Journal of Clinical Epidemiology 116 (2019) 114–121

Journal of Clinical Epidemiology

ORIGINAL ARTICLE

Half of systematic reviews about pain registered in PROSPERO were not published and the majority had inaccurate status

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Accepted 26 August 2019; Published online 30 August 2019

Abstract

Objectives: The aim of this study was to analyze the publication path of non-Cochrane systematic reviews (SR) in the field of anesthesiology and pain registered in the PROSPERO database.

Study Design and Setting: We analyzed characteristics of SRs registered in PROSPERO from its inception to May 2017 and their publication status in August 2018. We surveyed corresponding authors of unpublished SRs about accuracy of PROSPERO status and reasons for nonpublication.

Results: After screening 1,408 records from PROSPERO database, we found that the majority had "ongoing" (76.3%) and "completed not published" (9.2%) status. Survey of authors showed that most of the records had not been updated (82.4%, 526/638); SR had already been published in 75.2% (396/526), and work on SR had been discontinued in 7.8% (41/526) of cases. In total, based on PROSPERO status, survey of authors, and database searches, 53.6% (742/1,384) of SRs had been published within a period of 1.3 years or more following their registration. Main reasons for discontinuing work on SR were publication of an SR with similar or same topic by another author team and rejection of SR manuscript.

Conclusion: Only 16.3% of PROSPERO records had accurate status, and 46.4% of SRs were still unpublished. Further steps to ensure accuracy of PROSPERO status are needed, along with developing strategies for improvement of SR production process.

Keywords: Systematic review; PROSPERO; Review registration; Review protocol; Review process; Methodology

1. Introduction

Authors planning to do a systematic review (SR) should state their methods a priori, before conducting their SR. The SR should be registered in a freely accessible online resource, such as PROSPERO, international prospective register of SRs [1]. Registration of an SR offers multiple advantages. First, SR registration ensures transparency and helps in countering publication bias, as it provides a permanent record of a prospectively registered SR. It is expected that published SR registration will reduce reporting bias because the authors may be less likely to change methods or outcomes after registering them in a publicly available resource. In addition, registering an SR enables other authors that are pondering doing an SR on a similar research question to identify if there are ongoing SRs on a topic of interest, which may help in avoiding duplicate efforts in research community [2].

The PROSPERO database was launched in 2011, and it is the only open access online venue for prospective registration of SRs, including non-Cochrane SRs [3]. PROSPERO represents an invaluable asset to research community, as it is available for everyone, and registration of SR is free of charge, thanks to the Centre for Reviews and Dissemination at the University of York that manages and the UK National Institute for Health Research that funds PROSPERO [4].

It has been shown that registering an SR is feasible and not burdensome to the authors [3]. However, a study by

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest: None.

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https://doi.org/10.1016/j.jclinepi.2019.08.010

What is new?

Key findings

- Around half of systematic reviews (SRs) registered in PROSPERO are unpublished at least 1.3 years after registration.
- PROSPERO status of almost five of six unpublished SRs is outdated.

What this adds to what was known?

- High rate of unpublished SRs leads to waste of time, human resources, and potentially useful information.
- Inaccuracy of PROSPERO status prevents potential SR authors on taking over and reviving abandoned topics.

What is the implication and what should change now?

- Strategies for increasing efficiently of SR production process should be considered.
- Further interventions that would enhance accuracy of PROSPERO status are needed.

Tricco et al. [5] showed that the authors do not necessarily exercise idealistic approach toward SR registration, as one-third of published SRs changed primary outcomes, compared with registered PROSPERO entries.

Completing an SR requires a lot of time and human resources. An analysis of SRs that were published after registering an SR in PROSPERO showed that the mean estimated time for completion and publication of the SR was 1.3 years, and the mean number of authors was 5 [6]. Considering that, it is not surprising that many authors quit during the process of SR production, which results in a significant amount of unpublished SRs [7]. This leads to waste of potentially useful information, time, and human resources.

