predator* adj3 publish*).tw,kw,kf. (373)

6 (bogus adj3 edit*).tw,kw,kf. (2)

7 (bogus adj3 journal*).tw,kw,kf. (7)

8 (bogus adj3 periodical?).tw,kw,kf. (0)

9 (bogus adj3 publication?).tw,kw,kf. (0)

10 (bogus adj3 publish*).tw,kw,kf. (1)

11 (dark adj3 edit*).tw,kw,kf. (32)

12 (dark adj3 journal*).tw,kw,kf. (9)

13 (dark adj3 periodical?).tw,kw,kf. (4)

14 (dark adj3 publication?).tw,kw,kf. (2)

15 (dark adj3 publish*).tw,kw,kf. (19)

16 (decepti* adj3 edit*).tw,kw,kf. (21)

17 (decepti* adj3 journal*).tw,kw,kf. (15)

18 (decepti* adj3 periodical?).tw,kw,kf. (0)

19 (decepti* adj3 publication?).tw,kw,kf. (3)

20 (decepti* adj3 publish*).tw,kw,kf. (20)

21 (disreput* adj3 edit*).tw,kw,kf. (0)

22 (disreput* adj3 journal*).tw,kw,kf. (3)

23 (disreput* adj3 periodical?).tw,kw,kf. (0)

24 (disreput* adj3 publication?).tw,kw,kf. (3)

25 (disreput* adj3 publish*).tw,kw,kf. (0)

26 (distrust* adj3 edit*).tw,kw,kf. (1)

27 (distrust* adj3 journal*).tw,kw,kf. (2)

28 (distrust* adj3 periodical?).tw,kw,kf. (0)

29 (distrust* adj3 publication?).tw,kw,kf. (0)

30 (distrust* adj3 publish*).tw,kw,kf. (5)

31 (exploit* adj3 edit*).tw,kw,kf. (107)

32 (exploit* adj3 journal*).tw,kw,kf. (29)

33 (exploit* adj3 periodical?).tw,kw,kf. (1)

34 (exploit* adj3 publication?).tw,kw,kf. (37)

35 (exploit* adj3 publish*).tw,kw,kf. (93)

36 (fake? adj3 edit*).tw,kw,kf. (11)

37 (fake? adj3 journal*).tw,kw,kf. (36)

38 (fake? adj3 periodical?).tw,kw,kf. (0)

39 (fake? adj3 publication?).tw,kw,kf. (4)

40 (fake? adj3 publish*).tw,kw,kf. (20)

41 (hoax$2 adj3 edit*).tw,kw,kf. (1)

42 (hoax$2 adj3 journal*).tw,kw,kf. (5)

43 (hoax$2 adj3 periodical?).tw,kw,kf. (0)

44 (hoax$2 adj3 publication?).tw,kw,kf. (2)

45 (hoax$2 adj3 publish*).tw,kw,kf. (4)

46 (illegitim* adj3 edit*).tw,kw,kf. (3)

47 (illegitim* adj3 journal*).tw,kw,kf. (19)

48 (illegitim* adj3 periodical?).tw,kw,kf. (0)

49 (illegitim* adj3 publication?).tw,kw,kf. (6)

50 (illegitim* adj3 publish*).tw,kw,kf. (12)

51 (mislead* adj3 edit*).tw,kw,kf. (42)

52 (mislead* adj3 journal*).tw,kw,kf. (36)

53 (mislead* adj periodical?).tw,kw,kf. (0)

54 (mislead* adj3 publication?).tw,kw,kf. (57)

55 (mislead* adj publish*).tw,kw,kf. (5)

56 (non-legitim* adj3 edit*).tw,kw,kf. (0)

57 (non-legitim* adj3 journal*).tw,kw,kf. (0)

58 (non-legitim* adj3 periodical?).tw,kw,kf. (0)

59 (non-legitim* adj3 publication?).tw,kw,kf. (0)

60 (non-legitim* adj3 publish*).tw,kw,kf. (0)

61 (questionabl* adj3 edit*).tw,kw,kf. (24)

62 (questionabl* adj3 journal*).tw,kw,kf. (38)

63 (quesionabl* adj3 periodical?).tw,kw,kf. (0)

64 (questionabl* adj3 publication?).tw,kw,kf. (44)

65 (questionabl* adj3 publish*).tw,kw,kf. (48)

66 (racket? adj3 edit*).tw,kw,kf. (0)

67 (racket? adj3 journal*).tw,kw,kf. (1)

68 (racket? adj3 periodical?).tw,kw,kf. (0)

69 (racket? adj3 publication?).tw,kw,kf. (0)

70 (racket? adj3 publish*).tw,kw,kf. (0)

71 (rogue adj3 edit*).tw,kw,kf. (4)

72 (rogue adj3 journal*).tw,kw,kf. (2)

73 (rogue adj3 periodical?).tw,kw,kf. (0)

74 (rogue adj3 publication?).tw,kw,kf. (0)

75 (rogue adj3 publish*).tw,kw,kf. (4)

76 (scam* adj3 edit*).tw,kw,kf. (3)

77 (scam* adj3 journal*).tw,kw,kf. (9)

78 (scam* adj3 periodical?).tw,kw,kf. (0)

79 (scam* adj3 publication?).tw,kw,kf. (0)

80 (scam* adj3 publish*).tw,kw,kf. (5)

81 (sham adj3 edit*).tw,kw,kf. (1)

82 (sham adj3 journal*).tw,kw,kf. (9)

83 (sham adj3 periodical?).tw,kw,kf. (0)

84 (sham adj3 publication?).tw,kw,kf. (1)

85 (sham adj3 publish*).tw,kw,kf. (50)

86 (spam* adj3 edit*).tw,kw,kf. (1)

87 (spam* adj3 journal*).tw,kw,kf. (4)

88 (spam* adj3 periodical?).tw,kw,kf. (0)

89 (spam* adj3 publication?).tw,kw,kf. (2)

90 (spam* adj3 publish*).tw,kw,kf. (5)

91 (unethic* adj3 edit*).tw,kw,kf. (21)

92 (unethic* adj3 journal*).tw,kw,kf. (22)

93 (unethic* adj3 periodical?).tw,kw,kf. (0)

94 (unethic* adj3 publication?).tw,kw,kf. (52)

95 (unethic* adj3 publish*).tw,kw,kf. (51)

96 (unprofessional* adj3 edit*).tw,kw,kf. (1)

97 (unprofessional* adj3 journal*).tw,kw,kf. (4)

98 (unprofessional* adj3 periodical*).tw,kw,kf. (0)

99 (unprofessional* adj3 publication?).tw,kw,kf. (3)

100 (unprofessional* adj3 publish*).tw,kw,kf. (1)

101 (untrust* adj3 edit*).tw,kw,kf. (0)

102 (untrust* adj3 journal*).tw,kw,kf. (0)

103 (untrust* adj3 periodical?).tw,kw,kf. (0)

104 (untrust* adj3 publication?).tw,kw,kf. (1)

105 (untrust* adj3 publish*).tw,kw,kf. (2)

