Research in Social and Administrative Pharmacy 21 (2025) 110–115

Contents lists available at ScienceDirect

Research in Social and Administrative Pharmacy

journal homepage: www.elsevier.com/locate/rsap

Original Research Paper

Assessing methodological quality of systematic reviews with meta-analysis about clinical pharmacy services: A sensitivity analysis of AMSTAR-2

Inajara Rotta [a], Joyce A. Diniz [b], Fernando Fernandez-Llimos [c,*]

[a] Department of Pharmacy, Federal University of Paraná, Curitiba, Brazil
[b] Programa de Pós-Graduação Em Assistência Farmacêutica, Federal University of Paraná, Curitiba, Brazil
[c] Applied Molecular Biosciences Unit (UCIBIO), Laboratory of Pharmacology, Department of Drug Sciences, Faculty of Pharmacy, University of Porto, Porto, Portugal

ARTICLE INFO

Keywords:
Systematic review
Meta-analysis
Pharmaceutical services
Pharmacists
Reproducibility of results

ABSTRACT

Background: Systematic reviews are critical for evidence-based healthcare decisions, but their validity depends on the quality of conduct and reporting. AMSTAR-2, a widely used tool for assessing the quality of systematic reviews, identifies seven critical domains influencing review validity, although its developers recommend flexibility in prioritizing these domains. To date, no studies have analyzed the impact of this change on systematic reviews with meta-analysis (SRMAs) evaluating clinical pharmacy services.

Objective: To evaluate the quality of SRMAs on clinical pharmacy services and the effect of modifying AMSTAR-2 domains criticality on quality assessment.

Methods: Systematic searches (updated January 1, 2023) were conducted in PubMed, Scopus, and Web of Science to identify SRMAs reporting the effects of clinical pharmacy services. Manual reference list searches of included studies were also performed. The methodological quality of SRMAs was assessed using the AMSTAR-2 tool. Changes in the overall classification of each SRMA were analyzed by hypothetically removing the critical designation for domains in the original tool.

Results: Out of 153 eligible SRMAs, 138 (90.2 %) were classified as critically low quality, 13 (8.5 %) as low quality, and 2 (1.3 %) as moderate quality. Despite slight improvement in methodological quality over time, this change was not directly linked to the creation of various reporting and conducting guidelines and registries. Our analysis showed that the hypothetical removal of the criticality of each AMSTAR-2 domain did not significantly impact the overall quality assessment. Furthermore, all critical domains in AMSTAR-2 are considered essential in the field of pharmacy practice.

Conclusion: Most SRMAs on clinical pharmacy services were classified as low or critically low quality and modifying the AMSTAR-2 domain criticality did not improve these assessments. Researchers, journal editors, and peer reviewers must work to enhance SRMAs quality, which are crucial for providing robust evidence for pharmaceutical services.

1. Introduction

Systematic reviews provide the highest level of evidence by increasing precision and addressing questions that cannot be answered by individual studies alone. As a result, systematic reviews are essential pieces of literature to support evidence-based decision making in health care.[1] However, the validity of these studies depends on the quality of their conduct and reporting. To avoid bias, it is essential that systematic reviews use a robust methodology. Assessing whether robust method was used requires careful critical appraisal.[2,3]

Previous studies have shown that suboptimal and conflicting systematic reviews with meta-analysis (SRMAs) have been published in health care, with low quality and significant flaws being quite common.[4–6] The literature has shown that pitfalls are also common in the synthesis of evidence in pharmacy practice.[7–10]

The A Measurement Tool to Assess Systematic Reviews[11] - AMSTAR-2, is a widely used tool for assessing the methodological quality of systematic reviews. Its first version was published in 2007 and consisted of 11 items assessing reproducibility and quality. However, limitations of AMSTAR-1 have been described, namely that it does not

* Corresponding author. Laboratory of Pharmacology, Department of Drug Sciences, College of Pharmacy, University of Porto, R. Jorge de Viterbo Ferreira 228, 4050-313, Porto, Portugal.
E-mail addresses: inajara.rotta@ufpr.br (I. Rotta), joyceediniz@gmail.com (J.A. Diniz), fllimos@ff.up.pt (F. Fernandez-Llimos).

https://doi.org/10.1016/j.sapharm.2024.11.002
Received 23 October 2024; Received in revised form 25 November 2024; Accepted 25 November 2024
Available online 28 November 2024

assess systematic reviews that include non-randomized studies (i.e., potentially more biased than randomized studies). In addition, AMSTAR-1 did not provide an overall score, making it difficult to compare results between reviews.[11,12]

