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Epidemiology, methodological quality, and reporting characteristics of systematic reviews and meta-analyses on coronavirus disease 2019

A cross-sectional study

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Abstract

During the coronavirus disease 2019 (COVID-19) pandemic, convenient accessibility and rapid publication of studies related to the ongoing pandemic prompted shorter preparation time for studies. Whether the methodological quality and reporting characteristics of published systematic reviews (SRs)/meta-analyses are affected during the specific pandemic condition is yet to be clarified. This study aimed to evaluate the epidemiology, methodological quality, and reporting characteristics of published SRs/meta-analyses related to COVID-19.

The Ovid Medline, Ovid Embase, Cochrane Library, and Web of Science electronic databases were searched to identify published SRs/meta-analyses related to the COVID-19 pandemic. Study screening, data extraction, and methodology quality assessment were performed independently by 2 authors. The methodology quality of included SRs/meta-analyses was evaluated using revised version of a measurement tool to assess SRs, and the reporting characteristics were assessed based on the preferred reporting items for SRs and meta-analyses guidelines.

A total of 47 SRs/meta-analyses were included with a low to critically low methodological quality. The median number of days from the date of literature retrieval to the date that the study was first available online was 21 days; due to the limited time, only 7 studies had study protocols, and the studies focused on a wide range of COVID-19 topics. The rate of compliance to the preferred reporting items for SRs and meta-analyses checklists of reporting characteristics ranged from 14.9% to 100%. The rate of compliance to the items of protocol and registration, detailed search strategy, and assessment of publication bias was less than 50%.

SRs/meta-analyses on COVID-19 were poorly conducted and reported, and thus, need to be substantially improved.

Abbreviations: AMSTAR = a measurement tool to assess systematic reviews, COVID-19 = coronavirus disease 2019, PRISMA = preferred reporting items for systematic reviews and meta-analyses, RCT = randomized controlled trial, SRs = systematic reviews.

Keywords: coronavirus disease 2019, meta-analysis, preferred reporting items for systematic reviews and meta-analyses, revised version of a measurement tool to assess systematic reviews, systematic review

1. Introduction

A systematic review (SR) is intended to integrate all currently available pieces of evidence that meet the predefined eligibility criteria in order to address a specific research question using specific and systematic methods that have been tested to minimize bias and provide more reliable findings, from which conclusions can be drawn and decisions can be made. Many SRs include meta-analysis, which is a statistical method used to synthesize the

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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results of several independent studies.[1] SRs/meta-analyses provide the highest level of evidence because they examine all the available evidence instead of individual studies with reproducible and rigorous methods, and evaluate the entire body of evidence to ensure the reliability of the results.[2] With the dissemination of SRs/meta-analyses and training in methodology, the number of SRs/meta-analyses is increasing rapidly; more than 30,000 SRs/meta-analyses were published in 2019. For Cochrane reviews, the annual prevalence of SRs/meta-analyses increased by three-fold from 2004 to 2014.[3] Nevertheless, evidence from a SR/meta-analysis may be limited for use if the methodology or reporting is flawed.[4]

To assess the methodological quality of SRs/meta-analyses, the revised instrument of a measurement tool to assess systematic reviews (AMSTAR-2) tool for assessing SRs, a critical appraisal tool, was published in 2017.[5] To improve the reporting of SRs/meta-analyses, preferred reporting items for systematic reviews and meta-analyses (PRISMA) statements[6] and Meta-Analysis Of Observational Studies in Epidemiology guidelines[7] were published. However, the reporting guidelines were only applied in 29% of SRs, and the rate of compliance to the items of reporting guidelines varied, ranging from 0% to 93%.[3]

The coronavirus disease 2019 (COVID-19) is caused by severe acute respiratory syndrome coronavirus 2, which has a high case fatality rate (6.3%–15.23%),[8] and has attracted attention worldwide. The number of published studies on COVID-19 is increasing rapidly, and over 10,000 studies have been published since the pandemic. The number of SRs/meta-analyses is also accumulating. Whether the convenient accessibility, rapid publication of studies on COVID-19, and shorter preparation time affect the methodological quality and reporting characteristics of published SRs/meta-analyses, during the specific period of the COVID-19 pandemic, still needs to be clarified. To date, no study has assessed the methodological quality and reporting characteristics of SRs/meta-analyses related to COVID-19. Therefore, this cross-sectional study aimed to investigate the epidemiology, methodological quality, and reporting characteristics of published SRs/meta-analyses related to COVID-19.

1.1. Setting

This cross-sectional study aimed to investigate the epidemiology, methodological quality, and reporting characteristics of published SRs/meta-analyses related to COVID-19. Ethical approval was not required, as this study was cross-sectional in nature and only included SRs and meta-analyses.

2. Methods

2.1. Eligibility criteria

According to the definition provided by the Cochrane book, the following criteria were employed: the study is a SR and/or a meta-analysis, or a systematic scoping review, a scoping review, a systematic rapid living review, or a rapid review; the study clearly describes the search strategy; the study explicitly illustrates the study selection criteria and study selection; the study reports the statistical methods to synthesize data including but not limited to heterogeneity assessment, sensitivity analysis, subgroup analysis, and assessment of publication bias if applicable, or the descriptive summary when meta-analysis cannot be performed[3]; and the topic of published SRs/meta-analyses is related to COVID-19 regardless of the specific research theme. SRs/meta-analyses that were published in English or Chinese were included.