106 pseudo-journal*.tw,kw,kf. (13)

107 pseudo-periodical*.tw,kw,kf. (5)

108 pseudo-publish*.tw,kw,kf. (2)

109 Beall* list.tw,kw,kf. (44)

110 or/1-109 (1553)

111 limit 110 to yr="2012-current" (1101)

112 Checklist/ use emczd,medall (24630)

113 Check Lists/ use eric (6639)

114 Editorial Policies/ use medall (7197)

115 guideline.pt. (16004)

116 Guidelines/ use eric (23366)

117 Guides/ use eric (8271)

118 exp Journalism/st use medall (998)

119 Open Access Publishing/st use medall (36)

120 exp Peer Review/st use medall (2244)

121 Publishing/st use medall (5272)

122 checklist*.tw,kw,kf. (117991)

123 check list*.tw,kw,kf. (19096)

124 guide*.tw,kw,kf. (1713265)

125 guidance*.tw,kw,kf. (319738)

126 criteria.tw,kw,kf. (1516630)

127 criterion.tw,kw,kf. (228194)

128 (tool or tools).tw,kw,kf. (1634450)

129 (instrument or instruments).tw,kw,kf. (564019)

130 algorithm?.tw,kw,kf. (504760)

131 instruction?.tw,kf,kw. (545248)

132 (inventory or inventories).tw,kf,kw. (308435)

133 (list or lists or listing or listings).tw,kf,kw. (461420)

134 primer?.tw,kw,kf. (204194)

135 or/112-134 (CHECKLISTS) (6958828)

136 111 and 135 (PREDATORY JNL CHECKLISTS) (341)

137 (comment or editorial or news or newspaper article).pt. (1850264)

138 136 not 137 (OPINION PIECES REMOVED) (286)

139 remove duplicates from 138 (206)

****

Peer review assessment: this section to be filled in by the reviewer

Reviewer: Kaitryn Campbell Email: kcamlolo668@gmail.com Date completed: 10 Nov 2018

Do you wish to be acknowledged? (If yes, the review team will be advised to add an acknowledgement to any publications related to this work). No – unless your organization requires it

The suggested acknowledgement is " We thank Xxxxx Yyyyyy, MLIS, AHIP (xxxxx Health Sciences Library, University of xxxxxx) for peer review of the MEDLINE search strategy." (please edit to indicate your name, postnomials and institutional affiliation as you would like them presented).

1. TRANSLATION

A ---No revisions	X
B --- Revision(s) suggested	
C --- Revision(s) required	

If "B" or "C," please provide an explanation or example:

2. BOOLEAN AND PROXIMITY OPERATORS

A ---No revisions	X
B --- Revision(s) suggested	
C --- Revision(s) required	

If "B" or "C," please provide an explanation or example:

3. SUBJECT HEADINGS

A ---No revisions	X
B --- Revision(s) suggested	
C --- Revision(s) required	

If "B" or "C," please provide an explanation or example:

4. TEXT WORD SEARCHING

A ---No revisions	X
B --- Revision(s)suggested	
C --- Revision(s) required	

If "B" or "C," please provide an explanation or example:

5. SPELLING, SYNTAX, AND LINE NUMBERS

A ---No revisions	X
B --- Revision(s)suggested	
C --- Revision(s) required	

If "B" or "C," please provide an explanation or example:

6. LIMITS AND FILTERS

A ---No revisions	X
B --- Revision(s) suggested	
C --- Revision(s) required	

If "B" or "C," please provide an explanation or example:

OVERALL EVALUATION (Note: If one or more "revision required" is noted above, the response below must be "revisions required".)

A ---No revisions	X
B --- Revision(s) suggested	
C --- Revision(s) required	

Additional comments:

Solidly done. No errors or omissions found. Re: including just the "predatory journals" concept alone as the strategy for the bibliographic database searching, this seems like a strong option for 2 reasons: 1) limited retrieval numbers; 2) I have some experience doing "checklist" searches and found the description of these types of items can be extremely variable. My personal preference would be to leave the checklist concept out.

Additional File 2: Search strategy for the Ovid database; Word document (.docx)

Ovid Multifile

Database: Embase Classic+Embase <1947 to 2018 November 19>, Ovid MEDLINE(R) ALL <1946 to November 19, 2018>, PsycINFO <1806 to November Week 2 2018>, ERIC <1965 to October 2018>

Search Strategy:

---

1 (predator* adj3 edit*).tw,kw,kf. (29)

2 (predator* adj3 journal*).tw,kw,kf. (397)

3 (predator* adj3 periodical?).tw,kw,kf. (6)

4 (predator* adj3 publication?).tw,kw,kf. (49)

5 (predator* adj3 publish*).tw,kw,kf. (379)

6 (bogus adj3 edit*).tw,kw,kf. (2)

7 (bogus adj3 journal*).tw,kw,kf. (7)

8 (bogus adj3 periodical?).tw,kw,kf. (0)

9 (bogus adj3 publication?).tw,kw,kf. (0)

10 (bogus adj3 publish*).tw,kw,kf. (1)

11 (dark adj3 edit*).tw,kw,kf. (32)

12 (dark adj3 journal*).tw,kw,kf. (9)

13 (dark adj3 periodical?).tw,kw,kf. (4)

14 (dark adj3 publication?).tw,kw,kf. (2)

15 (dark adj3 publish*).tw,kw,kf. (19)

16 (decepti* adj3 edit*).tw,kw,kf. (21)

17 (decepti* adj3 journal*).tw,kw,kf. (15)

18 (decepti* adj3 periodical?).tw,kw,kf. (0)

19 (decepti* adj3 publication?).tw,kw,kf. (3)

20 (decepti* adj3 publish*).tw,kw,kf. (20)

21 (disreput* adj3 edit*).tw,kw,kf. (0)

22 (disreput* adj3 journal*).tw,kw,kf. (3)

23 (disreput* adj3 periodical?).tw,kw,kf. (0)

24 (disreput* adj3 publication?).tw,kw,kf. (3)

25 (disreput* adj3 publish*).tw,kw,kf. (0)

26 (distrust* adj3 edit*).tw,kw,kf. (1)

27 (distrust* adj3 journal*).tw,kw,kf. (2)

28 (distrust* adj3 periodical?).tw,kw,kf. (0)

29 (distrust* adj3 publication?).tw,kw,kf. (0)

30 (distrust* adj3 publish*).tw,kw,kf. (5)

31 (exploit* adj3 edit*).tw,kw,kf. (107)

32 (exploit* adj3 journal*).tw,kw,kf. (29)

33 (exploit* adj3 periodical?).tw,kw,kf. (1)

34 (exploit* adj3 publication?).tw,kw,kf. (37)

35 (exploit* adj3 publish*).tw,kw,kf. (96)

36 (fake? adj3 edit*).tw,kw,kf. (11)

37 (fake? adj3 journal*).tw,kw,kf. (37)

38 (fake? adj3 periodical?).tw,kw,kf. (0)

39 (fake? adj3 publication?).tw,kw,kf. (4)

40 (fake? adj3 publish*).tw,kw,kf. (20)