To provide a quantitative assessment of the methodological quality of systematic reviews, the R-AMSTAR tool was proposed in 2010, adopting the original 11 domains of AMSTAR and assigning a score to each domain.[13] However, the challenge of assigning weights to each item based on their relative importance in calculating the final score raised questions about the validity of this tool. This led to the development of a new version of the AMSTAR tool (AMSTAR-2) in 2017, which includes 16 domains and allows for more detailed analysis of systematic reviews that include randomized or nonrandomized trials of health care interventions. AMSTAR-2 provides an overall classification based on limitations identified in critical and non-critical domains.[14] In addition, the ROBIS tool[15] was published in 2016, which is specifically designed to assess the risk of bias in systematic reviews. ROBIS assesses not only the internal validity of the review process, but also the relevance of the research question to its users.[2] ROBIS makes it possible to distinguish between systematic reviews that are methodologically biased and those that include biased primary studies.[15]

AMSTAR-2 identified 7 domains as critical because they "can critically affect the validity of the review and its conclusions". However, the AMSTAR-2 development team recognized that this domain criticality may not apply equally to different domains and suggested that review teams "should decide which items are most important".[11] However, no analyses of the impact of this change in domain criticality have been conducted in SRMAs assessing the impact of clinical pharmacy services. The purpose of the present study was to evaluate the quality of SRMAs on clinical pharmacy services and the effect of modifying domain criticality on quality assessment.

2. Methods

2.1. Selection of studies

To identify all available SRMAs evaluating the impact of clinical pharmacy services on clinical, economic, humanistic outcomes or process indicators, a systematic review of systematic reviews with meta-analysis (SRMA) was conducted according to the recommendations of the Cochrane Collaboration[16] and reported according to the PRISMA statement.[17] The protocol was registered in the International Prospective Register of Systematic Reviews - PROSPERO (CRD42024580944).

The systematic review performed by Tonin et al.[18] was updated through January 1, 2023. To ensure consistency in the selection process, the original research team participated in the update.

Systematic searches were conducted in PubMed, Scopus, and Web of Science without time or language restrictions (see full search strategy in Supplementary Material 1). In addition, manual searches of the reference lists of the included studies were performed. Systematic reviews with meta-analysis of primary interventional or observational studies comparing clinical services provided by pharmacists with those provided by other healthcare professionals or usual care were included. Usual care was defined as the routine care provided to patients in standard practice. Studies were excluded if they met any of the following criteria: a) articles written in non-Roman characters; b) systematic reviews without meta-analysis; c) outdated meta-analyses (only the most recent version was included to avoid duplication of results); d) interventions or services provided by a multidisciplinary team without distinguishing the role of the pharmacist; and e) books, book chapters, dissertations, theses, and conference abstracts.

All steps of the study selection process (title and abstract screening, and full text eligibility) were performed independently by two reviewers. A consensus meeting was held between the two researchers to resolve any discrepancies. If any remained, a third researcher made the final decision.

2.2. Data extraction and quality assessment

A standardized spreadsheet was used to extract study characteristics, including author names, year of publication, language, country in which the study was conducted based on the affiliation of the first author, and the journal of publication. In addition, to assess the ability of SRMAs to be easily retrieved from bibliographic databases, whether the terms "systematic review", "meta-analysis" and "pharmacist" were mentioned in the title and abstract of the article was recorded.

The methodological quality of the SRMAs was assessed using a spreadsheet adapted and configured in Excel (Microsoft, Redmond, WA) containing the 16 domains of the AMSTAR-2 tool.[11] Each item within each domain was scored as "yes" or "no". Domains were then classified in an ordinal variable as "yes", "partially yes" (i.e., those with more than one item and discrepant classifications), or "no". Domains #9 and #11 were divided into two different branches: for randomized and non-randomized controlled trials. Following the recommendations of the development team, no overall numerical score was generated for the instrument. The overall methodological quality of the SRMA was also classified in an ordinal variable as "high", "moderate", "low" or "critically low quality" according to the criteria described in the original AMSTAR-2 publication.[11]

To refine the interpretation of the tool, the research team first applied AMSTAR-2 to a pilot sample of 20 SRMAs. The methodological quality of the remaining studies was then independently assessed by two researchers, with a third reviewer consulted to resolve discrepancies.

2.3. Data analysis

The methodological quality of the SRMAs was first assessed using AMSTAR-2, strictly following the criteria described in the original publication regarding the consideration of critical and non-critical items. The changes in the overall classification of each SRMA were then analyzed by hypothetically removing the critical designation from each domain (i.e., domains 2, 4, 7, 9, 11, 13, and 15) in the original tool.

Descriptive analyses were conducted. The association between the four categories of overall quality and the year of publication was assessed using the Kruskal-Wallis test. Each SRMA was classified as preceding or following four different dates: 2007 (publication of AMSTAR-1),[19] 2009 (publication of the PRISMA),[20] 2011 (creation of the PROSPERO registry),[21] and 2017 (publication of AMSTAR-2).[11] The association between overall quality (i.e., categorical ordinal variable) and the pre-post condition for each of the four dates (i.e., dichotomous variable) was evaluated with the linear-by-linear test.