Although such analyses were performed for Cochrane SRs [8,9], the rate of completion and publication of non-Cochrane SRs registered in PROSPERO is currently unknown. The aim of the study was to (1) assess frequency of completion and publication of non-Cochrane SRs in the field of anesthesiology and pain registered in the PROSPERO database, (2) analyze factors that may be associated with publication and (3) survey corresponding authors of nonpublished SRs about the current stages of SR production they are at and reasons for noncompletion.

2. Methods

The study consists of two parts. The first part is an analysis of the PROSPERO registry, whereas the second part is a survey of corresponding authors of nonpublished PROSPERO records.

2.1. First part of the study: analysis of PROSPERO registry

2.1.1. Study design

This was a primary methodological study.

2.1.2. Inclusion criteria

We included all PROSPERO records for non-Cochrane SRs that used pain as one of the outcome domains. We searched PROSPERO using the word "pain" on August 20, 2018, and screened all records to determine their eligibility. We included records that used pain as outcome in terms of pain intensity or pain relief and excluded records where pain was being assessed as an adverse event. As it was shown earlier that, on average, it takes 1.3 years to complete an SR [6], we included in our analysis SRs that were registered from the date of the PROSPERO inception to May 19, 2017. We excluded Cochrane protocols, records that were split into more than one SR and records that reported non-English language as language of SR or were published as non-English SRs.

2.1.3. Assessing publication status of PROSPERO records

1. We ascertained whether a record was published by analyzing the PROSPERO's SR status, which can be (1) review ongoing, (2) review completed not published, (3) review completed and published, (4) review completed published and being updated, and (5) review discontinued.
2. For all records that had "ongoing" or "completed not published" status, we surveyed authors about the current status.
3. For all records, we did not receive information from authors, we searched MEDLINE, EMBASE, and Google Scholar using title keywords, names of first and last author, and PROSPERO ID number to ascertain whether SR was published.

2.1.4. Data collection

One author (E.R.) extracted descriptive characteristics of the included records using a 37-item data extraction form. Another author (T.R.) verified 10% of randomly selected extractions. All discrepancies were reviewed, resolved by consensus, and 23 corrections (0.6% of verified data) were made.

We extracted the following data from the included records: unique PROSPERO identification number, publication date, number of record versions, number of authors, names of authors, country where authors were affiliated using the whole count method, in which each country got one mention when it appears in the address of an author,

regardless of the number of times it was used for other authors, number of authors with affiliations in multiple countries, population examined, number of primary outcomes, type of eligible studies (randomized, nonrandomized, or both), publication status of eligible studies (published, unpublished, or both), language restrictions (no restrictions, only English, and other), number of databases searched, searching trial registries, searching gray literature, publication bias assessment, heterogeneity assessment, date of the most recent amendment, and funding source reported in the record and type of funding source.

We defined databases according to the Gasparyan et al.: "*digital collections of references to published sources, particularly to journal articles and conference proceedings, which are tagged with specific titles, author names, affiliations, abstracts, and IDs*" [10].

2.1.5. Data analysis

We reported descriptive data using absolute numbers and percentages for nominal data and medians and ranges for ordinal and interval scaled data. Descriptive analyses were conducted using MedCalc (MedCalc Corp., Mariakerke, Belgium).

2.2. Second part of the study: survey of corresponding authors of nonpublished PROSPERO records

2.2.1. Study design

This was a cross-sectional survey.

2.2.2. Inclusion criteria

We included corresponding authors of records whose stage was "ongoing" or "completed not published."

2.2.3. Data collection

We contacted the corresponding author via the e-mail address provided in PROSPERO. If an e-mail address was not valid, we tried to find the current one by searching the Internet. Authors were asked whether the PROSPERO status of their SR is correct and what the current stage of SR production is. Authors of ongoing SRs were asked for their current stage according to the following categories: literature search, screening, data extraction, study quality, analysis, manuscript drafting, submitted, and waiting for feedback from peer reviewers. We also asked authors about the date of completion of those stages. Authors of "completed not published" SRs were asked about their current stage of SR publication according to the categories: updating the literature search before submitting, preparing manuscript for review, submitted to a scholarly journal, and not planning to publish the SR. An example of an email for a corresponding author of an ongoing SR is in Appendix A and for a corresponding author of a completed not published SR in Appendix B. We sent a reminder after 2 weeks if an author did not respond to our initial e-mail.

