Systematic Review Article
http://mjiri.iums.ac.ir
Medical Journal of the Islamic Republic of Iran (MJIRI)

Med J Islam Repub Iran. 2025 (6 May);39.64. https://doi.org/10.47176/mjiri.39.64

Methodological and Systematic Errors in Systematic Reviews in Health Domain: A Systematic Review

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Received: 20 Jul 2024 Published: 6 May 2025

Abstract

Background: According to the pyramid of evidence, systematic reviews hold the highest position among studies used in healthcare systems and policy-making. Avoiding systematic and methodological errors are demanding responsibility for authors. Clearly, erroneous studies can have irreparable consequences on health and treatment decisions. Therefore, this study aims to identify potential errors in systematic reviews within the field of health.

Methods: To systematically identify potential errors in systematic reviews, we conducted a comprehensive literature search using keywords such as "Bias," "Error," and "Systematic Reviews" across databases like PubMed, Web of Science, Scopus, Embase, Cochrane Library, and ProQuest without any time restrictions. This yielded 2333 articles and 11 books initially.
After removing duplicates and unrelated sources based on predefined inclusion/exclusion criteria tailored for this study context (e.g., relevance to error identification in systematic reviews), we closely examined 88 relevant sources.

Results: Upon analyzing the full texts of these sources with strict adherence to our criteria, we identified 77 distinct types of errors that could occur either within or between studies. These findings highlight the complexity of maintaining accuracy in systematic review methodologies.

Conclusion: Given the critical role systemic reviews play in informing clinical decisions and health policies, ensuring their quality is paramount. Accurate methodology ensures validity; biased studies risk leading to suboptimal patient care outcomes. By pinpointing error sources—such as selection bias or information bias—and implementing strategies to mitigate them through rigorous methodologies like robust search protocols or transparent reporting standards (e.g., PRISMA guidelines), researchers can enhance review quality significantly.

Keywords: Bias, Publications, Publication Bias, Data Accuracy, Systematic Reviews as Topic, Health

Conflicts of Interest: None declared
Funding: None

Cite this article as: Vesal Azad R, Riahinia N, Azimi A, Baradaran H. Methodological and Systematic Errors in Systematic Reviews in Health Domain: A Systematic Review. *Med J Islam Repub Iran.* 2025 (6 May);39:64. https://doi.org/10.47176/mjiri.39.64

Introduction

Systematic reviews often considered “the best evidence”, play a vital role in informing clinical decisions and healthcare policies. However, their validity and accuracy are crucial to ensure these decisions are effective and "cost-consciousness of these decisions". SRs of well-designed, randomized controlled trials (RCTs) with mini-

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↑What is “already known” in this topic:
Systematic reviews are widely regarded as the "gold standard" of evidence, playing a pivotal role in supporting decision-making within the healthcare sector. However, errors and biases can compromise their results, leading to incorrect healthcare decisions, unnecessary costs, and potential harm to patients.

→What this article adds:
This study underscores the importance of ensuring the validity and quality of systematic reviews for informed clinical decision-making. By identifying and addressing sources of errors, it is possible to significantly enhance the quality of outcomes. To minimize these errors effectively, it is essential to focus on several key factors: validity, high-quality evidence, study design, objectives, clinical policies and quality assessment.

[DOI: 10.47176/mjiri.39.64]

mal bias and low heterogeneity provide the strongest evidence in medicine (1, 2). The increasing number of SRs underscores the need for robust quality assessment and error prevention. Errors and biases in SRs can lead to flawed healthcare decisions, unnecessary costs and potential harm to patients. Recognizing the types and sources of errors, along with their impact on results, can significantly contribute to error reduction (3-10). best solution to reduce errors in studies is careful reflection and sufficient accuracy during the research design phase(11, 12).

The most important issue in evaluating a SR is that it is free of the following three potential sources of error (13):

1. Systematic error (or internal validity) also known as distortion or bias
2. Random error (or precision)
3. Risk due to study design

According to the Cochrane Handbook, at least six steps are necessary to conduct a SR (14). Errors may occur in each of these steps, potentially affecting the research results (15) (Figure 1). Table 1 shows how to control research errors at each stage of the research.

The existing literature and documents have sporadically identified errors and biases in SRs. Therefore, the aim of this study is to systematically assess and categorize the biases that commonly occur in SRs. By doing so, we hope to reduce the costs associated with healthcare studies and increase healthcare professionals' confidence in published SRs.

Methods

To identify types of errors in SRs, we conducted a comprehensive search across six databases: PubMed, Web of Science, Scopus, Embase, Cochrane Library, and ProQuest. Additionally, a manual library search was performed to identify relevant books and gray literature, supplementing database searches to mitigate publication bias. No time restrictions were imposed. Our search aimed to retrieve studies investigating errors in SRs. Inclusion criteria focused on articles with a clear emphasis on "error," "bias," and "systematic review studies." We employed search syntax tags such as [MAJR] and /mj to identify articles with these keywords as a major focus. To ensure comprehensive retrieval, we also considered variations in terminology, including synonyms and morphological variations, to address potential errors in search strategies.