Meanwhile, duplicate studies, letters, and study protocols were excluded from the analysis.

2.2. Search strategy

To perform a systematic retrieval of literatures, the Ovid PubMed, Ovid Embase, Cochrane Library, and Web of Science were searched using both Mesh terms and keywords, without language limitations, and the literature search was conducted from January 1, 2019 to April 28, 2020. The search terms used were as follows: "systematic review," "meta-analysis," and "COVID-19"; the detailed search strategy can be found in Supplemental Digital Content, http://links.lww.com/MD/G491. The reference lists of included studies were manually checked to identify potential eligible studies.

2.3. Study selection

The study screening was performed in 2 steps: title and abstract screening, and full-text screening. The references retrieved from electronic databases were introduced to Endnote; after removal of duplicates, the studies were exported to the Microsoft Access Database for preliminary screening of titles and abstracts. The full-texts of the remaining studies obtained from the first screening were downloaded and read for further screening based on the study eligibility criteria. The reference lists of all included SRs and meta-analyses were manually checked. Two authors independently screened the studies, and any disagreement was resolved via discussion or adjudication by a third reviewer, if necessary.

2.4. Data extraction

Two authors independently collected the following data: name of the first author; country of the first author; study question; main conclusion; number of authors; journal impact factor; literature retrieval date; date that the study was first available online; focus of review; number of included studies; study design and total number of participants included in the SRs/meta-analyses; risk of bias assessment tool; reporting guidelines mentioned; publication language; literature retrieved; whether the article is a Cochrane review or not; type of review; certainty of evidence based on the Grading of Recommendations Assessment, Development, and Evaluation; funding information; statistic information of the meta-analyses including the software used for data analysis; judgement standards for statistical significance; indicators of data pooling; model for data pooling; method for meta-analysis; statistical method for determining the heterogeneity; method used to assess for publication bias; and additional analyses, like subgroup analysis, sensitivity analysis, and meta-regression. Any disagreement on data extraction was resolved via discussion or adjudication by a third reviewer if necessary.

2.5. Methodological quality assessment

The methodological quality of all included SRs/meta-analyses was assessed using AMSTAR-2,[5] which has a total of 16 items and is used to assess the quality of SRs that enroll both randomized controlled trials (RCTs) and observational studies on

healthcare interventions. Each item is answered by partially yes, yes, or no. The overall quality can be categorized as critically low, low, moderate, or high, based on whether the study has noncritical or critical weakness domains and on the number of noncritical or critical flaw domains. Two authors independently performed the quality assessment, and any disagreement was resolved via discussion or adjudication by a third reviewer, if necessary.

2.6. PRISMA checklist assessment

The reporting information of each study was evaluated based on the PRISMA guidelines; if the information was reported according to the PRISMA checklist, the answer related to this item was yes; otherwise, the answer was no. Two authors independently performed the PRISMA checklist assessment, and any disagreement was resolved via discussion or adjudication by a third reviewer, if necessary.

2.7. Data analysis

The number was counted, and the proportions were calculated. The statistical distribution difference of counts was assessed using a chi-square (χ^2) test. Statistical significance was judged by a P value of $<.05$ by a two-tailed test. The information of each study was described and summarized in tables.

3. Results

3.1. Study screening results

A total of 319 references were retrieved from the Ovid PubMed (n=22), Ovid Embase (n=176), Cochrane Library (n=2), and Web of Science (n=119). After removal of duplicates (n=120), 199 studies underwent title and abstract screening, and 96 studies were excluded. A total of 103 studies underwent full-text reading, and 56 studies were excluded. No eligible studies were identified after manually checking the reference lists of all included studies. Overall, 47 SRs/meta-analyses were included in the final analysis (Fig. 1).

3.2. Epidemiology of included studies

Of the 47 included studies,[9–55] only 13 were SRs,[10,15,18,20,22,23,26,29,38–40,43,52] while 34 were meta-analyses.[9,11–14,16,17,19,21,24,25,27,28,30–37,41,42,44–51,53–55] A total of 17 studies were published by Chinese authors, 8 by Italian authors, and 4 by American authors. Nearly half of the SRs/meta-analyses were performed by <5 authors (n=20, 42.6%), which was comparable between SRs only (n=6, 46.2%) and meta-analysis (n=14, 41.2%); nevertheless, Chinese-based studies (n=11, 64.7%) were commonly performed by 6 to 10 authors compared with nonChinese-based studies (n=7, 23.3%). SRs/meta-analyses were most commonly published by journals with an impact