41 (hoax$2 adj3 edit*).tw,kw,kf. (1)

42 (hoax$2 adj3 journal*).tw,kw,kf. (5)

43 (hoax$2 adj3 periodical?).tw,kw,kf. (0)

44 (hoax$2 adj3 publication?).tw,kw,kf. (2)

45 (hoax$2 adj3 publish*).tw,kw,kf. (4)

46 (illegitim* adj3 edit*).tw,kw,kf. (3)

47 (illegitim* adj3 journal*).tw,kw,kf. (19)

48 (illegitim* adj3 periodical?).tw,kw,kf. (0)

49 (illegitim* adj3 publication?).tw,kw,kf. (6)

50 (illegitim* adj3 publish*).tw,kw,kf. (12)

51 (mislead* adj3 edit*).tw,kw,kf. (42)

52 (mislead* adj3 journal*).tw,kw,kf. (36)

53 (mislead* adj periodical?).tw,kw,kf. (0)

54 (mislead* adj3 publication?).tw,kw,kf. (57)

55 (mislead* adj publish*).tw,kw,kf. (5)

56 (non-legitim* adj3 edit*).tw,kw,kf. (0)

57 (non-legitim* adj3 journal*).tw,kw,kf. (0)

58 (non-legitim* adj3 periodical?).tw,kw,kf. (0)

59 (non-legitim* adj3 publication?).tw,kw,kf. (0)

60 (non-legitim* adj3 publish*).tw,kw,kf. (0)

61 (questionabl* adj3 edit*).tw,kw,kf. (24)

62 (questionabl* adj3 journal*).tw,kw,kf. (38)

63 (quesionabl* adj3 periodical?).tw,kw,kf. (0)

64 (questionabl* adj3 publication?).tw,kw,kf. (44)

65 (questionabl* adj3 publish*).tw,kw,kf. (48)

66 (racket? adj3 edit*).tw,kw,kf. (0)

67 (racket? adj3 journal*).tw,kw,kf. (1)

68 (racket? adj3 periodical?).tw,kw,kf. (0)

69 (racket? adj3 publication?).tw,kw,kf. (0)

70 (racket? adj3 publish*).tw,kw,kf. (0)

71 (rogue adj3 edit*).tw,kw,kf. (4)

72 (rogue adj3 journal*).tw,kw,kf. (2)

73 (rogue adj3 periodical?).tw,kw,kf. (0)

74 (rogue adj3 publication?).tw,kw,kf. (0)

75 (rogue adj3 publish*).tw,kw,kf. (4)

76 (scam* adj3 edit*).tw,kw,kf. (3)

77 (scam* adj3 journal*).tw,kw,kf. (9)

78 (scam* adj3 periodical?).tw,kw,kf. (0)

79 (scam* adj3 publication?).tw,kw,kf. (0)

80 (scam* adj3 publish*).tw,kw,kf. (6)

81 (sham adj3 edit*).tw,kw,kf. (1)

82 (sham adj3 journal*).tw,kw,kf. (9)

83 (sham adj3 periodical?).tw,kw,kf. (0)

84 (sham adj3 publication?).tw,kw,kf. (1)

85 (sham adj3 publish*).tw,kw,kf. (50)

86 (spam* adj3 edit*).tw,kw,kf. (1)

87 (spam* adj3 journal*).tw,kw,kf. (4)

88 (spam* adj3 periodical?).tw,kw,kf. (0)

89 (spam* adj3 publication?).tw,kw,kf. (2)

90 (spam* adj3 publish*).tw,kw,kf. (5)

91 (unethic* adj3 edit*).tw,kw,kf. (21)

92 (unethic* adj3 journal*).tw,kw,kf. (22)

93 (unethic* adj3 periodical?).tw,kw,kf. (0)

94 (unethic* adj3 publication?).tw,kw,kf. (52)

95 (unethic* adj3 publish*).tw,kw,kf. (51)

96 (unprofessional* adj3 edit*).tw,kw,kf. (1)

97 (unprofessional* adj3 journal*).tw,kw,kf. (4)

98 (unprofessional* adj3 periodical*).tw,kw,kf. (0)

99 (unprofessional* adj3 publication?).tw,kw,kf. (3)

100 (unprofessional* adj3 publish*).tw,kw,kf. (1)

101 (untrust* adj3 edit*).tw,kw,kf. (0)

102 (untrust* adj3 journal*).tw,kw,kf. (0)

103 (untrust* adj3 periodical?).tw,kw,kf. (0)

104 (untrust* adj3 publication?).tw,kw,kf. (1)

105 (untrust* adj3 publish*).tw,kw,kf. (2)

106 pseudo-journal*.tw,kw,kf. (13)

107 pseudo-periodical*.tw,kw,kf. (5)

108 pseudo-publish*.tw,kw,kf. (2)

109 Beall* list.tw,kw,kf. (46)

110 or/1-109 (1564)

111 limit 110 to yr="2012-current" (1112)

112 (comment or editorial or news or newspaper article).pt. (1853727)

113 111 not 112 (OPINION PIECES REMOVED) (869)

114 remove duplicates from 113 (586)

115 114 use medall (333)

116 114 use emczd (156)

117 114 use eric (16)

118 114 not (115 or 116 or 117) (81)

Table 1. Characteristics of checklists (oldest to most recently published)

Study	Checklist name	Number of items	Items weighted Y/N	Time to complete min	Methods used to develop checklist (NR = Not reported)	Qualitative guidance Y/N	Quantitative guidance Y/N
Checklists from electronic journal databases n = 53							
(REFERENCE CHECKLIST) Shamseer, 2017 (13)	Salient characteristics of potential predatory journals	13	N	0-5	Cross-sectional analysis 93 predatory journals, 99 OA, 100 subscription based journals assessed	No	No
Beall, 2012 (10)	Criteria for Determining Predatory Open-Access Publishers	5	No	10+ min	Criteria based on AOSPA[1] Code of Conduct, two COPE[2] publications	No	No

1 OASPA = Open Access Scholarly Publishers Association

2 COPE = Committee on Publication Ethics

Beall, 2013 (15)	Some warning signs of questionable publishers	7	No	0-5 min	Observational research on own emails received	No	No
Crawford, 2014 (82)	No title	11	No	6-10 min	Assessed all criteria in Beall's criteria	Yes	No
Knoll, 2014 (90)	Avoiding Predatory OA Journals	17	No	0-5 min	Works cited	No	No
Lukic, 2014 (91)	No title	13	No	0-5 min	Multiple references	No	No
Beall, 2015 (84)	Criteria for Determining Predatory Open-Access Publishers	5	No	10+ min	Criteria based on COPE documents: Code of Conduct and Principles of Transparency and Best Practices in Scholarly Publication	No	No