2.2.4. Data analysis

We used absolute numbers and percentages to describe the sample. Analyses were conducted using MedCalc.

2.2.5. Ethics

The study protocol for this survey was approved by the University of Split School of Medicine Ethics Committee.

3. Results

Our search identified 3,115 PROSPERO records. After screening, we found 1,408 records eligible for inclusion; their status was 1,074 (76.3%) ongoing, 130 (9.2%) completed not published, 195 (13.9%) published, and 9 (0.6%) discontinued.

Survey of authors identified additional 396 records, and database searches 169 published SRs among records that had "ongoing" and "completed not published" status.

We additionally excluded 24 records: one was published as a Cochrane SR, 11 were broken into two or more SRs, and 12 were published in languages other than English.

3.1. Characteristics of PROSPERO records

Finally, we analyzed 1,384 records, of which 742 (53.6%) were published: 712 in journals (95.9%), 18 (2.5%) as conference abstracts, 6 (0.8%) as governmental documents, 5 (0.7%) as thesis and college publications, and 1 (0.1%) as chapter in a book. Table 1 shows characteristics of all records included in our study and comparison of those characteristics based on publication status of SR and authors' response to survey (i.e., responders vs. nonresponders).

More than one version had 40.5% of PROSPERO records, with median number of 2 and maximum of 36 versions. Median number of authors per record was 4, and about two-thirds of authors were affiliated with an institution from the United Kingdom, Australia, China, the United States, Canada, or Brazil.

Authors of 44.5% records planned to include adult and elderly population, and 42.6% population of all ages. About half of records planned to include randomized or both randomized and nonrandomized studies; the majority did not indicate publication status of eligible studies. PROSPERO records usually did not have language restrictions for included studies, but about one-fourth planned to include just English studies (Table 1).

Median number of reported primary outcomes was 2, and median number of searched databases was 5. Three-quarters of records did not plan to search trial registries nor gray literature. In 82.1% of records, assessment of publication bias was not reported, and in more than half, heterogeneity assessment was not reported in methods (Table 1).