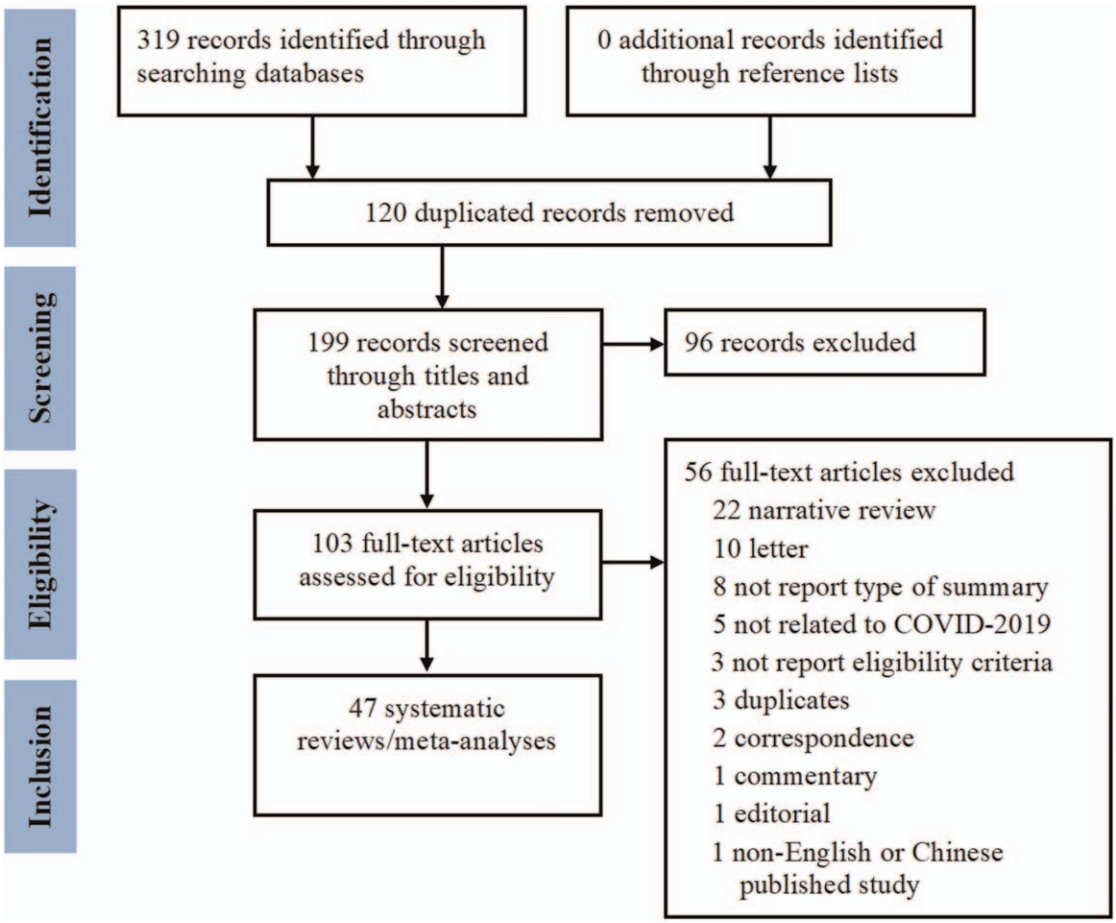

Figure 1. Study selection flowchart.

factor of no more than 5 (n = 34, 72.3%), and no difference was found between SRs only (n = 9, 69.2%) and meta-analyses (n = 25, 73.5%) or studies performed by Chinese authors (n = 12, 70.6%) or authors outside of China (n = 22, 73.3%) (Table S1, Supplemental Digital Content, http://links.lww.com/MD/G491). The studies mainly focused on the epidemiology (n = 14, 29.8%), clinical manifestations (n = 8, 17.0%), therapeutic interventions (n = 7, 14.9%), prevention (n = 7, 14.9%), diagnosis (n = 6, 12.8%), and prognosis (n = 1, 2.1%); the detailed study aims and main conclusions are listed in Table S2, Supplemental Digital Content, http://links.lww.com/MD/G491. The distribution of review focus was different between SRs only and meta-analysis ($\chi^2 = 14.991$, $P = .015$). For SRs, the study focused on the therapeutic interventions (n = 4, 30.8%) and prevention (n = 5, 38.5%); for meta-analysis, epidemiology (n = 13, 38.2%) was the most common topic. For studies published by Chinese authors, the top 2 study topics were epidemiology (n = 6, 35.3%) and clinical manifestations (n = 5, 29.4%); for studies published by authors from other countries, epidemiology (n = 8, 26.7%) the most common topic. The median number of days from the date of literature retrieval to the date that the study was first available online was comparable between SRs only and meta-analysis ($\chi^2 = 2.54$, $P = .314$) and most common ranged from 16 to 30 days. Nevertheless, the period from the date of literature retrieval to the date that the SR/meta-analysis performed by Chinese author was first available online was most common for more than 30 days (n = 8, 47.1%), while that conducted by nonChinese authors ranged from 16 to 30 days (n = 17, 56.7%) (Table S1, Supplemental Digital Content, http://links.lww.com/MD/G491).