From an initial pool of 2333 articles and 11 books, we excluded documents that reviewed or compared risk assessment tools or discussed errors in other study types. After removing duplicates and irrelevant articles, we reviewed 88 documents to identify and categorize biases

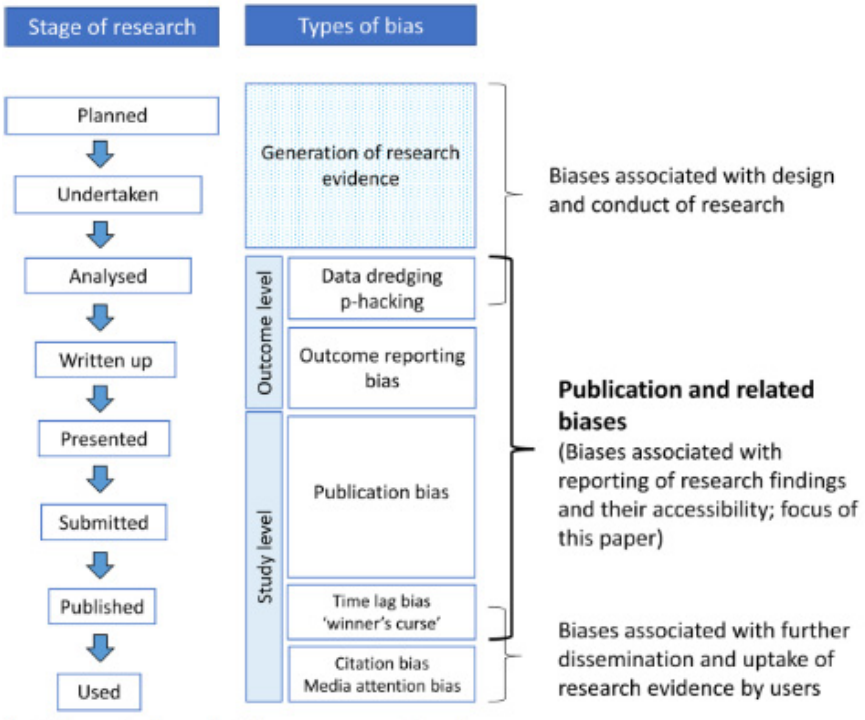

Figure 1. Biases at various stages of research (16)

Table 1. How to prevent research errors at every stage (11)

Research stage	How to prevent and control based on the type of error	
	Systematic Error	Random Error
Research design stage	• Improving research design • Increasing the credibility of research	• Improving research design • Increasing the research Sample • Increasing research accuracy
Research implementation stage	Quality Control	Quality Control

[DOI: 10.47176/mjiri.39.64]

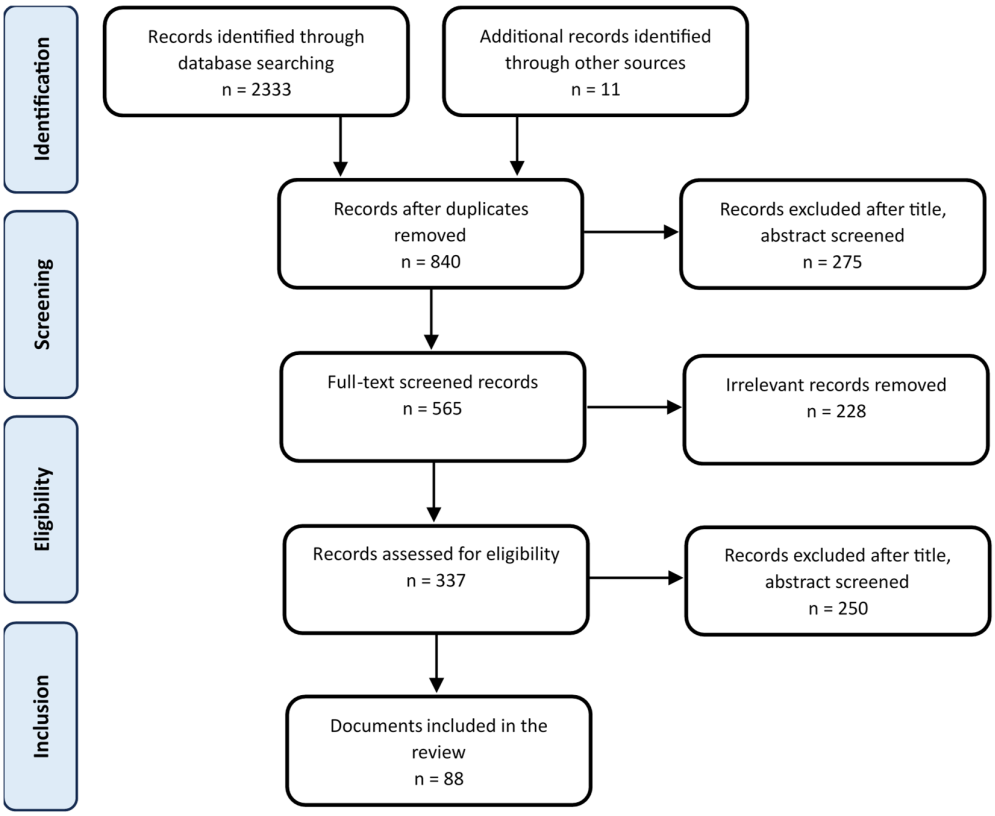

Figure 2. PRISMA flow diagram of the selection process

present in SRs. This involved assessing the full text of each document to identify specific errors in the review process, such as those related to data extraction, analysis, and interpretation. A PRISMA flow diagram of the selection process is presented in Figure 2.

Results

A full-text analysis of 88 selected documents led to the identification of 77 distinct types of errors in SRs, as presented in Appendix 1.

In summary, the identified biases in SRs can be categorized as outlined in Table 2.

Discussion

Systematic assessment, classification, and identification of error sources are crucial for both preventing and detecting errors, ultimately enhancing the quality and reliability of SR results (111). SRs strive for comprehensiveness and impartiality by including all relevant studies on a specific topic, making them valuable resources for healthcare stakeholders. However, SRs are not without limitations; Errors and biases can distort the true results and lead to misleading conclusions, potentially impacting health decisions. As Cook notes, "SRs apply scientific strategies to limit bias," underscoring the importance of acknowledging and addressing potential errors in these studies (29, 86).