Table 1. Characteristics of PROSPERO records

Item	All records (*N* = 1,384)	Comparison based on publication status of SR		Comparison based on authors' response to survey	
		SR published (*N* = 742)	SR not published (*N* = 642)	Responded (*N* = 620)	Did not respond (*N* = 558)
More than one published version of PROSPERO record, *n* (%)					
No	824 (59.5)	356 (48)	468 (72.9)	398 (64.2)	413 (74)
Yes	560 (40.5)	386 (52)	174 (27.1)	222 (35.8)	145 (26)
Number of versions, median (range)	2 (2–36)	2 (2–11)	2 (2–36)	2 (2–36)	2 (2–8)
Number of authors, median (range)	4 (1–21)	4 (1–21)	4 (1–20)	4 (1–21)	4 (1–17)
Country/countries of authors, *n* (%)	*N* = 1,695	*N* = 920	*N* = 775	*N* = 770	*N* = 642
The United Kingdom	261 (15.4)	149 (16.2)	112 (14.5)	117 (15.2)	91 (14.2)
Australia	189 (11.1)	96 (10.4)	93 (12)	90 (11.7)	65 (10.1)
China	166 (9.8)	61 (6.6)	105 (13.6)	51 (6.6)	106 (16.5)
The United States	163 (9.6)	96 (10.4)	67 (8.6)	75 (9.8)	62 (9.7)
Canada	154 (9.1)	97 (10.6)	57 (7.4)	74 (9.6)	51 (7.9)
Brazil	145 (8.6)	68 (7.4)	77 (9.9)	61 (7.9)	64 (10)
The Netherlands	66 (3.9)	40 (4.3)	26 (3.4)	37 (4.8)	18 (2.8)
Denmark	62 (3.7)	41 (4.5)	21 (2.7)	33 (4.3)	16 (2.5)
Germany	46 (2.7)	33 (3.6)	13 (1.7)	18 (2.3)	8 (1.2)
South Korea	40 (2.3)	15 (1.6)	25 (3.1)	13 (1.7)	26 (4.1)
Spain	40 (2.3)	17 (1.9)	23 (3)	19 (2.5)	16 (2.5)
Others (46 countries)	363 (21.5)	207 (22.5)	156 (20.1)	182 (23.6)	119 (18.5)
Author/s with multiple countries in affiliation, *n* (%)					
No	1,368 (98.8)	734 (98.9)	634 (98.8)	607 (97.9)	556 (99.6)
Yes	16 (1.2)	8 (1.1)	8 (1.2)	13 (2.1)	2 (0.4)
Population included, *n* (%)					
Adult and elderly (≥18 years of age)	616 (44.5)	321 (43.3)	295 (46)	267 (43.1)	258 (46.2)
All populations	589 (42.6)	328 (44.2)	261 (40.6)	263 (42.4)	232 (41.6)
Female	71 (5.1)	35 (4.7)	36 (5.6)	36 (5.8)	28 (5)
Neonate, children, adolescent (<18 years of age)	63 (4.6)	36 (4.9)	27 (4.2)	34 (5.5)	23 (4.1)
Adolescent, adult and elderly (≥12 years of age)	38 (2.7)	18 (2.4)	20 (3.1)	15 (2.4)	17 (3.1)
Male	6 (0.4)	3 (0.4)	3 (0.5)	4 (0.6)	0
Not reported	1 (0.1)	1 (0.1)	0	1 (0.2)	0
Type of studies eligible, *n* (%)					
Randomized	685 (49.5)	354 (47.7)	331 (51.6)	284 (45.8)	307 (55)
Randomized and nonrandomized	631 (45.6)	354 (47.7)	277 (43.1)	300 (48.4)	234 (42)
Nonrandomized	32 (2.3)	17 (2.3)	15 (2.3)	19 (3.1)	6 (1.1)
Systematic reviews	27 (1.9)	10 (1.4)	17 (2.6)	14 (2.2)	7 (1.2)
Systematic reviews and randomized	8 (0.6)	7 (0.9)	1 (0.2)	3 (0.5)	3 (0.5)
Not stated	1 (0.1)	0	1 (0.2)	0	1 (0.2)
Publication status of eligible studies, *n* (%)					
Not stated	1,006 (72.7)	536 (72.2)	470 (73.2)	443 (71.4)	420 (75.2)
Published and unpublished	249 (18)	131 (17.7)	118 (18.4)	119 (19.2)	88 (15.8)
Published	129 (9.3)	75 (10.1)	54 (8.4)	58 (9.4)	50 (9)
Language inclusion, *n* (%)					
No restrictions	561 (40.5)	290 (39.1)	271 (42.2)	260 (41.9)	221 (39.6)
English	365 (26.4)	202 (27.2)	163 (25.4)	158 (25.5)	159 (28.5)
English and one other language	73 (5.3)	39 (5.2)	34 (5.3)	30 (4.8)	33 (5.9)

(*Continued*)