3.3. General methodological characteristics of included studies

The number of included studies in the SR/meta-analysis was common for <10 (n = 18, 38.3%); the included studies were observational studies (n = 10, 21.3%), case series/case reports (n = 7, 14.9%), and RCTs (n = 3, 6.4%). The most common total number of participants ranged from 1001 to 5000 (n = 26, 55.3%). Several risk of bias assessment tools were used to evaluate the quality of studies included in the reviews, including the Newcastle–Ottawa Scale (NOS) (8, 17.0%), Cochrane risk of bias tool (n = 2, 4.3%), the British National Institute for Clinical Excellence (NICE) (n = 2, 4.3%), Murad tool (n = 2, 4.3%), methodological index for nonrandomized studies MINORS (n = 2, 4.3%), NIH methodological quality tool (n = 2, 4.3%), and others. Most of the studies were conducted in line with the PRISMA guidelines (n = 27, 57.4%) and were published in English (n = 46, 97.9%). The number of databases searched for relevant studies mostly was <6 (n = 44, 93.6%), and manual checking was performed in more than half of the studies (n = 31, 66.0%). Majority of the reviews did not use GRADE to categorize the quality of evidence (n = 40, 85.1%), and most of the reviews reported funding information (n = 34, 72.3%). The distribution of the number of included studies, reporting guidelines mentioned, publication language, number of databases retrieved, manual checking of reference lists, and funding information were comparable between SRs only and meta-analyses or between studies published by Chinese authors and by authors from other countries. The most commonly used study designs were multiple study designs (n = 7, 20.6%) for SRs, observational studies (n = 10, 21.3%) for meta-analyses, and observational studies (n = 7, 41.2%) for SRs only/meta-analyses published by Chinese authors, and multiple study designs (n = 13, 43.3%) for studies published by nonChinese authors (Table 1).

3.4. Statistical information regarding meta-analyses

Stata (StataCorp LP, USA) (n = 11, 32.4%), R (The R Foundation for Statistical Computing) (n = 4, 11.8%), and MetaXL (EpiGear International Pty Ltd., Sunrise Beach, Australia) (n = 4, 11.8%) were the statistical software commonly used for performing a meta-analysis. Only 12 (35.3%) studies reported the standard method for determining whether the result was statistically significant or not. The most common indicator to synthesize data was incidence with its 95% confidence interval (CI) (n = 15, 44.1%). A total of 27 (79.5%) studies reported the model used to synthesize data. The different data synthesizing methods used were double arcsine transforming (n = 6, 17.6%), inverse variance model (n = 6, 17.6%), Mantel–Haenszel formula (n = 3, 8.8%), and DerSimonian–Laird procedure (n = 1, 2.9%). Chi-square and I^2 tests were used to investigate the heterogeneity in 20 (58.8%) studies. The methods used to assess the risk of publication bias were Begg test, Egger test, funnel plots, or a combination of these tests. Additional analyses included meta-regression, sensitivity analysis, subgroup analysis, or a combination of these analyses to test the robustness of results or to find the possible source of heterogeneity (Table 2).

3.5. Assessment of methodological quality

All included SRs/meta-analyses used the participants, interventions, comparisons, and outcomes principles to construct a research question and the study selection criteria; however, only 14.9% of the included studies (7/47) were performed with a predefined protocol. Over half of the studies (n = 35) included the criteria for selecting a study, and all studies reported the comprehensive literature search strategy. Not all studies included study selection (43/47, 91.5%) and data extraction (35/47, 74.5%) in duplicate, according to the reports provided in the Methods section. Nevertheless, all studies described the included studies in detail, and 97.9% of studies (46/47) justified the reasons for excluding studies during the full-test screening. Nearly half of SRs/meta-analyses (n = 28, 59.6%) had a risk of bias assessment, and only 36.2% (17/47) of the studies interpreted the risk of bias when the results were discussed; meanwhile, none of the included studies reported the sources of funding. A total of 13 studies were SRs only, without data synthesis; therefore, items related to the appropriate statistical methods used for data pooling, the potential impact of risk of bias on the meta-analysis results, satisfactory statements related to the observed heterogeneity, and investigation of publication bias were not applicable; correspondingly, 91.2% (31/34), 29.4% (10/34), 61.8% (21/34), and 67.6% (23/34) of meta-analyses reported the relative items. Approximately 93.6% (44/47) of studies reported the potential source of conflict of interest. Overall, the quality of all included reviews was low to critically low; in particular, 31 (66.0%) studies were rated as having a critically low quality, 13 (27.7%) as having a low quality, and only 3 (6.4%) as having a high quality. Of the 3 high-quality studies, 2 were Cochrane reviews. The detailed descriptions of the SRs only, meta-analysis, studies published by Chinese authors, and studies published by nonChinese authors are listed in Table 3.

Table 1

Characteristics of included systematic reviews/meta-analyses.