The increasing production of unnecessary, misleading, and conflicted SRs and meta-analyses is a growing concern (6, 26). Biased SRs are increasingly recognized as a major source of research waste, with research bias occurring at various stages (112). These stages include: 1) "publication bias" (failure to publish results, especially negative ones) (112); 2) "time-lag bias" (delays in publishing negative results); and 3) "reporting bias" (failure to publish complete results for all pre-specified outcomes) (113). Addressing these biases is essential to ensure the validity and utility of SRs in guiding evidence-based healthcare decisions (114).

As mentioned, Various studies have classified errors in different types of research. Felson identified three major areas of bias in meta-analysis: a) retrieval, b) selection, and c) data extraction (89). Tricco introduced different types of errors that occur at various stages of SRs (41). Durach proposed methods to prevent the errors identified in Felson's classification through a six-step guideline (115), while Mohammadi classified types of bias in clinical trials (116).

In this study, errors in SRs were categorized into two general types: 1) Bias between Studies, 2) Bias within Single Studies, resulting in the identification of 77 specific errors and biases affecting these reviews.

To minimize missing data in healthcare intervention reviews and to detect and classify potential biases in reported benefits and harms, the following methods can be employed (3):

[DOI: 10.47176/mjiri.39.64]

Table 2. Biases affecting SRs

Bias between Studies OR Across-Studies BiAS		
Bias	Description	References
1. Information Bias	Refers to a systematic or methodological error that affects the accuracy of the data collected and reported.	(13, 17-22)
1.1. Recall Bias	Distorted results due to variations in memory of past events	(18)
1.2. Social Acceptability Bias	Bias in systematic reviews where participants give socially desirable answers	(18)
1.3. Recording Bias	Refers to systematic differences between reported and unreported findings.	(18)
1.4. Interviewer Bias	Bias introduced when interviewers alter questions or interpret responses subjectively.	(18)
1.5. Follow-Up Bias	Occurs when the association between a risk factor and a health outcome differs in dropouts compared with study participants.	(18)
1.6. Misclassification Bias	Systematically misclassifying patients' disease or exposure status introduces errors, affecting study validity	(18)
2. Selection Bias	Occurs because of errors in identifying the study populations. It can occur due to factors such as the following.	(4, 7, 15, 17-19, 21, 23-40)
2.1. Sampling Bias	Occurs when systematically excluding or over-representing certain groups.	(18, 41)
2.2. Allocation Bias	Bias introduced by systematic differences in how participants are assigned to study groups.	(18)
2.3. Responder Bias	Refers to situations where individuals do not answer questions truthfully or accurately for various reasons, leading to skewed or misleading survey results.	(18)
2.4. Self-Selection Bias	Bias from researchers choosing not to publish studies with null, unexpected, or unexplained results.	(20, 21, 42)
3. Bubble Effect Bias	Refers to the selection bias introduced by personalized search results when using internet search engines.	(24)
4. Publication Bias	Occurs when the publication of research results depends on their nature and direction.	(4, 7, 10, 14-16, 20, 21, 26, 28-31, 33, 41, 43-66)
5. Research Dissemination Bias	Occurs when the dissemination profile of a study's results depends on the direction or strength of its findings.	(2, 7, 65, 66)
6. Outcome Reporting Bias	Occurs when the reporting of research findings depends on the nature and direction of results.	(3, 4, 7, 14-16, 20, 27-29, 33, 38, 40, 41, 44, 47, 50, 65-78)
6.1. Selective Reporting Bias	Is defined as the selection of a subset of analyses to be reported.	(14, 15, 71, 76, 79)
7. P-Hacking Bias	Occurs when authors of research papers compete by reporting 'more extreme and spectacular results' in order to optimize chances of journal publication.	(7, 16, 48, 52, 80)
8. Positive Results Bias	Occurs when authors are more likely to submit, or editors accept, positive than null results.	(65, 66)
9. Hot Stuff Bias	Occurs when a topic is "hot", and neither investigators nor editors may be able to resist the temptation to publish additional results, no matter how preliminary or shaky.	(65, 66)
10. Time-Lag Bias	Occurs when the speed of publication depends on the direction and strength of the trial results.	(16, 22, 65, 66)

1. Selecting appropriate review outcomes
2. Inclusion and exclusion criteria
3. Identifying missing outcome data
4. Obtaining unpublished information
5. Detecting outcome reporting bias
6. Adjusting for outcome reporting bias in SRs.

Recognizing errors, investigating their possible effects, and minimizing them are critical responsibilities for researchers. This is particularly important in medical research involving human subjects, as providing inaccurate or biased results can have serious and sometimes irreparable consequences.

Conclusion

SRs are vital in modern medicine, serving as cornerstones for evidence-based decision-making .Here are key points to consider:

Validity of SRs: The validity of SRs hinges on the quality of the included studies. Recognizing biases or flaws in these studies is crucial, as they can compromise the credibility of the review's findings. Enhancing SR quality relies on a thorough understanding of potential biases.

[DOI: 10.47176/mjiri.39.64]