Bhad, 2015 (102)	How should one suspect a journal could be a predatory journal?	9	No	0-5 min	NR	No	No
Bradley-Springer, 2015 (92)	No title	6	No	0-5 min	Multiple references	No	No
Hemmat Esfe, 2015 (93)	Features of the Fake Journals	9	No	0-5 min	NR	No	No
INANE Predatory Publishing Practices Collaborative, 2015 (101)	Guidelines for evaluating the integrity of a journal / Red flags	7	No	0-5 min	Limited literature review	No	No
Pamukcu Gunaydin, 2015 (94)	No title	10	No	0-5 min	Authors' top 10 based on other references	No	No
Proehl, 2015 (88)	Guidelines for evaluating the	7	No	0-5 min	References to other checklists: COPE etc.	No	No

	integrity of a journal - Red flags						
Stone, 2015 (95)	Guidelines for evaluating the integrity of a journal	6	No	0-5 min	Other credible resources: COPE, INANE[3], other	No	No
Yucha, 2015 (89)	Guidelines for Evaluating the Integrity of a Journal - Red flags	10	No	0-5 min	Multiple references to other checklists	No	No
Cariappa, 2016 (96)	Telltale signs - Something is wrong!	7	No	0-5	Some literature cited	No	No
Carroll, 2016 (100)	Common Practices of Predatory Open Access Publications	4	No	0-5 min	Limited literature review	No	No

3 INANE = International Academy of Nursing Editors

Dadkhah, 2016 (85)	Criteria to rank predatory journals	14	Yes	10+ min	Observational study of 150 journals 80 predatory, 70 non	Yes	Yes
Fraser, 2016 (97)	Red Flags for Recognizing Predatory Journals	6	No	0-5 min	Two citations	No	No
Glick, 2016 (105)	What you can expect from a predatory publisher	7	No	0-5 min	Multiple citations	No	No
Glick, 2016a (98)	Clues suggesting a "predatory" journal	11	No	0-5 min	Multiple references	No	No
Hansoti, 2016 (86)	Overall Approach to Choosing the Journal	11	No	0-5 min	Extensive literature review	Yes	No
Morley, 2016 (87)	10 steps to spot a predatory publisher	10	No	0-5 min	A few citations	Yes	No

Nolan, 2016 (106)	None section title exists but not title	5	No	0-5 min	None noted	No	No
Ward, 2016 (83)	No title	8	No	6-10 min	None listed	No	No
Abadi, 2017 (16)	No title	26	No	6-10 min	NR	No	No
Balehegn, 2017 (30)	No title	5	No	0-5 min	References	No	No
Berger, 2017 (17)	Detailed Characteristics of Predatory Journals	15	No	6-10 min	NR	No	No
Das, 2017 (18)	How to identify predators?	15	No	0-5 min	Two citations	No	No
Erfanmanesh 2017 (19)	No title	18	No	6-10 min	Multiple references	No	No
Eriksson, 2017 (20)	Characteristics of a predatory journal	25	No	10+	Limited literature review	No	No

Janodia, 2017 (21)	No title	9	No	6-10 min	NR	Yes	No
Khan, 2017 (22)	Attributes, characteristics and practices of potential predatory journals	9	No	0-5 min	Citations	No	No
Klyce, 2017 (23)	Common characteristics of predatory journals	13	No	0-5 min	Limited literature review	No	No
Manca, 2017 (24)	No title	6	No	0-5 min	Limited literature review	No	No
Miller, 2017 (25)	Signs of a Predatory Publisher	8	No	0-5 min	NR	No	No
Misra, 2017 (26)	Red flags based on which one may	17	No	0-5 min	Literature review and authors' experiences	No	No

	suspect the legitimacy of a journal						
Mouton, 2017 (27)	Comparing the characteristics of good practice in scholarly publishing with those of predatory publishing	7	No	0-5 min	In-depth assessment of journals identified by Beall's list where South African authors published	No	No
Oren, 2017 (28)	Obvious signs of predatory journals	7	No	0-5 min	NR	No	No
Shamseer, 2017 (13)	Salient characteristics of potential predatory journals	13	No	0-5 min	Observational study 93 predatory journals, 99 OA[4], 100	No	No

[4] OA = Open Access

					subscription-based journals assessed		
Stratton, 2017 (29)	Characteristics of Health and Medical Journal Publishing Formats - Open Access Predatory	4	No	0-5 min	Cited references	No	No
Ajuwon, 2018 (33)	Characteristics of Predatory Publishers and Journals	12	No	0-5 min	Citations from other sources	No	No
Bowman, 2018 (34)	Identifying Predatory Journals and Publishers	29	No	6-10 min	NR	No	No
Gerberi, 2018 (35)	Quick List of Predatory Publisher Warning Signs	7	No	0-5 min	Limited literature review	No	No

Kokol, 2018 (37)	No title	4	No	0-5	Analysis of papers 2013-2017 predatory Beall's vs non	No	No
Lewinski, 2018 (38)	Eight tips to identify a predatory journal or publisher	8	No	0-5	NR	Yes	No
McCann, 2018 (31)	Guidelines for authors to avoid predatory publishers	25	No	0-5 min	Brief literature review	Yes	No
Memon, 2018 (39)	No title	14	No	6-10 min	Collecting emails and web pages of each journal /publisher. Used Beall's list, PubMed, DOAJ[5], Thomson and Reuters	No	No

[5] DOAJ = Directory of Open Access Journals

					now Clarivate Analytics		
Nnaji, 2018 (40)	No title	11	No	6-10 min	Two references	No	No
O'Donnell, 2018 (32)	Identifying a predator	17	No	6-10 min	Other evidence-based checklist	No	No
Pamukcu Gunaydin, 2018 (36)	How to avoid sending your work to a predatory journal	5	No	0-5	Limited literature review	No	No
Power, 2018 (41)	No title	11	No	6-10 min	References COPE, INANE	No	No
Richtig, 2018 (42)	Criteria identified or suggested in the literature that can potentially be used	13	No	6-10	Literature review	No	No

	to identify predatory journals						
Wikipedia, 2019 (99)	No title	10	No	0-5 min	Multiple citations	No	No
Study	Checklist name	Number of items	Items weighted Y/N	Time to complete min	Methods used to develop checklist	Qualitative guidance Y/N	Quantitative guidance Y/N
Checklists from university library websites n = 30							
(REFERENCE CHECKLIST) Shamseer, 2017 (13)	Salient characteristics of potential predatory journals	13	N	0-5	Cross sectional analysis 93 predatory journals, 99 OA, 100 subscription-based journals assessed	No	No
Carlson, 2014 (43)	None	11	No	0-5 min	Based on personal experiences looking	No	No

					into questionable OA journals		
Clark, 2015 (1)	None	5	No	0-5 min	NR	No	No
University of Edinburgh, 2015 (44)	Some warning signs to look out for	4	No	0-5 min	NR	No	No
Africa Check, 2017 (45)	None	7	No	0-5 min	NR	No	No
Cabell's – Clarivate, 2017 (46)	None	64	No	10+ min	Analysis by specialists see: https://www2.cabells.com/about-blacklist	No	No
Duke University Medical Center, 2017 (47)	Be iNFORMEd Checklist	6	No	0-5 min	NR	Yes	No
University of Calgary, 2017 (48)	No title	6	No	0-5 min	NR	No	No