Category	SR only (n = 13)	SR/Meta (n = 34)	$\chi 2$ (*P*-value)	Published by Chinese author (n = 17)	Published by other country (n = 30)	$\chi 2$ (*P*-value)	Overall (n = 47)
No. of included studies			2.044 (.526)			0.555 (.907)	
0 to 10	3 (23.1%)	15 (44.1%)		7 (41.2%)	11 (36.7%)		18 (38.3%)
11 to 19	4 (30.8%)	6 (17.6%)		3 (17.6%)	7 (23.3%)		10 (21.3%)
20 to 39	4 (30.8%)	8 (23.5%)		5 (29.4%)	7 (23.3%)		12 (25.5%)
≥40	2 (15.4%)	5 (14.7%)		2 (11.8%)	5 (16.7%)		7 (14.9%)
Included study design			9.541 (.031)			11.421 (.022)	
RCTs	2 (5.9%)	1 (2.1%)		0 (0.0%)	3 (10.0%)		3 (6.4%)
Observational study	0 (0.0%)	10 (21.3%)		7 (41.2%)	3 (10.0%)		10 (21.3%)
Case series/case report	2 (5.9%)	5 (10.6%)		4 (23.5%)	3 (10.0%)		7 (14.9%)
Multiple study design	7 (20.6%)	8 (17.0%)		2 (11.8%)	13 (43.3%)		15 (31.9%)
NR	2 (5.9%)	10 (21.3%)		4 (23.5%)	8 (26.7%)		12 (25.5%)
No. of included participants			26.667 (.000)			5.778 (.295)	
0 to 500	4 (30.8%)	2 (5.9%)		1 (5.9%)	5 (16.7%)		6 (12.8%)
501 to 1000	3 (23.1%)	0 (0.0%)		0 (0.0%)	3 (10.0%)		3 (23.1%)
1001 to 5000	2 (15.4%)	24 (70.6%)		12 (70.6%)	14 (46.7%)		26 (55.3%)
≥5001	1 (7.7%)	8 (23.5%)		4 (23.5%)	5 (16.7%)		9 (19.1%)
NR	3 (23.1%)	0 (0.0%)		0 (0.0%)	3 (10.0%)		3 (23.1%)
Risk of bias assessment tool used			10.945 (.219)			21.012 (.013)	
Mentioned, did not perform	4 (30.8%)	3 (8.8%)		0 (0.0%)	7 (23.3%)		7 (14.9%)
NOS scale (or modified)	0 (0.0%)	8 (23.5%)		6 (35.3%)	2 (6.7%)		8 (17.0%)
Cochrane risk of bias tool (or modification)	0 (0.0%)	2 (5.9%)		1 (5.9%)	1 (3.3%)		2 (4.3%)
NICE	0 (0.0%)	2 (5.9%)		2 (11.8%)	0 (0.0%)		2 (4.3%)
The Murad tool	1 (7.7%)	1 (2.1%)		0 (0.0%)	2 (6.7%)		2 (4.3%)
The MINORS	0 (0.0%)	2 (5.9%)		2 (11.8%)	0 (0.0%)		2 (4.3%)
NIH methodological quality	1 (7.7%)	1 (2.1%)		1 (5.9%)	1 (3.3%)		2 (4.3%)
Multiple study quality assessment tool	1 (7.7%)	3 (8.8%)		0 (0.0%)	4 (13.3%)		4 (8.5%)
Other quality assessment tool	3 (23.1%)	3 (8.8%)		1 (5.9%)	5 (16.7%)		6 (12.8%)
NR	3 (23.1%)	9 (26.5%)		4 (23.5%)	8 (26.7%)		12 (25.5%)
Reporting guideline mentioned			3.538 (.316)			7.729 (.052)	
PRISMA	10 (76.9%)	17 (50.0%)		6 (35.3%)	21 (70.0%)		27 (57.4%)
MOOSE	0 (0.0%)	2 (5.9%)		2 (11.8%)	0 (0.0%)		2 (4.3%)
Both PRISMA and MOOSE	0 (0.0%)	3 (8.8%)		1 (5.9%)	2 (6.7%)		3 (23.1%)
NR	3 (23.1%)	12 (35.3%)		8 (47.1%)	7 (23.3%)		15 (31.9%)
Publication language			0.391 (1.000)			1.803 (.362)	
Chinese	0 (0.0%)	1 (2.9%)		1 (5.9%)	0 (0.0%)		1 (2.1%)
English	13 (100.0%)	33 (97.1%)		16 (94.1%)	30 (100.0%)		46 (97.9%)
No of databases retrieved			1.244 (.537)			0.745 (.689)	
≤3	7 (53.8%)	16 (47.1%)		7 (41.2%)	16 (53.3%)		23 (48.9%)
4 to 6	6 (46.2%)	15 (44.1%)		9 (52.9%)	12 (40.0%)		21 (44.7%)
≥7	0 (0.0%)	3 (8.8%)		1 (5.9%)	2 (6.7%)		3 (23.1%)
Manually checking of reference lists			0.156 (.693)			0.019 (.892)	
Yes	8 (61.5%)	23 (67.6%)		11 (64.7%)	20 (66.7%)		31 (66.0%)
No	5 (38.5%)	11 (32.4%)		6 (35.3%)	10 (33.3%)		16 (34.0%)
GRADE assessment of evidence			3.573 (.059)			4.661 (.031)	
Yes	4 (30.8%)	3 (8.8%)		0 (0.0%)	7 (23.3%)		7 (14.9%)
NR	9 (69.2%)	31 (91.2%)		17 (100.0%)	23 (76.7%)		40 (85.1%)
Funding			0.649 (.723)			0.882 (.471)	
Yes	6 (46.2%)	13 (38.2%)		9 (52.9%)	10 (33.3%)		19 (40.4%)
No	3 (23.1%)	12 (35.3%)		4 (23.5%)	11 (36.7%)		15 (31.9%)
NR	4 (30.8%)	9 (26.5%)		4 (23.5%)	9 (30.0%)		13 (27.7%)

Meta = meta-analysis, MOOSE = preferred reporting items for meta-analyses of observational studies in epidemiology statement, NICE = the British National Institute for Clinical Excellence, No. = number, NOS = Newcastle–Ottawa Scale, NR = not reported, PRISMA = preferred reporting items for systematic reviews and meta-analysis statement, RCTs = randomized controlled trials, the MINORS = the methodological index nonrandomized study statement, the Murad tool = the framework for appraisal, synthesis and application of evidence suggested by Murad et al, SR = systematic review.