Chi-squared tests were performed to evaluate the association between publication date (described as before or after the median publication year) and the change in methodological quality classification, excluding the critical designation of each of the 7 domains. A change in methodological quality classification (dichotomous variable) was considered when a SRMA progressed in the overall methodological quality.

Analyses were performed in IBM SPSS v. 24.0 (IBM Corp, Armonk, NY). P-values less than 5 % were considered statistically significant.

4. Results

A total of 1006 records were retrieved in databases after duplicates removal, with 713 considered irrelevant in screening phase and 140 excluded in full text eligibility (Fig. 1). Finally, 153 systematic reviews with meta-analysis were included for analyses. Lists of included and excluded articles are presented in Supplementary Material 2 and 3.

The meta-analyses were published from 1989 to 2023 (6 published as ahead of print at the time of the searches). The median publication year was 2018 (IQR 2016:2021). A total of 743 different authors contributed to the articles, which were published in 81 distinct journals, all in English. The first authors were affiliated with institutions in 35 different

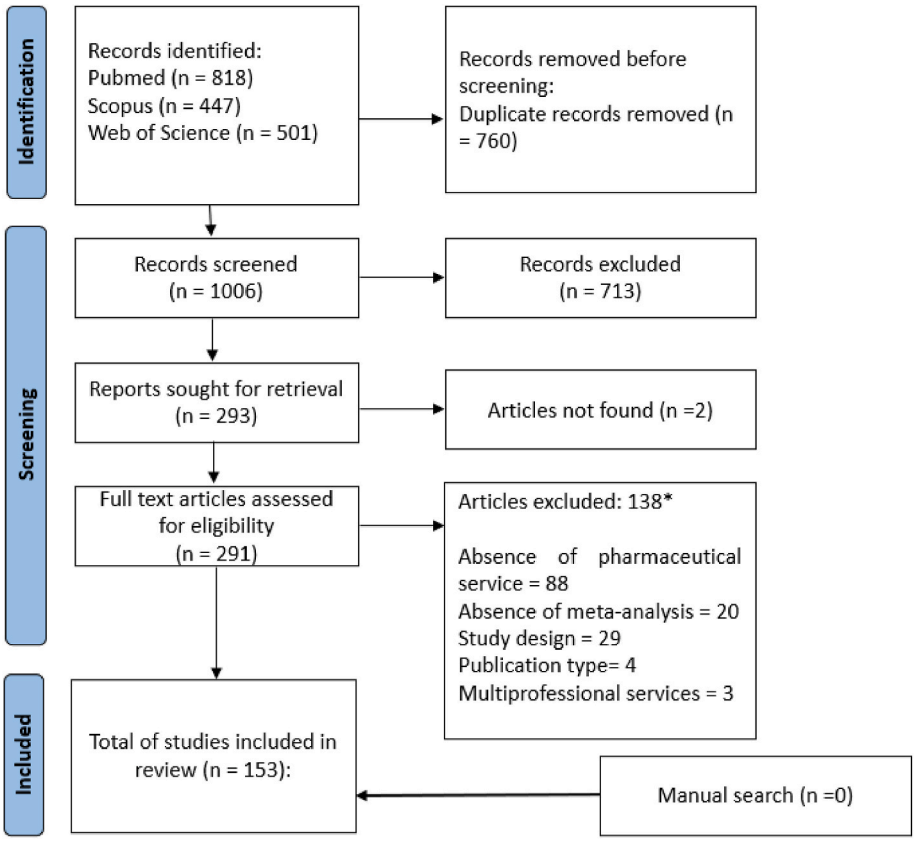

Fig. 1. Flowchart of the study selection process.
* The reasons for excluding records exceed 138, as some of them were excluded for more than one reason.

countries, with the highest representation from the United States (n = 33), Australia (n = 16), and China (n = 15).

From the perspective of reporting quality, 135 (88.2 %) articles included the term "meta-analysis" in their titles and 107 (69.9 %) in the abstracts, but 107 (69.9 %) had systematic review in the titles and 78 (51.0 %) in the abstract. Also, the term "pharmacists" was included in 93 (60.8 %) of the titles and in 127 (83.0 %) of the abstracts.

4.1. Original AMSTAR-2

The application of AMSTAR-2 to the 153 SRMA following original instructions resulted in 138 (90.2 %) classified as critically low quality, 13 (8.5 %) as low quality, and 2 (1.3 %) as moderate quality. No study was classified as high quality. Table 1 presents the detailed results for each AMSTAR-2 domain, and Supplementary Material 4 provides the responses to each item. The most positively scored domains were #1 – providing the components of PICO; and #16 – reporting conflicts of interest of the review. Conversely, the lowest scored domains were #10 – reporting funding sources of primary studies, with 98 % of meta-analyses failing; and #4 – use of a comprehensive literature search, with 54.2 % completely failing to comply, and 41.8 % partially complying.