Table 1. Continued

Item	All records (N = 1,384)	Comparison based on publication status of SR		Comparison based on authors' response to survey	
		SR published (N = 742)	SR not published (N = 642)	Responded (N = 620)	Did not respond (N = 558)
English and ≥2 other languages	67 (4.8)	42 (5.7)	25 (3.9)	36 (5.8)	23 (4.1)
Japanese	3 (0.2)	3 (0.4)	0	1 (0.2)	0
Not stated	315 (22.8)	166 (22.4)	149 (23.2)	135 (21.8)	122 (21.9)
Number of primary outcomes reported, median (range)	2 (1–26)	2 (1–22)	2 (1–26)	2 (1–26)	2 (1–18)
Number of searched databases, median (range)	5 (0–19)	5 (0–19)	5 (0–19)	5 (1–19)	5 (0–19)
Trial registries searched, *n* (%)					
No	1,050 (75.9)	570 (76.8)	480 (74.8)	473 (76.3)	423 (75.8)
Yes	334 (24.1)	172 (23.2)	162 (25.2)	147 (23.7)	135 (24.2)
Gray literature searched, *n* (%)					
No	1,075 (77.7)	587 (79.1)	488 (76)	473 (76.3)	450 (80.6)
Yes	309 (22.3)	155 (20.9)	154 (24)	147 (23.7)	108 (19.4)
Assessment of publication bias reported in the methods, *n* (%)					
No	1,136 (82.1)	604 (81.4)	532 (82.9)	503 (81.1)	460 (82.4)
Yes	248 (17.9)	138 (18.6)	110 (17.1)	117 (18.9)	98 (17.6)
Heterogeneity assessment reported in the methods, *n* (%)					
No	778 (56.2)	393 (53)	385 (60)	336 (54.2)	337 (60.4)
Yes	606 (43.8)	349 (47)	257 (40)	284 (45.8)	221 (39.6)
Funding reported in the record, *n* (%)					
Study will not receive funding	777 (56.1)	382 (51.5)	395 (61.5)	331 (53.4)	325 (58.2)
Study will receive funding	600 (43.4)	357 (48.1)	243 (37.9)	287 (46.3)	228 (40.9)
There was no information about funding in record	7 (0.5)	3 (0.4)	4 (0.6)	2 (0.3)	5 (0.9)
Category of the funding source, *n* (%)	N = 600	N = 357	N = 243	N = 287	N = 228
Not-for-profit organization	297 (49.5)	166 (46.5)	131 (53.9)	136 (47.4)	129 (56.6)
Government organization	198 (33)	129 (36.1)	69 (28.4)	98 (34.1)	62 (27.2)
Mixed funding	61 (10.2)	41 (11.5)	20 (8.2)	31 (10.8)	18 (7.9)
Self-funded	29 (4.8)	12 (3.4)	17 (7)	14 (4.9)	14 (6.1)
Pharmaceutical or another private donor	15 (2.5)	9 (2.5)	6 (2.5)	8 (2.8)	5 (2.2)

Authors of 43.4% records reported that they received funding; about half of them were funded by not-for-profit organizations and one-third from government organizations. Few were self-funded, funded by private donors or pharmaceutical companies (Table 1).

3.2. Survey of authors

We planned to contact authors of all records with "ongoing" or "completed not published" status (N = 1,204), but e-mail addresses of eight authors (0.7%) were invalid, and we were not able to obtain valid ones. Therefore, we contacted 1,196 authors and received 638 responses (response rate: 53.3%). Status of records based on authors' responses is shown in Table 2.

Based on information received from the authors, the majority of records had not been updated (82.4%, 526/638); most commonly, the SR had already been published, but the PROSPERO record had not been updated (75.2%, 396/526). Some authors (7.8%, 41/526) had discontinued their work on the SR without recording that. Only 16.3% (104/638) records had correct status.

From all authors that stated their SR is still "ongoing" or "completed not published," 84.5% (163/193) gave response about current stage of their SR production. Around two-thirds of authors stated that their SR is completed, and that manuscript is currently being prepared for submission to scholarly journal, that a manuscript had been submitted to journal or had been accepted for publication. However, 5.5% (9/163) of

Table 2. Status of PROSPERO records and systematic reviews (SR) based on information received from corresponding authors of records