Coopérer en information scientifique et technique, 2018 (49)	No title	35	No	10+ min	NR	No	No
Eaton, University of Calgary 2018 (50)	No title	12	No	0-5 min	Other sources cited	Yes	No
Lapinksi, Harvard, 2018 (51)	No title	3	No	0-5 min	NR	Yes	No
Sorbonne Université, 2018 (52)	Comment repérer un éditeur prédateur	12	No	0-5 min	NR	No	No
University of Alberta, 2018 (54)	No title	19	No	6-10 min	NR	No	No
University of British Columbia, 2018 (53)	No title	16	No	6-10 min	NR	No	No
University of Toronto Libraries, 2018 (55)	Identifying Deceptive	22	Yes	6-10 min	NR	Yes	Yes

	Publishers: A Checklist						
Dalhousie University, 2019 (56)	How to recognize predatory journals	6	No	0-5 min	NR	No	No
McGill University, 2019 (57)	No title	4	No	0-5 min	NR	No	No
McMaster University, 2019 (58)	No title	6	No	0-5 min	NR	No	No
Prater, American Journal Experts, 2019 (59)	No title	8	No	0-5 min	NR	Yes	No
Ryerson University Library, 2019 (60)	No title	5	No	0-5 min	NR	No	No
Université Laval, 2019 (61)	No title	8	No	0-5 min	NR	No	No

University of Cambridge, 2019 (62)	No title	9	No	6-10 min	NR	No	No
University of Pretoria, 2019 (63)	No title	19	No	0-5 min	NR	No	No
University of Queensland Library, 2019 (65)	No title	6	No	0-5 min	NR	No	No
University of Queensland Library, 2019a (64)	Red Flags for Open Access Journals	9	No	0-5 min	NR	Yes	No
University of Witwatersrand, 2019 (66)	Predatory Publisher Checklist	26	No	10+ min	NR	No	No
Canadian Association of Research Libraries, ND (67)	How to assess a journal A.K.A. How	12	No	0-5 min	NR	Yes	No

	not to publish in an undesirable journal						
Columbia University Libraries, ND (68)	No title	5	No	0-5 min	NR	Yes	No
Technion Library, ND (69)	No title	10	No	0-5 min	NR	No	No
UC Berkley, ND (70)	No title	3	No	0-5 min	Cited 1 paper	No	No
University of Ottawa Scholarly Communication, ND (71)	No title	12	No	0-5 min	NR	No	No
Study	Checklist name	Number of items	Items weighted Y/N	Time to complete min	Methods used to develop checklist	Qualitative guidance Y/N	Quantitative guidance Y/N

Checklists from YouTube n = 10							
(REFERENCE CHECKLIST) Shamseer, 2017(13)	Salient characteristics of potential predatory journals	13	N	0-5	Cross sectional analysis 93 predatory journals, 99 OA, 100 subscription-based journals assessed	No	No
Robbins, Western Sydney University, 2015 (72)	Red Flags	9	No	6-10 min	NR	No	No
Attia, 2017 (73)	Spot Predatory Publishers	4	No	0-5 min	NR	No	No
Kysh, USC Keck School of Medicine, 2017 (74)	Characteristics of Predatory Publishers	9	No	0-5 min	NR	No	No

McKenna, Rhodes University, 2017 (75)	Predatory Publications: Shark Spotting	7	No	0-5 min	NR	No	No
Nicholson, University of Witwatersrand, 2017 (76)	Cautionary Checklist	36	No	10+ min	NR	No	No
Raszewski, 2017 (77)	What to watch out for	4	No	0-5 min	NR	No	No
Seal-Roberts, Springer Healthcare, 2017 (78)	So how do we recognize a predatory publisher?	10	No	0-5 min	NR	No	No
Menon, SCMS Group of Educational Institutions, India and Berryman, Cabell's, 2018 (79)	Characteristics of Predatory Journals	7	No	0-5 min	NR	No	No

Office of Scholarly Communication, Cambridge University, 2018 (80)	None	12	No	0-5 min	NR	No	No
Weigand, UNC Libraries, 2018 (81)	No title	5	No	0-5 min	NR	No	No

Table 2. Risk of bias assessment. Three 'Yes' assessments results in an overall assessment of evidence based.

Study	Represent 1+ stakeholder groups (Y/N/U)*	Gather data for checklist development (Y/N/Only citations/ U)	Does the checklist meet at least one of these criteria? (count only the last column in total)				Pilot test (Y/N/U)	Includes number of criteria to be considered predatory (Y/N)	Overall assessment (is it evidence-based?) (Y/N)
			Title (Y/N)	Fits on one page (Y/N)	Each item one sentence (Y/N)	Meets at least one of these (Y/N)			
Checklists from electronic journal databases (n = 53)									
(REFERENCE CHECKLIST) Shamseer, 2017 (13)	U	Y	Y	Y	Y	Y	U	N	N
Beall, 2012 (10)	U	U	N	N	N	N	U	N	N
Beall, 2013 (15)	U	Y	Y	Y	Y	Y	U	N	N

Crawford, 2014 (82)	U	U	N	Y	Y	Y	U	N	N
Knoll, 2014 (90)	U	Only citations	Y	Y	N	Y	U	N	N
Lukic, 2014 (91)	U	Only citations	N	Y	N	Y	U	N	N
Beall, 2015 (84)	U	Only citations	N	N	N	N	U	N	N
Bhad, 2015 (102)	U	U	Y	Y	Y	Y	U	N	N
Bradley-Springer, 2015 (92)	U	Only citations	N	Y	N	Y	U	N	N
Hemmat Esfe, 2015 (93)	U	Only citations	N	Y	Y	Y	U	N	N
INANE Predatory Publishing Practices Collaborative, 2015 (101)	U	U	Y	Y	Y	Y	U	N	N
Pamukcu Gunaydin, 2015 (94)	U	Only citations	N	Y	N	Y	U	N	N

Proehl, 2015 (88)	U	U	N	Y	Y	Y	U	N	N
Stone, 2015 (95)	U	Only citations	N	Y	Y	Y	U	N	N
Yucha, 2015 (89)	U	U	Y	Y	Y	Y	U	N	N
Cariappa, 2016 (96)	U	Only citations	Y	Y	Y	Y	U	N	N
Carroll, 2016 (100)	U	Y	Y	Y	Y	Y	U	N	N
Dadkhah, 2016 (85)	U	Y	Y	Y	Y	Y	Y	Y	Y
Fraser, 2015 (97)	U	Only citations	Y	Y	Y	Y	U	N	N
Glick, 2016 (105)	U	U	Y	Y	Y	Y	U	N	N
Glick, 2016a (98)	U	Only citations	Y	Y	Y	Y	U	N	N
Hansoti, 2016 (86)	Y	Y	N	Y	N	Y	U	N	Y
Morley, 2016 (87)	U	U	N	N	N	N	U	N	N
Nolan, 2016 (106)	U	U	N	Y	N	Y	U	N	N
Ward, 2016 (83)	U	U	N	N	N	N	U	N	N
Abadi, 2017 (16)	U	U	N	Y	Y	Y	U	N	N
Balehegn, 2017 (30)	U	Only citations	N	Y	Y	Y	U	N	N