Table 2. Continued

Bias between Studies OR Across-Studies Bias		
Bias	Description	References
11. Gray Literature Bias	Occurs when journal article results differ systematically from those in non-peer-reviewed sources like reports and dissertations.	(7, 21, 31, 41, 48, 61, 65, 66)
12. Unpublished Studies Bias	Some completed studies remain unpublished, creating a bias towards "significant" outcomes being more likely to be published.	(15, 31, 61)
13. Full Publication Bias	Occurs when the full publication of studies is dependent on the direction and/or strength of their findings.	(41, 65, 66)
14. Place of Publication Bias	Occurs when the place of publication is associated with the direction or strength of its findings.	(65, 66, 81)
15. Multiple Publication Bias / Duplicate Publication Bias	Significant results more likely to be published multiple times.	(7, 14, 15, 20, 28, 33, 41, 65, 66)
16. Language Bias (As known Tower of Babel Bias)	Occurs when languages of publication depend on the direction and strength of the study results.	(4, 7, 15, 20, 41, 65, 66, 82-87)
17. Citation Bias (As known Reference Bias OR One-Sided Reference Bias)	Occurs when the chance of a study being cited by others is associated with its result.	(7, 14-16, 20, 41, 65, 66, 80, 88)
18. Indexing / Database Bias	Occurs when there is biased indexing of published studies in literature databases.	(7, 30, 33, 36, 41, 65, 66, 89)
19. Retrieval / Search Bias	Occurs when retrieved studies don't accurately represent the findings of all studies conducted in a research area.	(10, 20, 36, 41, 49, 65, 66)
20. Media Attention Bias	Occurs when studies with striking results are more likely to be covered by the media.	(7, 16, 65, 66, 90)
21. Incomplete Abstract Reporting / Abstract Reporting Bias	Occurs when articles focus on positive findings in their abstract, especially if multiple outcomes have been studied.	(91)
22. Selector Bias	Occurs when the inclusion criteria are not specific enough, leaving the reviewer free to choose studies, which may be susceptible to bias.	(37, 41, 65, 66)
23. Extractor Bias	Occurs when the data are not extracted accurately from the study.	(41, 89)
24. Study Quality Bias	Occurs when studies of lower or higher quality are associated with positive or favorable results.	(41, 89)
25. Bias in Scoring Study Quality	Reviewers rate studies by peers/high-impact journals as higher quality.	(41, 89)
26. Methodological Bias	Arises when included reviews don't meet minimum methodological standards to be considered systematic	(30, 92)
27. Inclusion Criteria Bias	Occurs when selective inclusion of studies depending on the nature and direction of the results.	(20, 41) (93)(94)
28. Librarian Co-Authorship Bias	Bias perception based on the involvement of librarians in systematic reviews, suggesting lower risk when they co-author.	(95)
29. Deviations from the Protocol Bias	Refer to instances where the execution of the review does not adhere to the predetermined plan or protocol.	(29)
30. Recording Error Bias	Occurs when the actual study results and the recorded results in the published paper differ.	(41, 89)
31. Protocol Registration Bias	Refers to the potential distortion of results and conclusions caused by selective reporting of study outcomes based on whether they were pre-registered in a SR protocol.	(29)
32. Indirect Comparison Bias	Occurs when indirect comparisons rather than direct comparisons are used to combine results in a SR.	(41)
33. Country of Conduct Bias	Occurs when the country of publication is associated with the strength or direction of research findings.	(41, 65, 66)
34. Non-Reproducibility Error	Refers to systematic or methodological errors that may affect the ability to replicate study findings.	(30)
35. Non-Comprehensiveness Error	Occurs when studies are selective about the data they include, affecting the overall validity and impact of the research.	(30)

High-Quality Evidence: High-quality SRs represent the

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Table 2. Continued

Bias between Studies OR Across-Studies Bias		
Bias	Description	References
36. Financial Conflicts of Interest Bias	Refers to the influence that authors' financial interests may have on the conclusions and quality of their reviews.	(69, 96)
37. Nonfinancial Conflicts of Interest Bias	Research influenced by authors' personal beliefs, affiliations, or experiences.	(97)
38. Vested Interest Bias	Bias introduced when researchers have a financial or personal stake in the review results.	(29)
39. Time-Point Bias (As known Bias from Timing of Analyses)	Refers to the issue where the timing of outcome measurements influences the results presented.	(28)
40. Availability Bias (As known Bias from Differential Availability of Trial Data)	Occurs when certain studies are excluded due to the unavailability of individual participant data.	(28)
41. Bias due to Changes in Specified Outcomes during the Systematic Review Process	Bias occurs when SR outcomes are changed after seeing the study results.	(98)
42. Pipeline Bias	Occurs when the results of studies that are initially available tend to be more optimistic or exaggerated compared to those published later.	(36, 65, 66)
43. Recruitment Bias	Refers to the systematic error that occurs when not all relevant studies or data are included in the review.	(14, 15, 29)
44. Spin	Reporting practices that exaggerate the benefits of an intervention beyond what the study supports.	(99, 100)
44.1. Misleading Reporting Spin	Inadequate reporting of research risks misleading readers.	(101)
44.2. Misleading Interpretation Spin	Was defined as an interpretation of the study results that could be misleading to the reader.	(38, 101)
44.3. Inappropriate Extrapolation Spin	Was defined as an inappropriate generalization of study results.	(101, 102)
45. Industry Sponsorship Bias	Research outcomes and interpretations are affected by sponsors' financial interests.	(103)
46. Study Design Bias	Systematic errors in study design, conduct, or reporting.	(10, 17, 29)
	Bias within Single Studies	
47. Ascertainment Bias	Information bias from inconsistent reference standard application based on test results.	(20)
48. Incorporation Bias	Refers to the risk of including studies or data that do not accurately represent all available evidence on a topic.	(20)
49. Attrition Bias	Relates to systematic differences due to differential loss of outcome data and in withdrawals from a study.	(4, 7, 14, 15, 20, 29, 32, 34, 35, 38, 50, 78, 104, 105)
50. Performance Bias (As known Unequal care for the intervention and control group)	When systematic differences in the provided care to participants influence the outcome.	(4, 7, 14, 15, 20, 27, 32, 34, 35, 38, 40, 50)
51. Detection Bias (As known assessment, ascertainment or measurement bias)	Refers to systematic differences that arise from how researchers gather and measure outcomes.	(7, 14, 15, 20, 27, 32, 34, 35, 38, 40, 50)
52. Implementation Bias (As known bias from trial conduct)	Inconsistencies in reporting and applying interventions lead to biased results.	(28)
53. Spectrum Bias	Occurs when the population studied in a diagnostic test does not accurately represent the intended population for that test.	(20)
54. Patient-Exclusion Bias (As known bias from differential exclusion of patients)	Refers to the systematic omission of certain patients from analyses based on specific criteria, such as ineligibility or protocol violations.	(28)

strongest level of evidence due to their methodologies, which align with the ideal of "best available" evidence. Exhaustive approaches to uncovering all relevant evidence ensure that SRs accurately reflect the available research.