Status of PROSPERO records and SRs	*n/N* (%)
The PROSPERO status of the SR has not been updated	526/638 (82.4)
SR is completed and published	396/526 (75.3)
SR is completed, but still unpublished	89/526 (16.9)
Authors discontinued work on SR permanently	41/526 (7.8)
The PROSPERO status of the SR is correct	104/638 (16.3)
SR is still ongoing	83/104 (79.8)
SR is completed, but still unpublished	21/104 (20.2)
Authors discontinued work on the SR for indefinite period	8/638 (1.3)
Current stages of ongoing and completed not published SRs	163/193 (84.5)
Literature search is not completed	9/163 (5.5)
Literature search is completed	13/163 (7.9)
Screening is completed	6/163 (3.7)
Data abstraction is completed	4/163 (2.5)
Study quality (risk of bias assessment) is completed	17/163 (10.4)
Synthesis of results (including meta-analysis) is completed	6/163 (3.7)
Writing a draft is ongoing	6/163 (3.7)
Draft of a manuscript is completed and preparing for submission	35/163 (21.5)
Updating the literature search before submitting to a journal	2/163 (1.2)
SR has been submitted to a scholarly journal	51/163 (31.3)
SR is accepted for publication	9/163 (5.5)
SR was rejected and preparing for new submission	4/163 (2.5)
SR is completed but authors do not plan to publish it	1/163 (0.6)
Authors did not respond about current stage of their ongoing and completed not published SRs	30/193 (15.5)
Reasons for discontinuing work on SR	45/49 (91.8)
Another SR with similar/same topic was published	8/45 (17.8)
Completed but could not be published—rejected	8/45 (17.8)
Authors changed methodology of SR and started a new one	5/45 (11.1)
Personal issues	5/45 (11.1)
Lack of funding	4/45 (8.9)
Research focus of authors changed	4/45 (8.9)
Lack of time	3/45 (6.7)
Change of job	3/45 (6.7)
Multiple problems	2/45 (4.4)
Methodology problems	2/45 (4.4)
Went out of date due to protraction	1/45 (2.2)
Authors did not indicate reason for discontinuing work on SR	4/49 (8.2)

authors responded that they had not yet finished literature search stage.

Almost all authors (91.8%, 45/49) who stated that work on SR had been discontinued permanently or for an indefinite period indicated reasons for doing that. Two main reasons were publication of an SR with similar or same topic by another author team and rejection of SR by different journals (17.8%, 8/45). Authors of 11.1% (5/45) SRs who were discontinued had to change methodology and start a new SR, and some had methodological problems that they could not overcome. Lack of funding was reported by 8.9% (4/45) of authors, and one-third of authors reported various specific or nonspecific personal problems that prevented them from working on SR (Table 2).

4. Discussion

Our study showed that the vast majority of PROSPERO records had an outdated status. Among them, almost 10% of authors discontinued work on their registered SR, and the most common reasons for abandoning an SR were publication of another SR with similar or same topic and inability to publish a completed SR. We found that around half of SRs have not been published at least 1.3 years after registration of an SR in PROSPERO.

To our best knowledge, this is the first study that had assessed the real status of PROSPERO records. Tsujimoto et al. [11] analyzed SRs registered in PROSPERO and found that 52% had unpublished PROSPERO status, but

we did not find other studies that have investigated the accuracy of status for PROSPERO records.

PROSPERO enables authors to update SR status in case of change, publication, or discontinuing work on SR, and in its guidance notes encourage authors to regularly update their SR status [4]. However, PROSPERO does not take further action to ensure that the status of registered SRs is up-to-date, so updating the status depends mostly on authors' personal diligence. Our finding that 82.4% of PROSPERO records did not have accurate status shows that there is a need for adopting an intervention that would ensure accuracy of PROSPERO status. This is particularly pertinent for SRs that have been abandoned but still marked as "ongoing," whose percentage was not negligible in our study (7.8%). These so-called "zombie reviews" could prevent new authors from taking over topics that have been abandoned [12]. Sending regular reminders for authors to update their SR status, as suggested by Andrade et al. [12], seems like a feasible solution to overcome this problem. This could be implemented as an automated reminder from PROSPERO. Another option is to inquire about SR status on yearly basis and record if there is no response from author or no progress in SR production. However, such inquiry may not be successful; in our study, almost half of contacted corresponding authors of PROSPERO records did not respond to us.