Berger, 2017 (17)	U	U	N	Y	N	Y	U	N	N
Das, 2017 (18)	U	Only citations	Y	Y	Y	Y	U	N	N
Erfanmanesh, 2017 (19)	U	Only citations	Y	Y	Y	Y	U	N	N
Eriksson, 2017 (20)	U	U	Y	Y	Y	Y	U	N	N
Janodia, 2017 (21)	U	U	Y	Y	N	Y	U	N	N
Khan, 2017 (22)	Y	Only citations	Y	Y	N	Y	U	N	N
Klyce, 2017 (23)	U	Only citations	Y	Y	Y	Y	U	N	N
Manca, 2017 (24)	U	Only citations	N	Y	N	Y	U	N	N
Miller, 2017 (25)	U	U	Y	Y	Y	Y	U	N	N
Misra, 2017 (26)	U	Y	Y	Y	Y	Y	U	N	N
Mouton, 2017 (27)	U	U	Y	Y	N	Y	Y	Y	Y
Oren, 2017 (28)	U	U	Y	Y	Y	Y	U	N	N
Shamseer, 2017 (13)	U	Y	Y	Y	Y	Y	U	N	N
Stratton, 2017 (29)	U	U	Y	Y	Y	Y	U	N	N

Ajuwon, 2018 (33)	U	Only citations	Y	Y	Y	Y	U	N	N
Bowman, 2018 (34)	U	U	Y	Y	N	Y	U	N	N
Gerberi, 2018 (35)	U	Only citations	Y	Y	N	Y	U	N	N
Pamukcu Gunaydin, 2018 (36)	U	Only citations	Y	Y	N	Y	U	N	N
Kokol, 2018 (37)	U	Y	N	Y	Y	Y	U	N	N
Lewinski, 2018 (38)	U	Y	Y	Y	N	Y	U	N	N
McCann, 2018 (31)	U	Y	Y	Y	Y	Y	U	N	N
Memon, 2018 (39)	U	Y	Y	Y	Y	Y	U	N	N
Nnaji, 2018 (40)	U	Only citations	Y	N	N	Y	U	N	N
O'Donnell, 2018 (32)	U	Only citations	N	N	N	N	U	N	N
Power, 2018 (41)	U	Only citations	N	N	N	N	U	N	N
Richtig, 2018 (42)	U	Only citations	Y	Y	N	Y	U	N	N
Wikipedia, 2019 (99)	U	Only citations	N	Y	Y	Y	U	N	N

Study	Represent 1+ stakeholder groups (Y/N/U)*	Gather data for checklist development (Y/N/Only citations/ U)	Does the checklist meet at least one of these criteria? (count only the last column in total)				Pilot test (Y/N/U)	Includes number of criteria to be considered predatory (Y/N)	Overall assessment (is it evidence-based?) (Y/N)
			Title (Y/N)	Fits on one page (Y/N)	Each item one sentence (Y/N)	Meets at least one of these (Y/N)			
Checklists from university library websites (n = 30)									
(REFERENCE CHECKLIST) Shamseer, 2017 (13)	U	Y	Y	Y	Y	Y	U	N	N

Carlson, 2014 (43)	U	Y	N	N	N	N	U	N	N
Clark, 2015 (1)	U	U	N	Y	N	Y	U	N	N
University of Edinburgh, 2015 (44)	U	U	Y	Y	Y	Y	U	N	N
Africa Check, 2017 (45)	U	Only citations	N	Y	N	Y	U	N	N
Cabell's - Clarivate, 2017 (46)	Y	U	N	N	Y	Y	U	N	N
Duke University Medical Center, 2017 (47)	U	U	N	N	N	N	U	N	N
University of Calgary, 2017 (48)	U	U	N	Y	N	Y	U	N	N
Coopérer en information	U	U	N	N	Y	Y	U	N	N

scientifique et technique, 2018 (49)									
Eaton, University of Calgary, 2018 (50)	U	Y	N	Y	Y	Y	U	N	N
Lapinski, Harvard University, 2018 (51)	U	U	N	N	N	N	U	N	N
Sorbonne Université, 2018 (52)	U	U	Y	Y	Y	Y	U	N	N
University of Alberta, 2018 (54)	U	U	N	N	N	N	U	N	N
University of British Columbia, 2018 (53)	U	Only citations	Y	N	N	Y	U	N	N

University of Toronto Libraries, 2018 (55)	Y	U	N	N	N	N	U	Y	N
Dalhousie University, 2019 (56)	U	U	Y	Y	N	Y	U	N	N
McGill University, 2019 (57)	U	U	N	Y	N	Y	U	N	N
McMaster University, 2019 (58)	U	U	N	Y	Y	Y	U	N	N
Prater - American Journal Experts, 2019 (59)	Y	U	N	N	N	N	U	N	N
Ryerson University Library, 2019 (60)	U	U	N	Y	N	Y	U	N	N

Université Laval, 2019 (61)	U	U	N	Y	N	Y	U	N	N
University of Cambridge, 2019 (62)	U	U	N	Y	N	Y	U	N	N
University of Pretoria, 2019 (63)	U	U	N	Y	Y	Y	U	N	N
University of Queensland Library, 2019 (65)	U	U	N	Y	N	Y	U	N	N
University of Queensland Library, 2019a (64)	U	U	N	Y	N	Y	U	N	N
University of Witwatersrand, 2019 (66)	U	U	Y	N	Y	Y	U	N	N

Canadian Association of Research Libraries, ND (67)	U	U	N	Y	Y	Y	U	N	N
Columbia University Libraries, ND (68)	U	U	N	Y	N	Y	U	N	N
Technion Library, ND (69)	U	U	N	Y	N	Y	U	N	N
UC Berkeley, ND (70)	U	U	N	Y	N	Y	U	N	N
University of Ottawa Scholarly Communication, ND (71)	U	U	N	Y	N	Y	U	N	N

Study	Represent 1+ stakeholder groups (Y/N/U)*	Gather data for checklist development (Y/N/Only citations/ U)	Does the checklist meet at least one of these criteria? (count only the last column in total)				Pilot test (Y/N/U)	Includes number of criteria to be considered predatory (Y/N)	Overall assessment (is it evidence-based?) (Y/N)
			Title (Y/N)	Fits on one page (Y/N)	Each item one sentence (Y/N)	Meets at least one of these (Y/N)			
Checklists from YouTube (n = 10) (URLs available at https://osf.io/eds9f/)									
(REFERENCE CHECKLIST) Shamseer, 2017 (13)	U	Y (cross-sectional study on journals)	Y	Y	Y	Y	U	N	N
Robbins S, Western Sydney University, 2015 (72)	U	U	Y	Y	Y	Y	U	N	N

Attia, 2017 (73)	U	U	Y	N	N	Y	U	N	N
Kysh, USC Keck School of Medicine, 2017 (74)	U	U	Y	Y	Y	Y	U	N	N
McKenna, Rhodes University, 2017 (75)	U	U	Y	Y	Y	Y	U	N	N
Nicholson, University of Witwatersrand, 2017 (76)	U	U	Y	N	N	Y	U	N	N
Raszewski, 2017 (77)	U	U	Y	Y	N	Y	U	N	N
Seal-Roberts, Springer	U	U	Y	Y	Y	Y	U	N	N