A significant association was found between the publication year and methodological quality (Kruskal-Wallis p = 0.013). The median publication year for critically low quality meta-analyses was 2018 (IQR 2016:2020), while the median for low quality meta-analyses was 2021 (IQR 2018:2022). This quality improvement was not associated with the publication of the several reporting and conducting guidelines and registries (Table 2) like AMSTAR-1 (p = 0.476), AMSTAR-2 (p = 0.241), PRISMA (p = 0.305), and PROSPERO (p = 0.157).

4.2. Sensitivity of critical domains

The results of applying AMSTAR-2, treating critical domains as non-critical, are presented in Table 3. No study was reclassified as high quality, and no study improved by more than one level (e.g., moving from critically low to moderate). Domain #7 – list and justification of excluded studies – showed the greatest improvement when not considered critical. Domain #9 – assessing the risk of bias in primary studies - and #13 – considering the risk of bias when interpreting the results of the review - showed no changes when their critical status was disregarded.

When the critical designation was removed from Domain #7, a significant association was found between publication date and improvement in methodological quality classification (chi-square = 8.895; p = 0.003), with 4 (5.9 %) studies published before 2018 and 20 (23.5 %) published since 2018 improving the score. Eliminating the critical designation of the other 4 domains (no change occurred with domains #9 and #13) had no association with publication date: domain #2 (p = 0.264), #4 (p = 0.840), #11 (p = 0.696), and #15 (p = 0.342).

5. Discussion

The present study evaluated the methodological quality of SRMAs assessing the impact of clinical pharmacy services using a robust instrument, the AMSTAR-2. The pool of SRMAs appraised was constituted by a long-term curated database of studies, compiled by the DEPICT project (www.depictproject.org), previously used in other meta-research studies.[9,18,22–26] This analysis showed a generally low quality, with 99 % of the SRMAs being of critically low or low quality. These results are consistent with previous assessments, whether in general meta-analyses[4,27] or in pharmacy practice area.[7–9]

The lowest scoring AMSTAR-2 domain was #10 – reporting funding

Table 1
Detailed results for each AMSTAR-2 domain.

Domain	Number of SRMA	Yes (%)	Partially yes (%)	No (%)
Domain 1: Provision of PICO components	153	99.3	–	0.7
Domain 2: An explicit statement regarding the existence of a review protocol and justification for any significant deviations from it	153	33.3	3.3	63.4
Domain 3: Justification for the inclusion of study designs in the review	153	52.3	–	47.7
Domain 4: Employ a comprehensive literature search strategy	153	3.9	41.8	54.2
Domain 5: Performance of study selection in duplicate	153	81.0	–	19.0
Domain 6: Performance of data extraction in duplicate	153	74.5	–	25.5
Domain 7: List and justification of excluded studies	153	11.8	–	88.2
Domain 8: Description of the included studies in details	153	64.1	19.0	17.0
Domain 9: Assessment the risk of bias in primary studies – Only for RCT	142	83.1	3.5	13.4
Domain 9: Assessment the risk of bias in primary studies – Only for NRCT	73	79.5	–	20.5
Domain 10: Report funding sources of primary studies	153	2.0	–	98.0
Domain 11: Use of appropriate methods for statistical combination of result (if presence of MA) – Only for RCT	143	73.4	–	26.6
Domain 11: Use of appropriate methods for statistical combination of result (if presence of MA) – Only for NRCT	78	64.1	–	35.9
Domain 12: Assessment the potential impact of RoB in individual studies on the results of the meta-analysis	153	83.7	–	16.3
Domain 13: Consideration of the risk of bias when interpreting the review results	153	77.8	–	22.2
Domain 14: Satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review	153	66.0	–	34.0
Domain 15: Adequate investigation of publication bias and discussion about their impact on the results of the review (if presence of MA)	153	41.8	–	58.2
Domain 16: Reporting conflicts of interest of the review	153	95.4	–	4.6

MA – meta-analysis; NRCT – non-randomized controlled trials; RCT – randomized controlled trials; RoB – risk of bias; SRMA – systematic review with meta-analysis.
The number of SRMA changed in the assessment of domains 9 and 11 because the result may not be applicable in some situations (only RCTs or NRCTs may have been included).

Table 2
Association between systematic review methodological quality and the development of guidelines for reporting, conducting, and registering systematic reviews.

		Critically low quality	Low quality	Moderate quality	p value
AMSTAR-1 (2007)	Pre	5	0	0	0.476
	Post	133	13	2	
AMSTAR-2 (2017)	Pre	64	3	1	0.241
	Post	74	10	1	
PRISMA (2009)	Pre	10	0	0	0.305
	Post	128	13	2	
PROSPERO (2011)	Pre	18	0	0	0.157
	Post	120	13	2	

NOTE: The numbers indicate the studies published before and after the development of the tools. The year of publication of each tool/platform is described in parentheses.

Table 3
Changes in the systematic review methodological quality when treating critical domains as non-critical.