3.6. PRISMA checklist assessment

The rate of compliance to the PRISMA guidelines ranged from 14.9% to 100%. All SRs and meta-analyses met the following criteria: provided the rationale and objectives in the Introduction section, indicated the eligibility criteria, and provided the sources of information in the Methods section. The keywords "systematic review" and/or meta-analysis were found in the titles of 44 (93.6%) studies, and a structured summary was included in 41 (87.2%) studies. In the Methods section, the rate of compliance for each item ranged from 14.9% to 100.0%. Only 7 (14.9%) studies provided information on the study protocol and registration, while 15 (31.9%) presented the detailed search

Table 2

Statistic methods reported by included meta-analyses.

Characteristic	Category	Meta-analysis (n = 34)
Statistic software	Stata	11 (32.4%)
	R	4 (11.8%)
	MetaXL	4 (11.8%)
	Comprehensive Meta Analysis	2 (5.9%)
	Review Manager	2 (5.9%)
	StatsDirect	2 (5.9%)
	>1 software	8 (23.5%)
	NR	1 (2.9%)
Reporting standards for statistical significance	Yes, a 2-sided *P*-value of ≤.05 was deemed significant	12 (35.3%)
	NR	22 (64.7%)
Indicator to synthesize data	Incidence with 95% CI	15 (44.1%)
	OR with 95%CI	7 (20.6%)
	RR with 95%CI	1 (2.9%)
	>2 indicators	9 (26.5%)
	NR	2 (5.9%)
Meta-analysis model used	A fixed or random effect model based on heterogeneity	11 (32.4%)
	A random effects model	16 (47.1%)
	NR	7 (20.6%)
Meta-analysis method used	Double arcsine method	6 (17.6%)
	An inverse variance model	6 (17.6%)
	Mantel–Haenszel formula	3 (8.8%)
	DerSimonian–Laird procedure	1 (2.9%)
	Reporting >1 method	3 (8.8%)
	NR	15 (44.1%)
Statistical heterogeneity investigated	Chi square and I^2 tests	20 (58.8%)
	I^2 statistic	8 (23.5%)
	NR	6 (17.6%)
Risk of publication bias assessed	Begg test	1 (2.9%)
	Egger test	9 (26.5%)
	Funnel plot	3 (8.8%)
	Both Begg test and Egger test	2 (5.9%)
	Egger test and Funel plots	5 (14.7%)
	Did not peform	2 (5.9%)
	Begg test, Egger test, and Funel plots	1 (2.9%)
	Egger test, Harbord test, and inverted plot analysis	1 (2.9%)
	NR	10 (29.4%)
Additional analyses	Meta-regression	1 (2.9%)
	Sensitivity analysis	6 (17.6%)
	Subgroup analysis	6 (17.6%)
	Meta-regression and sensitivity analysis	1 (2.9%)
	Sensitivity analysis and subgroup analysis	6 (17.6%)
	Sensitivity and meta-regression	1 (2.9%)
	Others	1 (2.9%)
	>2 additional analyses	1 (2.9%)
	NR	11 (32.4%)

CI = confidence interval, NR = not reported, OR = odds ratio, RR = relative risk.

strategy. Nearly half of the studies assessed the publication bias (n = 21, 44.7%) and performed an additional analysis (n = 23, 48.9%). More than half of the studies involved a study selection process (n = 43, 91.5%) or data collection process (n = 35, 74.5%), included the same data items (n = 35, 74.5%), assessed the risk of bias in individual studies (n = 29, 61.7%), provided summary measures (n = 45, 95.7%), and synthesized the results (n = 32, 68.1%). In the Results section, the rate of compliance to each of the items ranged from 42.6% to 97.9%. The risk of bias in less than half of the studies was similar to that within studies (n = 21, 44.7%), across studies (n = 20, 42.6%), and in additional analyses (n = 22, 46.8%); meanwhile, more than half of the studies performed the study selection process (n = 46, 97.9%), had similar study characteristics (n = 40, 85.1%), reported the results of individual studies (n = 43, 91.5%), and synthesized the results (n = 34, 72.4%). In the Discussion section, more than half of studies provided the summary of evidence (n = 42, 89.4%), limitations (n = 43, 91.5%), and conclusions (n = 43, 91.5%). With regard to the funding source, 34 (72.3%) studies reported this information in accordance with the PRISMA guidelines. The detailed descriptions of the SRs only, meta-analyses, studies published by Chinese authors, and studies published by nonChinese authors are listed in Table 4.

4. Discussion

This cross-sectional study investigated the methodological quality and reporting characteristics of published SRs and

Table 3

Methodological quality of included systematic reviews/meta-analyses assessed by AMSTAR-2.