Healthcare, 2017 (78)									
Menon, SCMS Group of Educational Institutions, India and Berryman, Cabells, 2018 (79)	U	U	Y	Y	Y	Y	U	N	N
Office of Scholarly Communication, Cambridge University, 2018 (80)	U	U	N	N	Y	Y	U	N	N
Weigand, UNC Libraries, 2018 (81)	U	U	N	Y	Y	Y	U	N	N

*Y = Yes, N = No, U = Unclear

Table 3. Thematic categories covered by the checklists (oldest to most recently published)

Study	Categories covered by checklist*					
	Journal Operations	Article	Editorial and Peer Review	Communications	Article Processing Charge	Dissemination, indexing + archiving
Checklists from electronic journal databases n = 53						
(REFERENCE CHECKLIST) Shamseer, 2017 (13)	X	X	X	X	X	X
Beall, 2012 (10)	X	X	X	X	X	X
Beall, 2013 (15)	X	X	X	X		
Crawford, 2014 (82)		X	X		X	
Knoll, 2014 (90)	X		X	X	X	X
Lukic, 2014 (91)	X		X	X		X
Beall, 2015 (84)	X	X	X	X	X	X

Bhad, 2015 (102)	X			X	X	X
Bradley-Springer, 2015 (92)	X			X		
Hemmat Esfe, 2015 (93)	X		X	X	X	
INANE Predatory Publishing Practices Collaborative, 2015 (101)	X		X	X		
Pamukcu Gunaydin, 2015 (94)	X	X		X	X	
Proehl, 2015 (88)	X		X	X		
Stone, 2015 (95)	X		X	X		
Yucha, 2015 (89)	X		X	X		
Cariappa, 2016 (96)	X	X	X	X		
Carroll, 2016 (100)	X		X	X		
Dadkhah, 2016 (85)	X		X	X	X	X
Fraser, 2016 (97)	X		X	X	X	
Glick, 2016 (105)	X		X	X	X	
Glick, 2016a (98)		X	X	X	X	
Hansoti, 2016 (86)	X	X	X			X

Morley, 2016 (87)	X			X	X	X
Nolan, 2016 (106)	X		X		X	X
Ward, 2016 (83)	X	X	X	X	X	X
Abadi, 2017 (16)	X	X	X	X	X	X
Balehegn, 2017 (30)						X
Berger, 2017 (17)	X		X	X	X	X
Das, 2017 (18)	X		X		X	X
Erfanmanesh, 2017 (19)	X	X	X	X	X	X
Eriksson, 2017 (20)	X	X	X	X	X	X
Janodia, 2017 (21)	X	X			X	
Khan, 2017 (22)	X		X	X	X	X
Klyce, 2017 (23)	X	X	X	X		X
Manca, 2017 (24)	X	X			X	X
Miller, 2017 (25)	X		X			X
Misra, 2017 (26)	X	X	X	X	X	X
Mouton, 2017 (27)	X		X	X		X

Oren, 2017 (28)	X	X	X	X		
Shamseer, 2017 (13)	X	X	X	X	X	X
Stratton, 2017 (29)			X	X	X	X
Ajuwon, 2018 (33)	X		X	X	X	X
Bowman, 2018 (34)	X	X	X	X	X	X
Gerberi, 2018 (35)	X	X	X			
Kokol, 2018 (37)		X				
Lewinski, 2018 (38)		X	X	X		X
McCann, 2018 (31)	X		X	X	X	X
Memon, 2018 (39)	X		X	X	X	
Nnaji, 2018 (40)	X	X	X	X	X	X
O'Donnell, 2018 (32)	X	X	X	X	X	X
Pamukcu Gunyadin, 2018 (36)	X		X	X		X
Power, 2018 (41)	X		X	X	X	X
Richtig, 2018 (42)	X	X	X	X	X	X
Wikipedia 2019 (99)	X		X		X	X

TOTALS /53 checklists from electronic journal databases (n, %)	47, 89	24, 45	45, 85	42, 79	34, 64	34, 64
Study	Categories covered by checklists*					
	Journal Operations	Article	Editorial and Peer Review	Communications	Article Processing Charge	Dissemination, indexing + archiving
Checklists from university library websites n = 30						
(REFERENCE CHECKLIST) Shamseer, 2017 (13)	X	X	X	X	X	X
Carlson, 2014 (43)	X			X		
Clark, 2015 (1)	X		X		X	X

University of Edinburgh, 2015 (44)	X			X		
Africa Check, 2017 (45)	X		X			X
Cabell's – Clarivate, 2017 (46)	X	X	X	X	X	X
Duke University Medical Center, 2017 (47)	X	X	X		X	X
University of Calgary, 2017 (48)	X	X	X		X	
Coopérer en information scientifique et technique, 2018 (49)	X		X	X	X	X
Eaton, University of Calgary, 2018 (50)	X		X	X		X
Lapinksi, Harvard, 2018 (51)						X
Sorbonne Université, 2018 (52)	X		X	X	X	X
University of Alberta, 2018 (54)	X			X	X	X
University of British Columbia, 2018 (53)	X	X	X	X	X	X
University of Toronto Libraries, 2018 (55)	X	X	X	X	X	X

Dalhousie University, 2019 (56)	X			X	X	X
McGill University, 2019 (57)	X		X	X		X
McMaster University, 2019 (58)	X		X	X	X	X
Prater, 2019 (59)	X	X	X		X	
Ryerson University Library, 2019 (60)	X	X	X	X	X	
Université Laval, 2019 (61)	X		X	X	X	X
University of Cambridge, 2019 (62)	X	X	X	X	X	X
University of Pretoria, 2019 (63)	X		X	X	X	X
University of Queensland Library, 2019 (65)	X		X	X	X	X
University of Queensland Library, 2019a (64)	X	X	X			X
University of Witwatersrand, 2019 (66)	X	X	X	X	X	X
Canadian Association of Research Libraries, ND (67)	X	X	X	X	X	X
Columbia University Libraries, ND (68)	X		X			

Technion Library, ND (69)	X	X				X
UC Berkley, ND (70)	X			X	X	X
University of Ottawa Scholarly Communication, ND (71)	X		X	X		X
Totals /30 checklists from university library websites (n, %)	29, 97	12, 40	23, 77	21, 70	20, 67	24, 80
Study	Categories covered by checklists*					
	Journal Operations	Article	Editorial and Peer Review	Communications	Article Processing Charge	Dissemination, indexing + archiving
Checklists from YouTube n = 10						
(REFERENCE CHECKLIST) Shamseer, 2017 (13)	X	X	X	X	X	X