	Critically low → low quality	Low → moderate quality	Moderate → high quality
Domain 2	3/138 (2.2 %)	3/13 (23.1 %)	0
Domain 4	9/138 (6.5 %)	3/13 (23.1 %)	0
Domain 7	18/138 (13.0 %)	6/13 (46.2 %)	0
Domain 9	0/138 (0.0 %)	0/13 (0.0 %)	0
Domain 11	2/138 (1.4 %)	1/13 (7.7 %)	0
Domain 13	0/138 (0.0 %)	0/13 (0.0 %)	0
Domain 15	10/138 (7.2 %)	0/13 (0.0 %)	0

sources of primary studies, with 98 % of meta-analyses failing to meet this criterion. This item is particularly important because research has shown that industry-funded trials often produce results that favor the sponsor's technologies.[28,29] It is worth noting that in AMSTAR-1, the assessment of the potential influence of funding sources was combined into one single item, item #11, which covered both the individual studies included in the review and the review itself. In AMSTAR-2, this item was split into two domains. Interestingly, domain #16 – reporting conflicts of interest for the review – was one of the highest scoring domains among the SRMAs analyzed, with 95.4 % of SRMAs meeting this criterion. However, it is important to note that this domain might be considered less relevant in the clinical pharmacy services literature, as most of these studies are typically not sponsored by the pharmaceutical industry.

Over the years, there has been a slight improvement in the methodological quality of published SRMAs. However, this improvement was not directly linked to the publication of the two versions of the AMSTAR tool. Similarly, although the introduction of PRISMA improves reporting standards for systematic reviews and the PROSPERO platform promotes greater transparency, reproducibility, and usability of systematic reviews, these initiatives have not contributed significantly to raising the standards of methodological quality. It is important to note that the PRISMA checklist and the AMSTAR-2 tool should be used complementarily in the development and reporting of systematic reviews, as they serve different purposes. The PRISMA focuses on comprehensively reporting what was done during the SRMA conduct, enhancing the transparency and replicability of the study. Therefore, the PRISMA checklist does not evaluate whether the steps were correctly performed but instead focuses on whether they were correctly reported.[19,30] The AMSTAR-2 assesses the process of conducting the systematic review, fostering greater credibility and methodological rigor.

To assess the overall confidence of the review, AMSTAR-2 established a classification system based on two types of domains: critical and non-critical. Although the development team selected seven domains as critical, they advised that researchers should decide which items are most relevant to the reviews under consideration. In our analysis, even when the criticality of each domain was hypothetically removed, there was no significant change in the methodological quality of the studies.

AMSTAR domain #2, protocol registration, is one of these seven critical domains. Developing and adhering to a well-structured protocol mitigates the risk of selection and reporting bias while also reducing waste from the unintentional duplication of systematic reviews by different author teams.[11,21] Given the lack of uniformity in the terminology surrounding pharmacy practice and clinical pharmacy lacks

uniformity,[31] it is crucial to conduct comprehensive literature searches, supplemented with manual searches and exploration of the grey literature, which underscores the importance on maintaining AMSTAR-2 domain #4 as critical. In addition, to ensure transparency and reproducibility, authors should provide a comprehensive list of potentially relevant studies that were ultimately excluded, along with the rationale for each exclusion, thus justifying the critical nature of domain #7.

A critical step in conducting a systematic review is to assess the risk of bias in the included studies, that is, the likelihood of overestimating or underestimating the true effect of the intervention. Deficiencies in the conduct of health intervention studies raise concerns about the internal validity of their results. This assessment is particularly important when the systematic review includes non-randomized studies, which is common in the field of clinical pharmacy services. This reinforces the critical condition of domain #9. Furthermore, because the conclusions of a review are based on the results of the included studies, any bias in these results may lead to a misleading overall conclusion when the studies are combined. In accordance with domain #13, authors of systematic reviews should consider the potential effects of bias in the results of the included studies when interpreting their findings and making recommendations.[16,32]

The decision to conduct a meta-analysis of data from the included studies depends on the degree of compatibility (i.e., homogeneity) among these studies, considering factors such as participants, interventions, comparators, outcomes, and study design. In addition to assessing the plausibility of combining studies in a meta-analysis, the presence of heterogeneity must be investigated, and the results carefully considered. This is where AMSTAR 2 domain #11 becomes critical. Heterogeneity between studies may be particularly important in reviews of nonrandomized trials.[11] Clinical pharmacy services are complex health care interventions with multiple interacting components.[33] As a result, the literature often shows high variability in reporting the effects of pharmacy interventions, which will result in high heterogeneity SRMAs.[34–36]

The coverage of pharmacy practice journals among bibliographic databases has been reported to be poor.[37] Thus, the assessment of publication bias is particularly important in SRMAs conducted after systematic searches in these databases, as recommended by AMSTAR-2 domain #15. In addition, authors must conduct thorough literature searches, including manual searches and the review of grey literature.

It appears that all critical domains defined in AMSTAR-2 are considered essential in the field of pharmacy practice. Although the AMSTAR-2 development team advised reviewers to include additional critical domains as needed, in our study this would only worsen the results and likely increase the percentage of critically low quality SRMAs to over 90 %.