Clinical Impact: Clinicians, decision-makers, and researchers rely on SRs to stay updated with current medical literature and to develop clinical practice guidelines. However, the quality of SRs can vary based on their methodology and the availability and quality of primary studies.

Ensuring Credibility: Researchers have a responsibility to recognize and investigate potential errors, aiming to

[DOI: 10.47176/mjiri.39.64]

Table 2. Continued

Bias between Studies OR Across-Studies Bias		
Bias	Description	References
55. Optimism Bias (As known novelty bias	Refers to unwarranted belief in the efficacy of new therapies, and significantly contributes to inconclusive results.	(106-108)
56. Verification Bias	Occurs when only a proportion of the study participants receive confirmation of the diagnosis by the reference standard test.	(20, 109, 110)
57. Compliance Bias	Refers to the distortion in study results caused by the differential treatment of participants based on their adherence to a study protocol or treatment.	(29)
58. Random Sequence Generation bias	Refers to the risk of selection bias in RCTs when the method of generating the random sequence is inadequate.	(40)
59. Sample Size Bias	Occurs when the studies included in the review are biased towards a particular sample size, which can affect the results and conclusions drawn.	(29)
60. Measures Bias	Refers to systematic or methodological errors that lead to the misrepresentation of study outcomes.	(29)
61. Co-interventions Bias	Refers to the risk of systematic error that arises when additional interventions, outside of the primary intervention being studied, are applied to participants in the trial.	(29)
62. Researcher Allegiance Bias	Refers to the tendency of researchers to favor their preferred treatment or theory when conducting studies.	(29)
63. Study Duration Bias	Refers to the distortion in results that can occur when studies included in a review have varying durations of follow-up or treatment.	(29)

minimize bias. Accurate results are crucial in medical research involving human societies, as incorrect conclusions can have irreversible consequences.

Objective Overviews: SRs provide objective overviews of all available evidence on specific topics. These overviews cover clinical trials, helping to determine where healthcare effects are consistent and where they may vary. Explicit, systematic methods are used to limit bias and reduce the chance of error.

Guiding Clinical Decisions and Policy: SRs are recommended as the best source of evidence for guiding clinical decisions and healthcare policy due to their rigorous methodologies that ensure validity and accuracy.

Quality Assessment and Error Prevention: The increasing number of SRs underscores the need for robust quality assessment and error prevention. Biased results in health-related SRs can lead to suboptimal decisions, affecting patient care and resource allocation.

While existing standards for systematic reviews (SRs) and meta-analyses have improved aspects such as reporting and design, they may not address all potential issues. A broader vision is necessary to ensure the highest quality of research. Simply focusing on the number of published SRs is insufficient; the true goal should be conducting high-quality research that expands scientific knowledge and understanding. This requires identifying and mitigating potential errors and biases throughout the research process.

Flawed SRs can lead to significant consequences, including misguided healthcare decisions, wasted resources, and ultimately, patient harm. Therefore, continuous improvement in methodology is crucial.

Authors' Contributions

All the authors have contributed to the study design, data collection, data analysis, and manuscript editing.

Ethical Considerations

Not applicable.

Acknowledgment

This study was a part of the PhD. dissertation in Knowledge and Information Science at Kharazmi University. All the authors thank all those who contributed to this study. They also sincerely appreciate Dr. Seyed Abbas Motevalian for all valuable comments and suggestions.

Conflict of Interests

The authors declare that they have no competing interests.

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[DOI: 10.47176/mjiri.39.64]

Appendix 1. Characteristics of included studies

NO	Author's Name	Article Title	Errors	Pub Year
1.	Booth, A, et al.	Applying GRADE-CERQual to qualitative evidence synthesis findings-paper 7: understanding the potential impacts of dissemination bias	• Research Dissemination Bias	2018
2.	Aleu, FG, et al.	Assessing systematic literature review bias	• Systematic Literature Review Bias	2020
3.	Ayorinde AA, et al.	Assessment of publication bias in systematic reviews of health services and delivery research	• Publication Bias	2018
4.	Ayorinde AA, et al.	Assessment of publication bias and outcome reporting bias in systematic reviews of health services and delivery research	• Publication Bias • Outcome Reporting Bias (ORB)	2020
5.	Babic A, et al.	Assessments of attrition bias in Cochrane systematic reviews are highly inconsistent and thus hindering trial comparability	• Attrition Bias (Incomplete Outcome Data)	2019
6.	Redulla, R, et al.	Bias because of selective inclusion and reporting of outcomes and analyses in systematic reviews of randomized trials of healthcare interventions	• Selection Bias • Reporting of Outcomes and Analyses Bias	2016
7.	Kirkham, JJ, et al.	Bias due to changes in specified outcomes during the systematic review process	• Bias due to changes in specified outcomes during the systematic review process	2010
8.	Page, Matthew J, et al.	Bias due to selective inclusion and reporting of outcomes and analyses in systematic reviews of randomised trials of healthcare interventions	• Selection Bias • Reporting of Outcomes and Analyses Bias	2014
9.	Herkner, H, et al.	Bias in systematic reviews: Considerations when updating your knowledge	• Selection Bias • Performance Bias • Information Bias • Detection Bias • Attrition Bias • Publication Bias • Retrieval Bias • Biased Inclusion Criteria • Time Lag Bias • Multiple Publication Bias • Citation Bias and Reference Bias • Language Bias • "Place of Publication" Bias • Outcome Reporting Bias • Verification Bias • Incorporation Bias • Ascertainment Bias • Spectrum Bias	2006
10.	Millett, D, et al.	Bias in systematic reviews?	• Outcome Reporting Bias	2011
11.	Ćurković, M, et al.	Bubble effect: including internet search engines in systematic reviews introduces selection bias and impedes scientific reproducibility	• Selection Bias • Research Bubble Effect	2018
12.	Vassar, Matt, et al.	Citation bias in otolaryngology systematic reviews	• Citation Bias	2011