Robbins S. Western Sydney University, 2015 (72)	X		X	X	X	
Attia, 2017 (73)	X		X	X		
Kysh, USC Keck School of Medicine, 2017 (74)	X		X		X	X
McKenna, Rhodes University, 2017 (75)	X	X		X		
Nicholson, University of Witwatersrand, 2017 (76)	X	X	X	X	X	X
Raszewski 2017 (77)			X	X	X	
Seal-Roberts, Springer Healthcare, 2017 (78)	X		X	X	X	
Menon, SCMS Group of Educational Institutions, India and Berryman, Cabells, 2018 (79)	X		X	X	X	X
Office of Scholarly Communication, Cambridge University, 2018 (80)	X	X	X		X	X

Weigand, 2018 UNC Libraries (81)	X		X	X		
Totals /10 checklists from YouTube (n, %)	9, 90	3, 30	9, 90	8, 80	7, 70	4, 40
TOTAL (n, %)	85, 91	39, 42	77, 83	71, 93	61, 66	62, 67

*Categories as described by Cobey et al. 2018(3), reprinted with permission:

Journal operations: Features related to how the journal conducts its business operations

Article: Features related to articles appearing in the journal

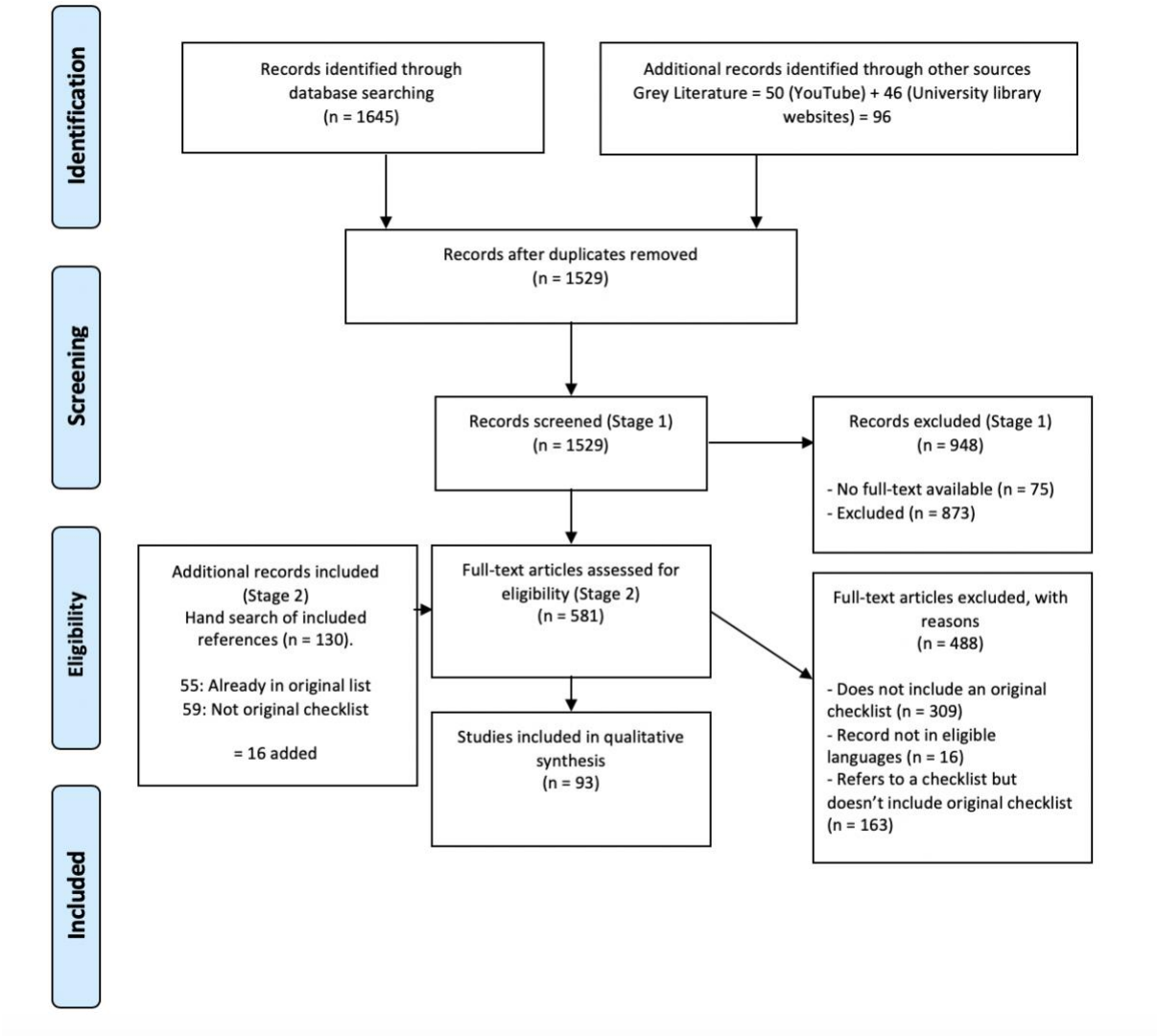
Editorial and peer review: Any aspect of the internal or external review of submitted articles and decisions on what to publish

Communications: How the journal interacts with potential authors, editors, and readers

Article processing charge: Fees taken in by journal as part of their business model

Dissemination, indexing and archiving: Information on how the journal disseminates articles and use of indexing and archiving tools

Figure 1. PRISMA Flow Diagram of the Inclusion Process



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Final Considerations

This manuscript is a compendium of different sources of avoidable waste in biomedical research and its potential counteracts. The correct choice of a research question, avoiding duplication of research is a thing that needs to be considered and was vastly explored in this thesis, as well as the low methodological quality of SRMAs.

First, this was observed using the case of high intensity interval training, a mode of physical exercise that is still a hype outside academia. Second, we demonstrated that a low percentage of journals adhere to such practices using Cardiology as a proxy for this case. If a result is poorly or no reproducible with all of the tools in hands, it is probably waste in research. Without the tools, we cannot even investigate in which level of reproducibility and transparency studies are, and editors are the gatekeepers to change this scenario. Finally, there is an avoidable waste through predatory journals – i.e., the journals that approach authors in a deceptive manner to publish their research with a very low (or absent) capacity of research spreading and editorial process/handling and checklists are available in the literature to guide authors to avoid predatory journals, whose most reflects bad editorial practices and the research spread.

This said, the main messages of this thesis could be resumed in:

A careful literature search in different databases is mandatory before embarking in a new research;

The use of free guidance to plan and conduct SRMAs, especially the Cochrane Handbook for Systematic Reviews of Interventions versions 5.0 and 6.0;

The registration of SRMAs should be performed by researchers and demanded by regulators;

Mandatory policy and guidance for transparency and reproducibility practices in biomedical journals, especially for research involving a wide range of resources and people, such as RCTs but not restrict to them, addressing other experimental designs*;*

Educational initiatives related to transparency in research must take place in graduate programs;

Penalization of researchers that make use of predatory journals in universities through different manners*;*

Education of young researchers about predatory journals*;*

The dissemination of checklists to detect predatory journals not only by the academic mainstream but social media as well*;*

A deep change in the manner that scientists are assessed for hiring, promotion and tenure – which is based in the volume of publication and directly implies in easy ways to publish research (i.e., predatory journals).