SRMAs are the studies providing the highest level of evidence and should guide practice guidelines.[38] But their reliability is highly dependent on the methodological quality they were conducted. A robust SRMA should first identify any methodologically weak primary study, and then compensate the potential biases with other included studies. However, a methodologically weak SRMA will produce unreliable results, which will not be mitigated with any subsequent technique. Obviously, ensuring the quality of a SRMA is first a responsibility of its authors. But in a peer review scholarly publication system, peer reviewers and journal editors have also a role in ensuring the quality of the articles they publish, including the SRMAs. Among the initiatives promoting the quality of publications, especially in pharmacy practice research,[39,40] the International Collaboration of Pharmacy Journal Editors (ICPJE),[41] created the Granada Statements with the aim of discussing "how journals could contribute to strengthening pharmacy practice as a discipline".[42,43] Some studies have already been published by signatories of this initiative.[44,45] A potential future goal of the ICPJE could be producing conduct and reporting checklists or adapting the existing ones to pharmacy practice field.

5.1. Limitations

The present study may have some limitations. Publication year, and not submission date or last searches update (not always available in the published articles), was used for the analysis of potential influences of reporting and conducting guidelines. This may have an impact on the evaluation of changes in methodological quality over time. Other evidence synthesis exercises, conducted without meta-analysis, exist to evaluate pharmacy services. These could also be evaluated with AMSTAR-2, but with several domains classified as non-applicable. For this reason, but also because of the greater conclusiveness of SRMA, systematic reviews without meta-analyses were not included in this study.

6. Conclusion

Most SRMAs of clinical pharmacy services were classified as of low or critically low quality. Modification of the domain criticality did not improve the results of this quality assessment. Efforts should be made, not only by pharmacy practice researchers, but also by pharmacy practice journal editors and peer reviewers to improve the quality of SRMAs as crucial pieces of evidence of pharmaceutical services.

CRediT authorship contribution statement

Inajara Rotta: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Joyce A. Diniz:** Writing – review & editing, Data curation. **Fernando Fernandez-Llimos:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization.

Funding

No external funding existed for the study. Open access fees funded by Fundação para a Ciência e a Tecnologia (FCT).

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Fernando Fernandez-Llimos reports was provided by University of Porto. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sapharm.2024.11.002.

References

1. Lau J, Ioannidis JP, Schmid CH. Summing up evidence: one answer is not always enough. *Lancet.* 1998;351(9096):123–127. https://doi.org/10.1016/S0140-6736(97)08468-7.
2. Banzi R, Cinquini M, Gonzalez-Lorenzo M, Pecoraro V, Capobussi M, Minozzi S. Quality assessment versus risk of bias in systematic reviews: AMSTAR and ROBIS had similar reliability but differed in their construct and applicability. *J Clin Epidemiol.* 2018;99:24–32. https://doi.org/10.1016/j.jclinepi.2018.02.024.
3. Bühn S, Mathes T, Prengel P, et al. The risk of bias in systematic reviews tool showed fair reliability and good construct validity. *J Clin Epidemiol.* 2017;91:121–128. https://doi.org/10.1016/j.jclinepi.2017.06.019.
4. Ioannidis JP. The mass production of redundant, misleading, and conflicted systematic reviews and meta-analyses. *Milbank Q.* 2016;94(3):485–514. https://doi.org/10.1111/1468-0009.12210.
5. Page MJ, Shamseer L, Altman DG, et al. Epidemiology and reporting characteristics of systematic reviews of biomedical research: a cross-sectional study. *PLoS Med.* 2016;13(5), e1002028. https://doi.org/10.1371/journal.pmed.1002028.
6. Abbott R, Bethel A, Rogers M, et al. Characteristics, quality and volume of the first 5 months of the COVID-19 evidence synthesis infodemic: a meta-research study. *BMJ*