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NO	Author's Name	Article Title	Errors	Pub Year
13.	Lindsley K, et al.	Clinical trial registration was associated with lower risk of bias compared with non-registered trials among trials included in systematic reviews	• Random Sequence Generation • Allocation Concealment Bias • Performance Bias • Detection Bias • Outcome Reporting Bias	2022
14.	Wieland, L.S, et al.	Assessing performance and detection bias in systematic reviews of unblinded trials	• Selection Bias • Performance Bias • Detection Bias • Outcome Reporting Bias	2020
15.	Granados-Duque V, et al.	Systematic review and meta-analysis: Which pitfalls to avoid during this process	• Selection Bias • Publication Bias	2021
16.	Müller, KF, et al.	Defining publication bias: protocol for a systematic review of highly cited articles and proposal for a new framework	• Publication Bias	2013
17.	Salandra R, et al.	Directing scientists away from potentially biased publications: the role of systematic reviews in health care	• Outcome Reporting Bias	2021
18.	Müller, KF, et al.	Dissemination bias in systematic reviews of animal research	• Publication Bias	2014
19.	Stewart, L, et al.	Do Systematic Reviews Based on Individual Patient Data Offer a Means of Circumventing Biases Associated with Trial Publications?	• Outcome Reporting Bias • Publication Bias • Duplicate Publication Bias • Selection Bias • Implementation Bias • Patient-Exclusion Bias • Time-Point Bias • Availability Bias • Time Lag Bias	2005
20.	Gartlehner G, et al.	The effect of study sponsorship on a systematically evaluated body of evidence of head-to-head trials was modest	• Industry Sponsorship Bias	2010
21.	Turner, L, et al.	The evolution of assessing bias in Cochrane systematic reviews of interventions: celebrating methodological contributions of the Cochrane Collaboration	• Reporting Bias • Publication Bias • Selective Outcome Reporting Bias	2013

[DOI: 10.47176/mjiri.39.64]

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NO	Author's Name	Article Title	Errors	Pub Year
22.	Tricco, C, et al.	Few systematic reviews exist documenting the extent of bias: a systematic review	• Bias in Identifying Studies (Sampling Bias) • Publication Bias • Gray Literature Bias • Funding Bias • Time Lag Bias • Abstract to Full Publication Bias • "Place of Publication" Bias • Country of Conduct Bias • Language Bias • Indexing Bias • Search Bias • Citation Bias • Multiple/Duplicate Publication Bias • Inclusion Criteria Bias • Selector Bias • Bias in Scoring Study Quality • Extractor Bias • Study Quality Bias • Recording Error Bias • Outcome Reporting Bias • Indirect Comparison Bias	2008
23.	Bes-Rastrollo, M, et al.	Financial conflicts of interest and reporting bias regarding the association between sugar-sweetened beverages and weight gain: a systematic review of systematic reviews	• Financial Conflicts of Interest Bias • Outcome Reporting Bias	2013
24.	Jackson, JL, et al.	Bias in Systematic Reviews—Let the Reader Beware	• Study Design Bias • Search Bias • Quality of Included Articles Bias • Publication Bias • Data Analyze and Reported Bias • Outcome Time Points Bias	2018
25.	Winters, M, et al.	Gray matters; on the importance of publication bias in systematic reviews	• Publication Bias • Gray Literature Bias	2017
26.	Dong, B, et al.	How does the bias influence the quality of systematic reviews	• Publication Bias • Literature Retrieval Bias • Literature Inclusion Bias	2003
27.	Camargo, CP, et al.	How to distinguish best evidence from bias: a basic guide to understanding a systematic review	• Publication Bias • Performance Bias • Detection Bias • Attrition Bias • Outcome Reporting Bias • Conflict of Interest Bias	2020

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NO	Author's Name	Article Title	Errors	Pub Year
28.	Dwan, KM, et al.	Impact of outcome reporting bias do systematic reviews still exclude studies with "no relevant outcome data"?	• Outcome Reporting Bias (No Relevant Outcome Data: NROD)	2017
29.	Kirkham, JJ, et al.	The impact of outcome reporting bias in randomised controlled trials on a cohort of systematic reviews	• Outcome Reporting Bias	2010
30.	Bally, S, et al.	Publication bias in pharmacogenetics of adverse reaction to antiseizure drugs	• Publication Bias	2022
31.	Dickersin, K, et al.	The Importance of Reporting Biases in Patient Care: Can We Trust the Evidence from Either Individual Studies or Systematic Reviews?	• Outcome Reporting Bias	2018
32.	Mikelis, F, et al.	Is data missing?	• Publication Bias	2022
33.	Babic, A, et al.	The judgement of biases included in the category "other bias" in Cochrane systematic reviews of interventions	• Other Biases Include: • Baseline Characteristics of Participants Bias • Funding Bias • Sample Size Bias • Outcome Reporting Bias • Conflict of Interest Bias • Inclusion/Exclusion Criteria Bias • Confounding Error • Data Analyses Bias • Outcome Domains and Outcome Measures Bias • Co-Interventions Bias • Deviations from the Protocol Bias • Randomisation Error • Recruitment bias • Selection Bias • Study Design Bias • Study Quality Bias • Intention-to-treat analysis (ITT) Bias • Compliance Bias • Attrition Bias • Publication Bias • Adequacy of Comparators Bias • Researcher Allegiance Bias • Study Duration Bias • Vested Interest Bias • Protocol Registration Bias • Terminated Early Bias • Blinding Bias • Clustering Bias	2019