One of the main goals of SR registration is to reduce duplication [13]. Nevertheless, almost one-fifth of authors who discontinued work on their SR said that they did so because another SR with similar or the same topic was published. Five of those authors stated that the SR that "scooped" them was not registered in PROSPERO, which opens question about necessity for making SR registration obligatory. Tough PRISMA statement encourages SR registration [14], and subsequently, PRISMA for protocol statements was developed with intention to facilitate protocol preparation and registration [15]; there is still no universal requirement for registration of SR protocols that would be equivalent to the requirements of the International Association of Journal Editors (ICMJE) regarding mandatory registration of clinical trials' protocols [16].

Insufficient rates of SR protocol registration have been well documented. Tsujimoto et al. [17] showed that just 21% of SRs published in high-impact factor journals were registered, and Sideri et al. [18] found that only 20.3% of orthodontic SRs were registered in PROSPERO. Although both studies showed increment of registration rates over analyzed years, further steps are needed to make SR registration a standard practice.

Our study pointed out to some potentially preventable reasons for discontinuing work on SR: some authors indicated that their SR could not be published because of low quality; some authors had to change methodology and start a new SR; some had methodological problems. PROSPERO registration includes reporting information about planned SR, mainly information about methodology. After submission, an SR record is assessed by PROSPERO for eligibility based on PROSPERO inclusion criteria but that does not involve assessment of quality [1]. Mechanisms for ensuring quality check, that is, peer review of registered SRs would be helpful. For this reason, some authors decide to publish protocols of their SRs in peer-reviewed journals [19]. However, although such publication undergoes peer review, few journals publish SR protocols, and such journals usually have article processing charges that may be prohibitive to some SR authors.

Although it has been shown that SRs registered in PROSPERO have higher quality than ones that are not registered [20], so far it is unknown whether their quality is inferior to those that were peer-reviewed and published in journals. It has been reported that SRs with peer-reviewed protocols have higher quality than SRs that did not publish their protocol [21], but on the other hand, publishing a protocol in a journal is time consuming [19,21]. Because of the rapid increase of the number of SR records in PROSPERO, which had over 30,000 records at the end of 2017 [22], peer reviewing all records would require a massive effort. One option would be to reorganize the PROSPERO as a scholarly journal, with the in-built peer-review process. However, it has to be acknowledged that any changes to PROSPERO may be difficult to implement, depending on the availability of resources.

We found that 46.4% of PROSPERO records were still unpublished at least 1.3 years after SR registration. This is not surprising as SR may be difficult to complete; we recently showed that 22.6% of Cochrane protocols are not published 8 years after protocol publication [9]. Our comparison of characteristics of published and nonpublished SRs did not reveal major differences except that nonpublished SRs were more likely to have one version of record (72.9% vs. 48%), and this is because adding information about SR publication in PROSPERO is noted as new version of record. A study being conducted by Ruano et al. [23] could give better observation about characteristics of PROSPERO records as predictors of publication. On the other hand, it is encouraging that the majority of PROSPERO records we analyzed that are still ongoing are at final stages of production, so their publication should be expected soon.

4.1. Limitations and strengths

The majority of our SRs were reviews of intervention, which is not necessarily representative for all PROSPERO records. The strengths of our study are extensive number of PROSPERO records analyzed from its inception and large number of surveyed authors with high response rate. Responder bias should not be an issue in this study because we had a high response rate, and descriptive comparison of characteristics of responders and nonresponders did not reveal major differences.

5. Conclusion

Only 16.3% of PROSPERO records from the field of anesthesiology and pain had accurate status. Around half of PROSPERO records were still unpublished, with high percentage of discontinued SRs. Further steps to ensure accuracy of PROSPERO status are needed, along with developing strategies for improvement of SR production process.

CRediT authorship contribution statement

Edita Runjic: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing - original draft, Writing - review & editing. **Tanja Rombey:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing - original draft, Writing - review & editing. **Dawid Pieper:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing - original draft, Writing - review & editing. **Livia Puljak:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing - original draft, Writing - review & editing.

Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclinepi.2019.08.010.

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