Evid Based Med. 2022;27(3):169–177. https://doi.org/10.1136/bmjebm-2021-111710.
7. Melchiors AC, Correr CJ, Venson R, Pontarolo R. An analysis of quality of systematic reviews on pharmacist health interventions. *Int J Clin Pharm*. 2012;34(1):32–42. https://doi.org/10.1007/s11096-011-9592-0.
8. Aguiar PM, Brito GS, Correr CJ, Lyra Júnior DP, Storpirtis S. Exploring the quality of systematic reviews on pharmacist interventions in patients with diabetes: an overview. *Ann Pharmacother*. 2014;48(7):887–896. https://doi.org/10.1177/1060028014529411.
9. Bonetti AF, Tonin FS, Della Rocca AM, Lucchetta RC, Fernandez-Llimos F, Pontarolo R. Methodological quality and risk of bias of meta-analyses of pharmacy services: a systematic review. *Res Soc Adm Pharm*. 2022;18(3):2403–2409. https://doi.org/10.1016/j.sapharm.2020.12.011.
10. MacLure K, Paudyal V, Stewart D. Reviewing the literature, how systematic is systematic? *Int J Clin Pharm*. 2016;38(3):685–694. https://doi.org/10.1007/s11096-016-0288-3.
11. Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J. Amstar 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. *BMJ*. 2017;358, j4008. https://doi.org/10.1136/bmj.j4008.
12. Lee S. What tool do undergraduate pharmacy students prefer when grading systematic review evidence: AMSTAR-2 or ROBIS? *Cochrane Evidence Synthesis and Methods*. 2023;1(6):1–9. https://doi.org/10.1002/cesm.12023.
13. Kung J, Chiappelli F, Cajulis OO, et al. From systematic reviews to clinical recommendations for evidence-based health care: validation of revised assessment of multiple systematic reviews (R-AMSTAR) for grading of clinical relevance. *Open Dent J*. 2010;4(84-91). https://doi.org/10.2174/1874210601004020084.
14. Bojcic R, Todoric M, Puljak L. Adopting AMSTAR 2 critical appraisal tool for systematic reviews: speed of the tool uptake and barriers for its adoption. *BMC Med Res Methodol*. 2022;22(1):104. https://doi.org/10.1186/s12874-022-01592-y.
15. Whiting P, Savović J, Higgins JPT, et al. ROBIS: a new tool to assess risk of bias in systematic reviews was developed. *J Clin Epidemiol*. 2016;69, 225234. https://doi.org/10.1016/j.jclinepi.2015.06.005.
16. Higgins JPT, Thomas J, Chandler J, et al., eds. *Cochrane Handbook for Systematic Reviews of Interventions*. Cochrane; 2023. Available in: version 6.4. www.training.cochrane.org/handbook.
17. Page MJ, Mckenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372, n71. https://doi.org/10.1136/bmj.n71.
18. Tonin FS, Gmünder V, Bonneti AF, Mendes AM, Fernandez-Llimos F. Use of 'pharmaceutical services' medical subject headings (MeSH) in articles assessing pharmacists' interventions. *Explor Res Clin Soc Pharm*. 2022;7, 100172. https://doi.org/10.1016/j.rcsop.2022.100172.
19. Shea BJ, Grimshaw JM, Wells GA, Boers M, Andersson N, Hamel C. Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. *BMC Med Res Methodol*. 2007;7(10):1–7. https://doi.org/10.1186/1471-2288-7-10.
20. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339, b2700. https://doi.org/10.1136/bmj.b2700.
21. Page MJ, Shamseer L, Tricco AC. Registration of systematic reviews in PROSPERO: 30,000 records and counting. *Syst Rev*. 2018;7(1):32. https://doi.org/10.1186/s13643-018-0699-4.
22. Sabater-Hernández D, Sabater-Galindo M, Fernandez-Llimos F, et al. A systematic review of evidence-based community pharmacy services aimed at the prevention of cardiovascular disease. *J Manag Care Spec Pharm*. 2016;22(6):699–713. https://doi.org/10.18553/jmcp.2016.22.6.699.
23. Rotta I, Souza TT, Salgado TM, Correr CJ, Fernandez-Llimos F. Characterization of published randomized controlled trials assessing clinical pharmacy services around the world. *Res Soc Adm Pharm*. 2017;13(1):201–208. https://doi.org/10.1016/j.sapharm.2016.01.003.
24. Tonin FS, Lopes LA, Rotta I, et al. Usability and sensitivity of the risk of bias assessment tool for randomized controlled trials of pharmacist interventions. *Int J Clin Pharm*. 2019;41(3):785–792. https://doi.org/10.1007/s11096-019-00818-2.
25. Bonetti AF, Della Rocca AM, Lucchetta RC, Tonin FS, Fernandez-Llimos F, Pontarolo R. Mapping the characteristics of meta-analyses of pharmacy services: a systematic review. *Int J Clin Pharm*. 2020;42(5):1252–1260. https://doi.org/10.1007/s11096-020-01058-5.
26. Bonetti AF, Tonin FS, Lucchetta RC, Tonin FS, Pontarolo R, Fernandez-Llimos F. Methodological standards for conducting and reporting meta-analyses: ensuring the replicability of meta-analyses of pharmacist-led medication review. *Res Soc Adm Pharm*. 2022;18(2):2259–2268. https://doi.org/10.1016/j.sapharm.2021.06.002.