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Appendix 1. Characteristics of included studies

NO	Author's Name	Article Title	Errors	Pub Year
34.	Mao, C, et al.	Language bias among Chinese-sponsored randomized clinical trials in systematic reviews and meta-analyses can anything be done?	• Language Bias	2020
35.	Grzybowski, A, et al.	Language bias and methodological issues in determining reliable evidence for systematic reviews	• Language Bias	2019
36.	Stern, C, et al.	Language bias in systematic reviews: you only get out what you put in	• Language Bias	2020
37.	Aamodt, M, et al.	Librarian co-authored systematic reviews are associated with lower risk of bias compared to systematic reviews with acknowledgement of librarians or no participation by Librarians	• Librarian co-Authorship Bias	2019
38.	Page, MJ, et al.	Many scenarios exist for selective inclusion and reporting of results in randomized trials and systematic reviews	• Selective Inclusion and Reporting of Results Bias	2013
39.	Bruschettini, M, et al.	Many sources of bias in medical research: experience from systematic reviews	• Outcome Reporting Bias	2023
40.	Li, Z, et al.	Methodological bias and variation of systematic reviews on diagnostic test accuracy	• Methodological Bias	2016
41.	Kirkham, JJ, et al.	A multivariate meta-analysis approach for reducing the impact of outcome reporting bias in systematic reviews	• Outcome Reporting Bias	2012
42.	Shah, K, et al.	Outcome reporting bias in Cochrane systematic reviews	• Outcome Reporting Bias	2020
43.	Kirkham, JJ, et al.	Outcome reporting bias in trials: a methodological approach for assessment and adjustment in systematic reviews	• Outcome Reporting Bias	2018
44.	McGrath, TA, et al.	Overinterpretation of Research Findings: Evaluation of "Spin" in Systematic Reviews of Diagnostic Accuracy Studies in High-Impact Factor Journals	• Spine	2020
45.	Faggion, CM, et al.	Overview authors rarely defined systematic reviews that are included in their overviews	• Publication Bias • Database Bias • Methodology Bias • Selection Bias • Non-Reproducibility Error • Non-Comprehensiveness Error	2019
46.	Zhang, et al.	Potential bias due to the definition of RCTs for inclusive criteria of systematic reviews published in Chinese journals	• Inclusion/Exclusion Criteria Bias	2013
47.	Steinert,T, et al.	Potential language bias in systematic reviews on the use of coercion in psychiatry	• Language Bias	2020
48.	Knobloch, K, et al.	Preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement and publication bias	• Publication Bias	2011

[DOI: 10.47176/mjiri.39.64]

Appendix 1. Characteristics of included studies

NO	Author's Name	Article Title	Errors	Pub Year
49.	Frampton, G, et al.	Principles and framework for assessing the risk of bias for studies included in comparative quantitative environmental systematic reviews	• Systematic Error • Random Error	2020
50.	Viswanathan, M, et al.	A proposed approach may help systematic reviews retain needed expertise while minimizing bias from nonfinancial conflicts of interest	• Nonfinancial Conflicts of Interest Bias	2014
51.	Nankervis, H, et al.	Prospective registration and outcome-reporting bias in randomized controlled trials of eczema treatments	• Outcome Reporting Bias • Selective Reporting Bias	2012
52.	Schmucker, C, et al.	A protocol for a systematic review on the impact of unpublished studies and studies published in the gray literature in meta-analyses	• Selection Bias • Publication Bias • Unpublished Studies Bias • Gray Literature Bias	2013
53.	Littell, JH, et al.	Assessment of outcome reporting bias in studies included in Campbell systematic reviews	• Outcome Reporting Bias	2023
54.	Ayorinde, AA, et al.	Publication and related biases in health services research: a systematic review of empirical evidence	• Publication Bias • Biases Associated with Design and Conduct of Research • Outcome Reporting Bias • Time-Lag Bias • Citation Bias • Media Attention Bias • P-Hacking Bias • Biases Associated with Reporting of Research Findings and Their Accessibility • Biases Associated with Further Dissemination and Uptake of Research Evidence by Users	2020
55.	Lee, A, et al.	Publication bias affected the estimate of postoperative nausea in an acupoint stimulation systematic review	• Publication Bias	2006
56.	Hedin, RJ, et al.	Publication bias and nonreporting found in majority of systematic reviews and meta-analyses in anesthesiology Journals	• Publication Bias	2016
57.	Briel, M, et al.	Publication bias in animal research: a systematic review protocol	• Publication Bias	2013
58.	Atakpo, P, et al.	Publication bias in dermatology systematic reviews and meta-analyses	• Publication Bias	2016
59.	Barbui, C, et al.	Publication bias in systematic reviews	• Publication Bias	2007
60.	Khayyamfar A, et al.	Publication bias in urology systematic reviews and meta-analyses	• Publication Bias	2022
61.	Onishi, A, et al.	Publication bias is underreported in systematic reviews published in high-impact-factor journals	• Publication Bias	2014
62.	Torgerson, Carole J.	Publication bias: the achilles' heel of systematic reviews?	• Publication Bias • Unpublished Studies and Gray Literature Bias	2006

[DOI: 10.47176/mjiri.39.64]