Study quality assessment item (Yes)	SR only (n = 13)	SR/meta (n = 34)	Published by Chinese author (n = 17)	Published by other country (n = 30)	Overall (n = 47)
1. Did the research questions and inclusion criteria for the review include the components of PICO?	13 (100.0%)	34 (100.0%)	17 (100.0%)	30 (100.0%)	47 (100.0%)
2*. Did the report of the review contain an explicit statement that the review methods were established prior to the conduct of the review and did the report justify any significant deviations from the protocol?	3 (23.1%)	4 (11.8%)	0 (0.0%)	7 (23.2%)	7 (14.9%)
3. Did the review authors explain their selection of the study designs for inclusion in the review?	9 (69.2%)	26 (76.5%)	14 (82.4%)	21 (70.0%)	35 (74.5%)
4*. Did the review authors use a comprehensive literature search strategy?	13 (100.0%)	34 (100.0%)	17 (100.0%)	30 (100.0%)	47 (100.0%)
5. Did the review authors perform study selection in duplicate?	12 (92.3%)	31 (91.2%)	14 (82.4%)	29 (96.7%)	43 (91.5%)
6. Did the review authors perform data extraction in duplicate?	10 (76.9%)	25 (73.5%)	11 (64.7%)	24 (80.0%)	35 (74.5%)
7*. Did the review authors provide a list of excluded studies and justify the exclusions?	12 (92.3%)	34 (100.0%)	17 (100.0%)	29 (96.7%)	46 (97.9%)
8. Did the review authors describe the included studies in adequate detail?	13 (100.0%)	34 (100.0%)	17 (100.0%)	30 (100.0%)	47 (100.0%)
9*. Did the review authors use a satisfactory technique for assessing the risk of bias (RoB) in individual studies that were included in the review?	6 (46.2%)	22 (64.7%)	13 (76.5%)	15 (50.0%)	28 (59.6%)
10. Did the review authors report on the sources of funding for the studies included in the review?	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
11*. If meta-analysis was performed, did the review authors use appropriate methods for statistical combination of results?	Not applicable	31 (91.2%)	15 (88.2%)	16 (53.3%)	31 (66.0%)
12. If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?	Not applicable	10 (29.4%)	3 (17.6%)	7 (23.3%)	10 (21.2%)
13*. Did the review authors account for RoB in primary studies when interpreting/ discussing the results of the review?	5 (38.5%)	12 (35.3%)	6 (35.3%)	11 (36.7%)	17 (36.2%)
14. Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review?	Not applicable	21 (61.8%)	9 (52.9%)	12 (40.0%)	21 (44.7%)
15*. If they performed quantitative synthesis did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review?	Not applicable	23 (67.6%)	14 (82.4%)	9 (30.0%)	23 (48.9%)
16. Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?	11 (84.6%)	33 (97.1%)	17 (100.0%)	27 (90.0%)	44 (93.6%)
Rating overall confidence					
High	2 (15.4%)	1 (2.9%)	0 (0.0%)	3 (10.0%)	3 (6.4%)
Low	4 (30.8%)	9 (26.5%)	5 (29.4%)	8 (26.7%)	13 (27.7%)
Critically low	7 (53.8%)	24 (70.6%)	12 (70.6%)	19 (63.3%)	31 (66.0%)

PICO = participants, interventions, comparisons, outcomes.
* Critical weakness domains.

meta-analyses related to COVID-19. Overall, the study quality was low to critically low, and the rate of compliance to the PRISMA guidelines varied from 14.9% to 100%. As the first COVID-19 outbreak occurred in China, the number of studies performed by Chinese authors was relatively high. The median number of days from the date of literature retrieval to the date that the study was first available online was 21 days; due to the limited time, only 7 studies had study protocols.

Various risk of bias assessment tools were used in different SRs/meta-analyses; this was due to the fact that SRs/meta-analyses focused on several topics such as epidemiology, therapeutic interventions, prevention, diagnosis, and prognosis. The following methodological quality assessment tools were recommended, based on the study designs:[56] the Cochrane Collaboration's tool for RCTs, the Newcastle–Ottawa Scale for cohort and case-control studies, the methodological index for nonrandomized studies for nonrandomized interventional studies, the Agency for Healthcare Research and Quality methodology checklist for cross-sectional studies, the Quality Assessment of Diagnostic Accuracy Studies-2 for diagnostic accuracy test studies, the Systematic Review Centre for Laboratory animal Experimentation for animal studies, the revised version of the AMSTAR for SRs/meta-analyses, an 18-item tool for case series studies, and the Appraisal of Guidelines Research and Evaluation-II instrument for clinical practice guidelines.

In this study, none of the SRs/meta-analyses reported the sources of funding of the studies included in the review. Although this is only a noncritical weakness item and does not dramatically affect the methodological quality, it had associations with the published journal impact factor.[57] This may be partially

Table 4

Preferred reporting items for systematic review and meta-analysis assessment of reporting characteristics.