27. Moore RA, Fisher E, Eccleston C. Systematic reviews do not (yet) represent the 'gold standard' of evidence: a position paper. *Eur J Pain*. 2022;26(3):557–566. https://doi.org/10.1002/ejp.1905.
28. Canestaro WJ, Hendrix N, Bansal A, Sullivan SD, Devine EB, Carlson JJ. Favorable and publicly funded studies are more likely to be published: a systematic review and meta-analysis. *J Clin Epidemiol*. 2017;92:58–68. https://doi.org/10.1016/j.jclinepi.2017.08.004.
29. Gazendam AM, Slawaska-Eng D, Nucci N, Bhatt O, Ghert M. The impact of industry funding on randomized controlled trials of biologic therapies. *Medicines (Basel)*. 2022;9(3):18. https://doi.org/10.3390/medicines9030018.
30. Faggion CM. Methodological quality, risk of bias, and reporting quality: a confusion persists. *J Evid Base Med*. 2023;16(3):261–263. https://doi.org/10.1111/jebm.12550.
31. Fernandez-Llimos F, Desselle S, Stewart D, et al. Improving the quality of publications in and advancing the paradigms of clinical and social pharmacy practice research: the Granada statements. *Res Soc Adm Pharm*. 2023;19(5):830–835. https://doi.org/10.1016/j.sapharm.2023.01.007.
32. Kolaski K, Logan LR, Ioannidis JPA. Guidance to best tools and practices for systematic reviews. *Br J Pharmacol*. 2024;181(1):180–210. https://doi.org/10.1111/bph.16100.
33. Rotta I, Salgado TM, Feliz DC, Souza TT, Correr CJ, Fernandez-Llimos F. Ensuring consistent reporting of clinical pharmacy services to enhance reproducibility in practice: an improved version of DEPICT. *J Eval Clin Pract*. 2015;21(4):584–590. https://doi.org/10.1111/jep.12339.
34. Santschi V, Chiolero A, Burnan B, Colosimo AL, Paradis G. Impact of pharmacist care in the management of cardiovascular disease risk factors: a systematic review and meta-analysis of randomized trials. *Arch Intern Med*. 2011;171(16):1441–1453. https://doi.org/10.1001/archinternmed.2011.399.
35. Lambert M, Smit CCH, De Vos S, et al. A systematic literature review and meta-analysis of community pharmacist-led interventions to optimise the use of antibiotics. *Br J Clin Pharmacol*. 2022;88(6):2617–2641. https://doi.org/10.1111/bcp.15254. Epub 2022 Feb 28.
36. Kelly WN, Ho M-J, Smith T, Buller K, Kumar A. Association of pharmacist intervention counseling with medication adherence and quality of life: a systematic review and meta-analysis of randomized trials. *J Am Pharm Assoc JAPhA*. 2023;63(4):1095–1105. https://doi.org/10.1016/j.japh.2023.04.024 (2003).
37. Mendes AM, Tonin FS, Buzzi MF, Pontarolo R, Fernandez-Llimos F. Mapping pharmacy journals: a lexicographic analysis. *Res Soc Adm Pharm*. 2019;15(12):1464–1471. https://doi.org/10.1016/j.sapharm.2019.01.011.
38. Paudyal V, Okuyan B, Henman MC, et al. Scope, content and quality of clinical pharmacy practice guidelines: a systematic review. *Int J Clin Pharm*. 2024;46(1):56–69. https://doi.org/10.1007/s11096-023-01658-x.
39. Harpe SE. Rising to the challenge: advancing the profession through science and research. *J Am Pharm Assoc JAPhA*. 2023;63(2):456–458. https://doi.org/10.1016/j.japh.2023.02.011 (2003).
40. Wirth F, Cadogan CA, Fialová D, et al. Writing a manuscript for publication in a peer-reviewed scientific journal: guidance from the European Society of Clinical Pharmacy. *Int J Clin Pharm*. 2024;46(2):548–554. https://doi.org/10.1007/s11096-023-01695-6.
41. Alves da Costa F, Fernandez-Llimos F, Desselle S, Arnet I, Babar Z, Bond C, et al. The International Collaboration of Pharmacy Journal Editors (ICPJE) formally constituted to foster quality around clinical and social pharmacy practice research publications. Res Soc Adm Pharm. https://doi.org/10.1016/j.sapharm.2024.10.001.
42. Fernandez-Llimos F, Desselle S, Stewart D, et al. Improving the quality of publications in and advancing the paradigms of clinical and social pharmacy practice research: the Granada statements. *Rev Bras Farm Hosp Serv Saude*. 2023;14(1):913. https://doi.org/10.30968/rbfhss.2023.141.0913.
43. Desselle SP. Pharmacy practice and social pharmacy forging ahead. *Res Soc Adm Pharm*. 2024;20(4):377–378. https://doi.org/10.1016/j.sapharm.2024.01.007.
44. Shcherbakova N, Desselle S, Bandiera C, Canedo J, Law AV, Aslani P. Drivers of citations in social pharmacy and practice research articles. *Res Soc Adm Pharm*. 2024;20(7):590–596. https://doi.org/10.1016/j.sapharm.2024.03.004.
45. Fernandez-Llimos F, Negrão LG, Bond C, Stewart D. Influence of automated indexing in Medical Subject Headings (MeSH) selection for pharmacy practice journals. *Res Soc Adm Pharm*. 2024;20(9):911–917. https://doi.org/10.1016/j.sapharm.2024.06.003.