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NO	Author's Name	Article Title	Errors	Pub Year
63.	Dieste, O, et al.	Quantitative determination of the relationship between internal validity and bias in software engineering experiments: Consequences for systematic literature reviews	• Selection Bias • Performance Bias • Detection Bias • Attrition Bias	2011
64.	Sinha, MK, et al.	Reporting bias and other biases affecting systematic reviews and meta-analyses: a methodological commentary	• Outcome Reporting Bias • Selection Bias • Database Bias • Publication Bias • Funding Bias • Duplicate Publication Bias	2006
65.	Foster, BK, et al.	Reporting bias in systematic reviews and meta-analyses related to the treatment of distal radius fractures: the presence of spin in the abstract	• Reporting Bias • Spin	2022
66.	Hopp, Lisa	Risk of bias reporting in Cochrane systematic reviews	• Selection Bias • Performance Bias • Detection Bias • Attrition Bias • Reporting Bias	2015
67.	Copas, JB, et al.	A sensitivity analysis for publication bias in systematic reviews	• Publication Bias	2001
68.	Duyx, B, et al.	The strong focus on positive results in abstracts may cause bias in systematic reviews: a case study on abstract reporting bias	• Abstract Reporting Bias	2019
69.	Dias, S, et al.	Study designs to detect sponsorship and other biases in systematic reviews	• Confounding Error • Optimism Bias OR Novelty Bias	2010
70.	Kahale, LA, et al.	Systematic reviews do not adequately report or address missing outcome data in their analyses	• Attrition Bias • Outcome Reporting Bias	2018
71.	Sterne, JAC, et al.	Systematic reviews in health care: Investigating and dealing with publication and other biases in meta-analysis	• Publication Bias • Reporting Bias	2001
72.	Reeves, BC, et al.	Systematic reviews incorporating evidence from nonrandomized study designs: reasons for caution when estimating health effects	• Selection Bias • Performance Bias • Detection Bias • Attrition Bias	2005
73.	Mickenautsch, Steffen	Systematic reviews, systematic error and the acquisition of clinical knowledge	• Systematic Error	2010
74.	Jacobsen, K.	A taxonomy of bias in systematic reviews	• Selection Bias • Pipeline Bias • Indexing Biase • Search Bias • Eligibility Bias	2011
75.	Parekh-Bhurke, S, et al.	Uptake of methods to deal with publication bias in systematic reviews has increased over time, but there is still much scope for improvement	• Publication Bias	2011
76.	Stoll, C, et al.	The value of a second reviewer for study selection in systematic reviews	• Selection Bias • Selector Bias • Screening Bias	2011

[DOI: 10.47176/mjiri.39.64]

Appendix 1. Characteristics of included studies

NO	Author's Name	Article Title	Errors	Pub Year
77.	Baradaran Attar Moghadam, HR, et al.	Systematic review & mata-analysis: concepts, applications & statistical practices	• Research Dissemination Bias • Publication Bias • Outcome Reporting Bias • Language Bias • Database Bias • Citation Bias • Duplicate Publication Bias • Gray Literature Bias • Time Lag Bias • Media Attention Bias • Selection Bias • Performance Bias • Attrition Bias • Detection Bias	2018
78.	Higgins, JPT, et al.	Cochrane handbook for systematic reviews of interventions	• Systematic Errors • Random Errors • Outcome Reporting Bias • Selective reporting Bias • Recruitment Bias • Selection Bias • Attrition Bias • Detection Bias • Time Lag Bias • Publication Bias • Within-Study Bias • Multiple/Duplicate Publication Bias • Citation Bias • Performance Bias • Language Bias • "Place of Publication" Bias	2022
79.	Center for Reviews and Dissemination (CRD)	Systematic reviews: CRD's guidance for undertaking reviews in health care	• Language Bias • Publication Bias • Selection Bias OR Allocation Concealment Bias • Performance Bias • Attrition Bias • Outcome Reporting Bias	2008
80.	Weisberg, Herbert I.	Bias and causation: models and judgment for valid comparisons	• Selection Bias • Information Bias • Confounding Error • Study Design Bias	2010
81.	Stewart, Antony	Basic statistics and epidemiology: a practical guide	• Random Error • Confounding Error • Selection Bias • Sampling Bias • Allocation Bias • Responder Bias • Information Bias • Recall Bias • Social Acceptability Bias • Recording Bias • Interviewer Bias • Follow-Up Bias • Misclassification Bias	2022

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NO	Author's Name	Article Title	Errors	Pub Year
82.	Lash, Timothy L, et al.	Applying quantitative bias analysis to epidemiologic data	• Selection Bias • Confounding Error • Information Bias	2009
83.	Drucker, AM, et al.	Research techniques made simple: assessing risk of bias in systematic reviews	• Outcome Reporting Bias • Selection Bias • Detection Bias • Performance Bias • Attrition Bias • Spin	2016
84.	Almeida CPB de, et al.	How to avoid bias in systematic reviews of observational studies	• Selection Bias • Information Bias • Self-Selection Bias • Gray Literature Bias • Publication Bias • Confounding Error	2017
85.	Yavchitz, Amélie, et al.	A new classification of spin in systematic reviews and meta-analyses was developed and ranked according to the severity	• Misleading Reporting Spin • Misleading Interpretation Spin • Inappropriate Extrapolation Spin	2016
86.	McGauran N, et al.	Reporting bias in medical research	• Reporting Bias • Reporting Bias on a Study Level • Reporting Bias on an Outcome Level	2010
87.	Song, F, et al.	Publication and related biases / Dissemination and publication of research findings: an updated review of related biases	• Research Dissemination Bias	2000
88.			• Publication Bias • Positive Results Bias • Hot Stuff Bias • Time-Lag Bias • Pipeline Bias • Gray Literature Bias • Full Publication Bias • "Place of publication" Bias • Outcome Reporting Bias • Multiple/Duplicate Publication Bias • Language Bias • Citation Bias • Database Bias • Indexing Bias • Retrieval Bias • Media Attention Bias	2010

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