Category	Item (Yes)	SR only (n = 13)	SR/meta (n = 34)	Published by Chinese author (n = 17)	Published by other country (n = 30)	Overall (n = 47)
Title	1. Title	13 (100.0%)	31 (91.2%)	16 (94.1%)	28 (93.3%)	44 (93.6%)
Abstract	2. Structured summary	11 (84.6%)	30 (88.2%)	15 (88.2%)	26 (86.7%)	41 (87.2%)
Introduction	3. Rationale	13 (100.0%)	34 (100.0%)	17 (100.0%)	30 (100.0%)	47 (100.0%)
	4. Objectives	13 (100.0%)	34 (100.0%)	17 (100.0%)	30 (100.0%)	47 (100.0%)
Methods	5. Protocol and registration	3 (23.1%)	4 (11.8%)	0 (0.0%)	7 (23.3%)	7 (14.9%)
	6. Eligibility criteria	13 (100.0%)	34 (100.0%)	17 (100.0%)	30 (100.0%)	47 (100.0%)
	7. Information sources	13 (100.0%)	34 (100.0%)	17 (100.0%)	30 (100.0%)	47 (100.0%)
	8. Search	9 (69.2%)	6 (17.6%)	2 (11.8%)	13 (43.3%)	15 (31.9%)
	9. Study selection	13 (100.0%)	30 (88.2%)	13 (76.5%)	30 (100.0%)	43 (91.5%)
	10. Data collection process	9 (69.2%)	26 (76.5%)	12 (70.6%)	23 (76.7%)	35 (74.5%)
	11. Data items	10 (76.9%)	25 (73.5%)	13 (76.5%)	22 (73.3%)	35 (74.5%)
	12. Risk of bias in individual studies	7 (53.8%)	22 (64.7%)	13 (76.5%)	16 (53.3%)	29 (61.7%)
	13. Summary measures	12 (92.3%)	33 (97.1%)	17 (100.0%)	28 (93.3%)	45 (95.7%)
	14. Synthesis of results	0 (0.0%)	32 (94.1%)	16 (94.1%)	16 (53.3%)	32 (68.1%)
	15. Risk of bias across studies	0 (0.0%)	21 (61.8%)	13 (76.5%)	8 (26.7%)	21 (44.7%)
	16. Additional analyses	0 (0.0%)	23 (67.6%)	12 (70.6%)	11 (36.7%)	23 (48.9%)
Results	17. Study selection	13 (100.0%)	33 (97.1%)	17 (100.0%)	29 (96.7%)	46 (97.9%)
	18. Study characteristics	11 (84.6%)	29 (85.3%)	13 (76.5%)	27 (90.0%)	40 (85.1%)
	19. Risk of bias within studies	6 (46.2%)	15 (44.1%)	9 (52.9%)	12 (40.0%)	21 (44.7%)
	20. Results of individual studies	11 (84.6%)	32 (94.1%)	15 (88.2%)	28 (93.3%)	43 (91.5%)
	21. Synthesis of results	0 (0.0%)	34 (100.0%)	17 (100.0%)	17 (56.7%)	34 (72.3%)
	22. Risk of bias across studies	0 (0.0%)	20 (58.8%)	11 (64.7%)	9 (30.0%)	20 (42.6%)
	23. additional analyses	0 (0.0%)	22 (64.7%)	11 (64.7%)	11 (36.7%)	22 (46.8%)
Discussion	24. Summary of evidence	11 (84.6%)	31 (91.2%)	17 (100.0%)	25 (83.3%)	42 (89.4%)
	25. Limitations	9 (69.2%)	34 (100.0%)	17 (100.0%)	26 (86.7%)	43 (91.5%)
	26. Conclusions	12 (92.3%)	31 (91.2%)	14 (82.4%)	29 (96.7%)	43 (91.5%)
Funding	27. Funding	9 (69.2%)	25 (73.5%)	12 (70.6%)	22 (73.3%)	34 (72.3%)

influenced by the shorter manuscript preparation time, although the rate of reporting of funding sources in meta-analyses of trials on pharmacological treatment in high-impact biomedical journals was low (7%).[58] For individual conflicts of interest, 49% and 33% of Cochrane and nonCochrane reviews, respectively, reported the type of conflict of interest for at least 1 author; for institutional conflicts of interest, the rate of reporting was lesser: 19% and 5% for Cochrane and non-Cochrane reviews, respectively.[8]

With regard to the compliance to the PRISMA guidelines, the number of items related to the risk of bias within studies and the risk of bias across studies were higher for the Methods section than for the Results section; this finding indicated that some SRs/meta-analyses did not report the risk of bias within studies and across studies in the Results section, although the methodology was reported in the Methods section. Other reporting items, like the detailed search strategy and performance of additional analysis, need to be improved. In our study, 72.3% of SRs/meta-analyses reported the funding information, which was similar to the percentage of previous studies that reported this information (64%[3] but higher than 41.4%).[59]

This cross-sectional study was the first to assess the study quality of published SRs/meta-analyses related to COVID-19 regardless of the study topic. This study has several limitations. Firstly, we did not compare the study characteristics, methodological quality, and reporting characteristics of SRs/meta-analyses on COVID-19 with those of studies investigating other topics published during the same period. Nevertheless, when compared with the study performed by Page et al in 2014,[3] our study showed similar results and concluded that the performance and reporting should be improved. Secondly, due to the limited time to conduct the reviews, only 7 studies had a study protocol, which is one of the critical domains in the study quality assessment tool, AMSTAR-2; thus, the study quality was considered low if the reviews did not have a study protocol; only 3 (6.4%) studies were Cochrane reviews. In addition, none of the original studies included in the SRs/meta-analyses reported the funding information.

5. Conclusions

This study aimed to evaluate the methodological quality and reporting characteristics of SRs/meta-analyses on COVID-19. However, the conduct and reporting quality of SRs/meta-analyses on COVID-19 were poor, which should be improved. The funding information of studies included in the SRs/meta-analyses should be reported.

Author contributions

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